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This document has been prepared for **Aurecon Group Pty Ltd on behalf of NEXTDC Ltd** by:

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Horsley Park Data Centre (S4)

Air Quality Impact Assessment

Addressee(s):	Aurecon Group Pty Ltd on behalf of NEXTDC Ltd
Site Address:	16 Johnston Crescent, Horsley Park NSW
Report Reference:	24.1064.FR3V1
Date:	5 June 2024
Status:	Final

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Quality Control

Study	Version	Status	Prepared by	Reviewed by	Authorised by
Horsley Park Data Centre (S4) - Air Quality Impact Assessment	24.1064.FR3V1	Final	Northstar	GCG, AS, JVZ	GCG

Report Status

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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. A draft report is provided on a 'without prejudice' basis and may be subject to change.

M Doyle **5 June 2024**

Non-Technical Summary

Northstar Air Quality Pty Ltd was engaged by Aurecon Group Pty Ltd on behalf of NEXTDC Limited to perform an air quality impact assessment for the proposed construction and operation of a data centre, to be located at 16 Johnston Crescent, Horsley Park, NSW. The assessment has considered the potential impacts on air quality associated with the construction and operation of the data centre.

During the construction phase, the potential dust soiling and human health risks are assessed as being manageable through appropriate implementation of the recommended mitigation measures.

Under the justified worst-case emergency back-up generator operational scenario with all generators operating at the same time at full (100 %) load, for three Stages of operation, a number of additional exceedances of the air quality criteria for a number of pollutants are predicted. With reference to published power supply reliability statistics, the probability of both the interruption to the power supply, the dual redundant power supply, and an exceedance of the relevant air quality criteria occurring was calculated through the multiplication of the probability of each event occurring, with values indicating the chance of an additional exceedance of the air quality criteria during a power outage is low.

Predicted incremental concentrations for a realistic emissions scenario during routine maintenance of the back-up generators during each of three Stages of operation show that no exceedances are predicted to occur at any surrounding receptors for all assessed pollutants. The predicted incremental concentrations for all assessed pollutants are shown to be below the relevant criteria under realistic operations where the emergency generators are appropriately operated under the testing schedule.

Nonetheless, a number of additional mitigation measures considered to be Best Available Technology have been reviewed to provide context for how air quality impacts may be further reduced.

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TABLES

1. INTRODUCTION

Aurecon Group Pty Ltd (Aurecon) has commissioned Northstar Air Quality Pty Ltd (Northstar) on behalf of NEXTDC Limited (the Proponent) to perform an air quality impact assessment (AQIA) to accompany a detailed State Significant Development Application (SSDA) for the S4 data centre development (the Proposal) at 16 Johnston Crescent, Horsley Park (the Proposal site). The site is legally described as Lot 305 in Deposited Plan (DP) 1275011.

The AQIA has been performed in accordance with the NSW Environment Protection Authority (NSW EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (the Approved Methods) (NSW EPA, 2022).

This AQIA identifies and examines potential air quality (including odour impacts) associated with the Proposal, in accordance with the NSW Planning Secretary's Environmental Assessment Requirements (SEARs) and identifies mitigation and monitoring requirements commensurate with those anticipated impacts.

1.1. Secretary Environmental Assessment Requirements

The report has been prepared in response to the requirements contained within the NSW Planning Secretary's Environmental Assessment Requirements (SEARs) dated 27 October 2023, issued for the SSDA (SSD-63741210).

Specifically, this report has been prepared to response to the SEARs requirements as outlined in Table 1 below.

Table 1 Secretary's Environmental Assessment Requirements – SSD-63741210

Issue	Requirements	Addressed
Air Quality	Provide an assessment of air quality impacts, prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.	Section 3 Section 6 Section 7
	The assessment must address construction works …	Section 5.1 Section 6
	… and include modelling of emissions and air pollutants from predicted operations (including testing of the back-up power system) …	Section 5.2 Section 7.1.2 Section 7.2.2 Section 7.3.2
	… and a peak emission and air pollutant scenario …	Section 5.2 Section 7.1.1 Section 7.2.1 Section 7.3.1
	… and outline the proposed mitigation, management and monitoring measures that would be implemented.	Section 8.2.3 Section 8.2.4 Appendix D

1.2. Purpose of the Report

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

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

- *Protection of the Environment Operations Act* 1997;
- Protection of the Environment Operations (Clean Air) Regulation 2022;
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2022); and
- Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2024).

2. THE PROPOSAL

2.1. Environmental Setting

The Proposal site is situated at 16 Johnson Crescent, Horsley Park, within the City of Fairfield Local Government Area (LGA). The Proposal site occupies Lot 305 in DP 1275011 which is zoned for industrial purposes and is approximately 8.206 hectares (ha) in area. The Proposal site comprises vacant land which has been cleared of vegetation and does not contain any existing built form structures.

It is noted that the Proposal site is located within a developing employment precinct, including the ESR Horsley Logistics Park, Oakdale Central, Oakdale South and Horsley Park Employment Precinct.

A map showing the site location if provided in Figure 1.

2.2. Proposal Overview

The application seeks consent for construction and operation of a data centre development and includes site preparation works, bulk earthworks and infrastructure, and construction of the buildings, ancillary facilities, and associated site works.

Specifically, the Proposal comprises the redevelopment of the site as summarised below:

- Site preparation works including earthworks, excavation and retaining walls;
- Construction and operation of a data centre development comprising five (5) buildings;
- Vehicle access via Johnstone Crescent; and
- On-site car parking and loading within at-grade hardstand areas.

Important: During a power outage event (see Section 8.2 for details), a dual redundant power supply will be used. If one power feeder fails, the second will fully back up the site. If both feeders fail, the site will use backup generators, effectively serving as a back-up to the back-up:

- Primary site power provision: primary power supply;
- Secondary site power provision: dual redundant power supply; and
- Tertiary site power provision: back-up generators.

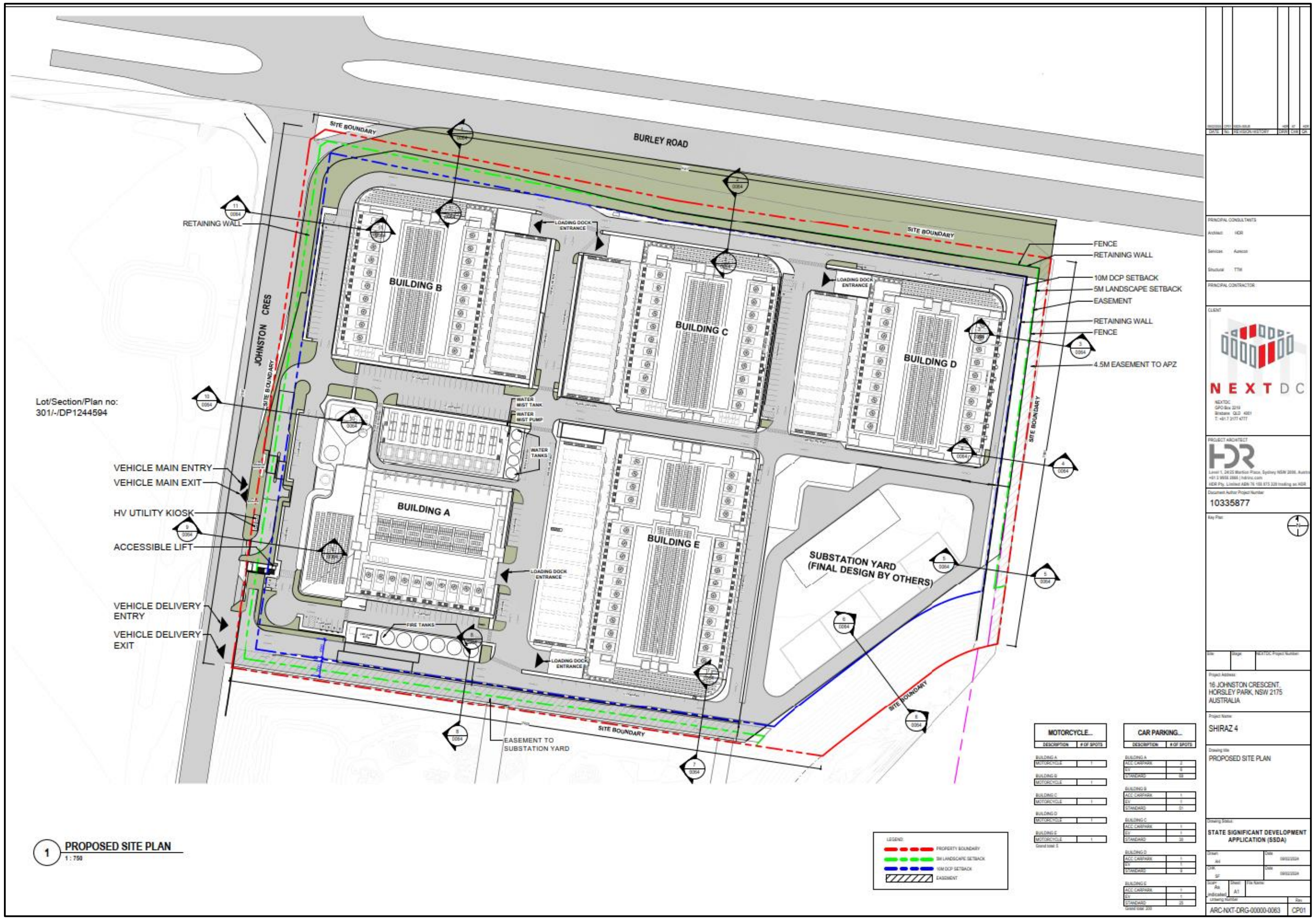
As such the anticipated utilisation of the back-up generators is correspondingly low.

Figure 2 provides an illustration of the Proposal site layout.

Figure 1 Proposal site location

Source: Northstar

Figure 2 Proposal site layout



Source: HDR

Standby power will be provided by a total of 98 (98 no.) containerised diesel-powered back-up generators (including redundancy).

The Proposal would be constructed and operated in three stages, as outlined below (refer Figure 2):

- Stage 1: Buildings A, B, C, and the substation;
- Stage 2: Stage 1 plus Building D; and
- Stage 3: Stage 2 plus Building E.

The construction phase assessment has been performed assuming that all buildings at the Proposal site would be constructed concurrently. Although conservative, this provides the greatest potential impact magnitude associated with those works, and the determined emission control measures would be at their maximum level required. Adoption of those emission control measures throughout all three stages of construction would ensure that any impacts associated with construction dust would be minimised. Refer to Section 5.1 for the construction phase risk assessment methodology, and Section 6 for the results of that assessment.

Each stage of the operational phase has been assessed discretely. Refer to Section 2.3.1 for a detailed description of the potential air emissions at each stage, Section 5.2.2 for descriptions of the operational scenarios assessed, and Section 7 for the assessment results.

2.3. Identification of Emissions to Atmosphere

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

2.3.1. Construction Phase

Construction of the Proposal would involve bulk earthworks, construction of the data centre development, car parking, associated infrastructure, site access points and landscaping. It is noted that no demolition works are proposed.

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

- Excavators;
- Front end loaders;
- Graders;
- Light vehicles;
- Heavy vehicles;
- Drills;
- Pneumatic hand or power tools;
- Cranes;

- Commercial vans; and
- Cherry pickers.

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

2.3.2. Operational Phase

Operational emissions from the data centre on a day-to-day basis would be anticipated to be negligible, with the exception of potential emissions from diesel-fuelled back-up generators during periodic maintenance testing or during a power outage event.

The Proposal is anticipated to install the following units:

Stage 1:

- 10 no. MTU model 16V 4000 G84F diesel-fuelled generators each with a capacity of 2 megawatts (MW) and a fuel consumption rate at 100 % load of 513.3 litres per hour ($L{\cdot}hr^{-1}$), all in Building A; and,
- 40 no. MTU model 20V 4000 G94LF diesel-fuelled generators each with a capacity of 3 MW and a fuel consumption rate at 100 % load of 806 $L{\cdot}hr^{-1}$, 20 no. in Building B, and 20 no. in Building C.

Stage 2 – as above plus:

- 20 no. MTU model 20V 4000 G94LF diesel-fuelled generators each with a capacity of 3 MW and a fuel consumption rate at 100 % load of 806 $L{\cdot}hr^{-1}$, all in Building D.

Stage 3 – as above plus:

- 28 no. MTU model 20V 4000 G94LF diesel-fuelled generators each with a capacity of 3 MW and a fuel consumption rate at 100 % load of 806 $L{\cdot}hr^{-1}$, all in Building E.

During a power outage, the first back up (or remediation) is that the dual redundant power supply. If this also suffers a failure, the second back up is to utilise the generators to power the site. Essentially, the back-up generators serve as a back-up to the primary provision of a dual redundant power supply, and as such their anticipated use is anticipated to be minimal.

During periods when the back-up generators may be required short-term emissions of combustion related pollutants may be generated. The pollutants of concern from the operation of the back-up generators includes (in no order):

- Particulate matter (PM);

- Oxides of nitrogen (NO_X);
- Carbon monoxide (CO);
- Sulfur dioxide (SO_2);
- Polycyclic aromatic hydrocarbons (PAHs);
- Volatile organic compounds (VOCs), assessed as benzene (C_6H_6), toluene (C_7H_8) and xylene (C_8H_{10}); and,
- Formaldehyde (CH_2O).

The anticipated maintenance testing schedule for each of stage of operation has been provided by the Proponent and is outlined overleaf in Table 2 for Stage 1, Table 3 for Stage 2, and Table 4 for Stage 3. Additional information provided by the Proponent indicates that maintenance testing would be performed between 7:00 am and 6:00 pm Monday to Saturday and 8:00 am to 6:00 pm on Sundays.

2.3.3. Odour

Construction phase activities may include the operation of plant and machinery, that may pose an insignificant risk of odour in the event of accidental fuel spillage, however this risk is very minor and can be effectively managed through the provision of spill kits to promptly manage any spillages.

Operational phase activities will not result in any air emissions, with the exception of the periodic operation of the diesel-fuelled generators for testing and tertiary back-up power generation purposes only, as outlined above. Air emissions of VOCs has been assessed as benzene (C_6H_6) as a principal toxic air pollutant, and additionally compared against the odour impact assessment criterion for toluene (C_7H_8) and xylene (C_8H_{10}).

Table 2 Back-up generator maintenance testing schedule – Stage 1 operation

Quarter	Duration (Minute)		Building A Gen Testing			Building B-E Gen Testing			Total Number of Tests	Total Gens Tested	Total Mins
	Run	Cooldown (excluded from runtime)	Number of Generators	Gens run per test	Number of Tests	Number of Generators	Gens run per test	Number of Tests			
1	20	10	10	1	10	40	2	20	30	50	600
2	40	10	10	1	10	40	2	20	30	50	1 200
3	20	10	10	1	10	40	2	20	30	50	600
4	90	10	10	1	10	40	2	20	30	50	2 700
										Total Minutes per Year	5 100
										Total Hours per Year	85

Table 3 Back-up generator maintenance testing schedule – Stage 2 operation

Quarter	Duration (Minute)		Building A Gen Testing			Building B-E Gen Testing			Total Number of Tests	Total Gens Tested	Total Mins
	Run	Cooldown (excluded from runtime)	Number of Generators	Gens run per test	Number of Tests	Number of Generators	Gens run per test	Number of Tests			
1	20	10	10	1	10	60	2	30	40	70	800
2	40	10	10	1	10	60	2	30	40	70	1 600
3	20	10	10	1	10	60	2	30	40	70	800
4	90	10	10	1	10	60	2	30	40	70	3 600
										Total Minutes per Year	6 800
										Total Hours per Year	113

Table 4 Back-up generator maintenance testing schedule – Stage 3 operation

Quarter	Duration (Minute)		Building A Gen Testing			Building B-E Gen Testing			Total Number of Tests	Total Gens Tested	Total Mins
	Run	Cooldown (excluded from runtime)	Number of Generators	Gens run per test	Number of Tests	Number of Generators	Gens run per test	Number of Tests			
1	20	10	10	1	10	88	2	44	54	98	1 080
2	40	10	10	1	10	88	2	44	54	98	2 160
3	20	10	10	1	10	88	2	44	54	98	1 080
4	90	10	10	1	10	88	2	44	54	98	4 860
										Total Minutes per Year	9 180
										Total Hours per Year	153

3. LEGISLATION, REGULATION AND GUIDANCE

3.1. Protection of the Environment Act

The *Protection of the Environment Operations Act* 1997 (POEO Act) sets the statutory framework for managing air quality in NSW, including establishing the licensing scheme for major industrial premises (scheduled activities) and a range of air pollution offences and penalties.

Schedule 1, Part 1 of the POEO Act provides definitions for scheduled activities, and the associated threshold activity rates. For the Proposal, the thresholds relevant to electricity generation are most relevant, given the use of emergency diesel-fuelled generators at the Proposal site:

> *17 Electricity generation*
>
> *(1) This clause applies to the following activities:*
>
> *…*
>
> *metropolitan electricity works (internal combustion engines), meaning the generation of electricity by means of electricity plant:*
>
> *(a) that is based on, or uses, an internal combustion engine, and*
>
> *(b) that is situated in the metropolitan area or in the local government area of Port Stephens, Maitland, Cessnock, Singleton, Wollondilly, or Kiama.*
>
> *(1A) However, this clause does not apply to the generation of electricity by means of electricity plant that is emergency stand-by plant operating for less than 200 hours per year.*
>
> *(2) Each activity referred to in Column 1 of the Table to this clause is declared to be a scheduled activity if it meets the criteria set out in Column 2 of that Table.*

During times of stable external supply of electricity, the standby generators will only operate during scheduled maintenance events. On this basis, the Proposal is highly unlikely to exceed the 200-hour limit, on the generation of electricity by means of electricity plant that is emergency stand-by plant and is not deemed to be a scheduled activity under the POEO Act.

Part 5.4 of the POEO Act outlines a number of requirements associated with air pollution. These requirements generally relate to the appropriate maintenance of plant and equipment in an efficient condition and dealing with materials in a manner as to not cause air pollution.

3.2. Protection of the Environment Operations (Clean Air) Regulation

The Protection of the Environment Operations (POEO) (Clean Air) Regulation 2022 (POEO CAR) sets requirements and standards of concentration for emissions to air for industrial activities within NSW.

Clause 73, Part 5, Division 6 of the POEO CAR provides the following in regard to the regulation of emissions from emergency electricity generation:

> *73 Exemption relating to emergency electricity generation*
>
> *Emergency standby plant is exempt from the air impurities standard for nitrogen dioxide and nitric oxide specified in Schedule 2, Part 2, Division 3 for the plant if –*
>
> *(a) the plant comprises a stationary reciprocating internal combustion engine for generating electricity, and*
>
> *(b) it is used for a total of not more than 200 hours per year.*

Schedule 2, Part 3 of the POEO CAR sets out emission limits relevant to unscheduled activities (including emergency and standby electricity generators), being solid particles at an emission limit concentration of 100 mg·Nm^{-3} and an opacity limit of 20 %.

Although the operations may be exempt from the relevant emission limit regulations (i.e. in-stack emission concentrations), the Proponent would not be exempt from ensuring the emissions do not exceed ambient air quality criteria, which are discussed in Section 3.3.

3.3. NSW Approved Methods

State air quality guidelines adopted by the NSW EPA are published in the Approved Methods (NSW EPA, 2022) which has been consulted during the preparation of this AQIA.

The Approved Methods lists the statutory methods that are to be used to assess emissions of criteria air pollutants in NSW. Section 7.1 and Section 7.2 of the Approved Methods clearly outlines the impact assessment criteria for those key pollutants of interest and both individual and principal toxic air pollutants. Principal toxic air pollutants are defined in the Approved Methods (NSW EPA, 2022) on the basis that they are carcinogenic, mutagenic, highly persistent, or highly toxic in the environment.

The criteria listed in the Approved Methods (NSW EPA, 2022) are derived from a range of sources (including National Health and Medical Research Council [NHMRC], National Environment Protection Council [NEPC], and World Health Organisation [WHO]).

The criteria specified in the Approved Methods (NSW EPA, 2022) are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW for relevant individual air pollutants are presented in Table 5.

To assess the potential impact of emissions of Total Volatile Organic Compounds (VOC) (which is a complex mixture of hydrocarbons), the 1-hour impact assessment criterion for benzene (C_6H_6) of 0.029 mg·m^{-3} (29 µg·m^{-3}) as outlined in table 12 of the Approved Methods has been adopted. Benzene is one of the primary components of TVOC emissions resulting from diesel combustion engines and correspondingly, compliance with the benzene criterion (refer Table 5) would generally result in compliance with all VOC components from a health-perspective. Formaldehyde (CH_2O) is assessed as a discrete VOC.

VOC emissions have additionally been assessed against the 1-hour odour impact assessment criteria for toluene of 0.36 mg·m^{-3} (360 µg·m^{-3}) and xylene of 0.19 mg·m^{-3} (190 µg m^{-3}) to address odour.

Table 5 NSW EPA impact assessment criteria

<table>
<tr><th rowspan="2">Pollutant</th><th rowspan="2">Averaging period</th><th colspan="2">Criterion</th><th rowspan="2">Notes</th></tr>
<tr><th colspan="2">µg·m^{-3} (a)</th></tr>
<tr><td rowspan="2">Nitrogen dioxide (NO_2)</td><td>1 hour</td><td colspan="2">164</td><td rowspan="6">Numerically equivalent to the AAQ NEPM (b) standards and goals</td></tr>
<tr><td>Annual</td><td colspan="2">31</td></tr>
<tr><td rowspan="2">Particulates (as PM_{10})</td><td>24 hours</td><td colspan="2">50</td></tr>
<tr><td>Annual</td><td colspan="2">25</td></tr>
<tr><td rowspan="2">Particulates (as $PM_{2.5}$)</td><td>24 hours</td><td colspan="2">25</td></tr>
<tr><td>Annual</td><td colspan="2">8</td></tr>
<tr><td>Particulates (as TSP)</td><td>Annual</td><td colspan="2">90</td><td></td></tr>
<tr><td rowspan="3">Sulfur dioxide (SO_2)</td><td>1 hour</td><td colspan="2">286</td><td rowspan="3">Numerically equivalent to the AAQ NEPM (b) standards and goals</td></tr>
<tr><td>24 hours</td><td colspan="2">57</td></tr>
<tr><td>1 year (d)</td><td colspan="2">4</td></tr>
<tr><th rowspan="2">Pollutant</th><th rowspan="2">Averaging period</th><th colspan="2">Criterion</th><th rowspan="2">Notes</th></tr>
<tr><th>ppm (c)</th><th>mg·m^{-3} (d)</th></tr>
<tr><td rowspan="3">Carbon monoxide (CO)</td><td>15 minutes</td><td>87</td><td>100</td><td rowspan="3">Numerically equivalent to the AAQ NEPM(b) standards and goals</td></tr>
<tr><td>1 hour</td><td>25</td><td>30</td></tr>
<tr><td>8 hours</td><td>9</td><td>10</td></tr>
</table>

Notes: (a): micrograms per cubic metre of air
(b): National Environment Protection (Ambient Air Quality) Measure
(c): parts per million (10^6)
(d): milligrams per cubic metre of air

Table 6 below provides a summary of impact assessment criteria for principal toxic, and both individual odorous and toxic pollutants that are referenced within this AQIA, as outlined in Section 7.2 of (NSW EPA, 2022).

Table 6 NSW EPA impact assessment criteria for principal and individual toxic pollutants

Pollutant	Averaging period	Criterion		Notes
		ppm [(a)]	$mg \cdot m^{-3}$ [(b)]	
Polycyclic Aromatic Hydrocarbon (PAH) as benzo(a)pyrene	1 hour	N/A	0.0004	
Benzene	1 hour	0.009	0.029	
Ethylbenzene	1 hour	1.8	8.0	
Toluene	1 hour	0.06	0.36	Odour
Xylene	1 hour	0.04	0.19	Odour
Formaldehyde	1 hour	0.018	0.02	

Notes: (a): parts per million (10^6)

(b): milligrams per cubic metre of air

4. EXISTING CONDITIONS

4.1. Surrounding Land Sensitivity

The Proposal site is situated within an IN1 – General Industrial zone according to the Fairfield Local Environment Plan (LEP) 2013.

The land use surrounding the Proposal site contains a mix of RU4 – Primary Production Small Lots and C2 – Environmental Conservation land uses pursuant to the zoning provisions under the Fairfield LEP 2013.

The closest identified residence is noted to be located 26 m to the east of the Proposal site on Burley Road, Horsley Park.

4.2. Discrete Receptor Locations

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

It is noted that the assessment criteria applied to particulates and sulfur dioxide (SO_2) (see Table 5) are for 24-hour averaging periods, and as such the predicted impacts need to be interpreted at commercial and industrial receptor locations with care. It is considered to be atypical for a person to be at those locations for a complete 24-hour period and as such, the exposure risks at those locations would be over-estimated by adoption of those locations in the modelling assessment.

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

It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see Section 4.2.1) that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location that is sensitive to changes in air quality, does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

In accordance with the requirements of the Approved Methods (NSW EPA, 2022), several receptors have been identified and the receptors adopted for use within this AQIA are presented in Table 7. Note that the nomenclature has been adopted to be consistent with that adopted for the assessment of noise impacts. Additional receptors have also been identified and adopted in this AQIA. Table 7 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 7 Receptor locations used in the study

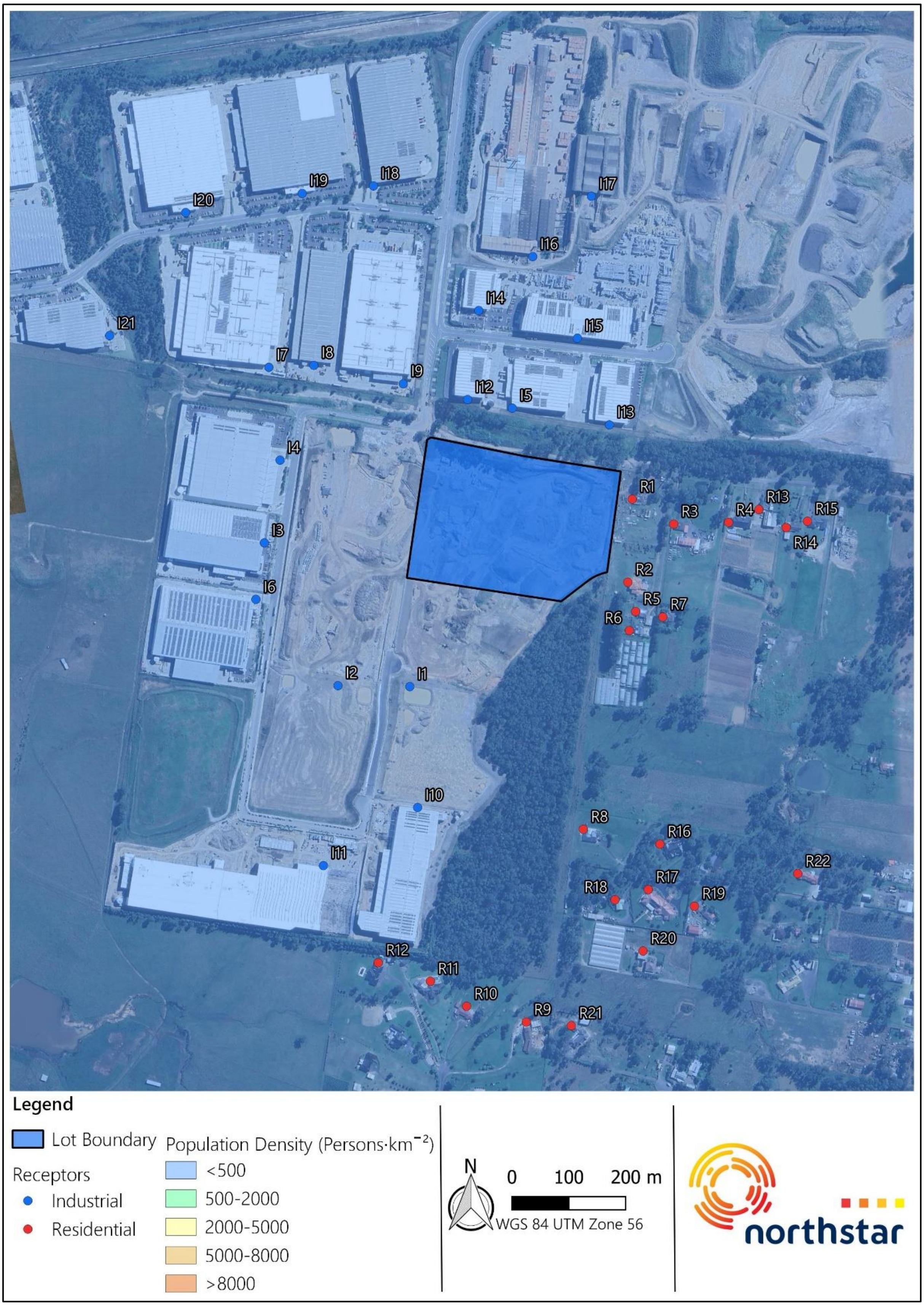
Receptor ID	Location	Land use	Coordinates (UTM)	
			mE	mS
R1	Burley Road, Horsley Park	Residential	299 114	6 254 701
R2	Burley Road, Horsley Park	Residential	299 106	6 254 554
R3	Burley Road, Horsley Park	Residential	299 187	6 254 657
R4	Burley Road, Horsley Park	Residential	299 283	6 254 660
R5	Burley Road, Horsley Park	Residential	299 120	6 254 503
R6	Burley Road, Horsley Park	Residential	299 109	6 254 470
R7	Burley Road, Horsley Park	Residential	299 168	6 254 493
R8	Delaware Road, Horsley Park	Residential	299 028	6 254 120
R9	Greenway Place, Horsley Park	Residential	298 928	6 253 781
R10	Greenway Place, Horsley Park	Residential	298 823	6 253 809
R11	Greenway Place, Horsley Park	Residential	298 759	6 253 853
R12	Greenway Place, Horsley Park	Residential	298 667	6 253 885
R13	Burley Road, Horsley Park	Residential	299 337	6 254 682
R14	Burley Road, Horsley Park	Residential	299 385	6 254 651
R15	Burley Road, Horsley Park	Residential	299 422	6 254 662
R16	Delaware Road, Horsley Park	Residential	299 163	6 254 094
R17	Delaware Road, Horsley Park	Residential	299 142	6 254 014
R18	Delaware Road, Horsley Park	Residential	299 084	6 253 996
R19	Delaware Road, Horsley Park	Residential	299 223	6 253 985
R20	Delaware Road, Horsley Park	Residential	299 133	6 253 906
R21	Delaware Road, Horsley Park	Residential	299 007	6 253 775
R22	Delaware Road, Horsley Park	Residential	299 405	6 254 042
I1	Johnston Crescent, Horsley Park	Industrial	298 723	6 254 371
I2	Johnston Crescent, Horsley Park	Industrial	298 596	6 254 373
I3	Johnston Crescent, Horsley Park	Industrial	298 467	6 254 624
I4	Johnston Crescent, Horsley Park	Industrial	298 495	6 254 769
I5	Old Wallgrove Road, Horsley Park	Industrial	298 903	6 254 861
I6	Johnston Crescent, Horsley Park	Industrial	298 452	6 254 524
I7	Burley Road, Horsley Park	Industrial	298 475	6 254 932
I8	Burley Road, Horsley Park	Industrial	298 554	6 254 936
I9	Burley Road, Horsley Park	Industrial	298 711	6 254 903

Receptor ID	Location	Land use	Coordinates (UTM)	
			mE	mS
I10	Johnston Crescent, Horsley Park	Industrial	298 736	6 254 158
I11	Johnston Crescent, Horsley Park	Industrial	298 571	6 254 056
I12	Old Wallgrove Road, Horsley Park	Industrial	298 824	6 254 876
I13	Old Wallgrove Road, Horsley Park	Industrial	299 074	6 254 831
I14	Old Wallgrove Road, Horsley Park	Industrial	298 844	6 255 032
I15	Old Wallgrove Road, Horsley Park	Industrial	299 017	6 254 983
I16	Old Wallgrove Road, Horsley Park	Industrial	298 939	6 255 127
I17	Old Wallgrove Road, Horsley Park	Industrial	299 042	6 255 233
I18	Millner Avenue, Horsley Park	Industrial	298 659	6 255 251
I19	Millner Avenue, Horsley Park	Industrial	298 534	6 255 238
I20	Millner Avenue, Horsley Park	Industrial	298 329	6 255 204
I21	Millner Avenue, Horsley Park	Industrial	298 195	6 254 988

4.2.1. Uniform Receptor Locations

Additional to the sensitive receptors identified in Section 4.2, a grid of uniform receptor locations has been used in the AQIA to allow presentation of contour plots of predicted impacts.

Figure 3 Sensitive receptors surrounding the Proposal site



Source: Northstar

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 surrounding Automatic Weather Stations (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

To characterise the meteorology at the Proposal site, a meteorological modelling exercise was conducted. A summary of the inputs and outputs, including validation of the results, is presented in Appendix B.

Three stations have been identified proximate to the Proposal site. A summary of the relevant AWS is provided in Table 8 below (listed by proximity).

Table 8 Details of meteorological monitoring surrounding the Proposal site

Site name	Station #	Source	Approximate location		Approximate distance (km)
			mE	mS	
Horsley Park Equestrian Centre AWS	067119	BoM	301 708	6 252 298	3.5
Badgerys Creek AWS	067108	BoM	289 920	6 246 951	11.6
Bankstown Airport AWS	066137	BoM	313 855	6 245 099	17.6

It is considered that data collected at Horsley Park Equestrian Centre AWS is most likely to represent the conditions at the Proposal site, based upon its proximity. The meteorological conditions measured at Horsley Park Equestrian Centre AWS for the period 2019 to 2023 (most recent five years of completed data) are presented in Appendix B.

The wind roses presented in Appendix B indicate that from 2019 to 2023, winds at Horsley Park Equestrian Centre AWS show similar wind distribution patterns across the years assessed, with a predominant south-westerly wind direction.

The majority of wind speeds experienced at Horsley Park Equestrian Centre AWS between 2019 and 2023 are generally in the range 0.5 meters 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 mostly north-westerly directions. Winds of this speed are rare and occur during 0.16 % of the observed hours during the years. Calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 20.3 % of hours on average across the years between 2019 and 2023.

4.4. Background Air Quality

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

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

Two AQMS have been identified within a 10 km radius of the Proposal site, operated by NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW). These locations (listed by proximity) are briefly summarised in Table 9.

Table 9 NSW DCCEEW AQMS within 10 km of the Proposal site

AQMS location	Distance to Proposal site (km)	2020 data	Measurements					
			PM_{10}	$PM_{2.5}$	TSP	NO_2	CO	SO_2
St Marys	6.5	✓	✓	✓	×	✓	×	×
Prospect	8.6	✓	✓	✓	×	✓	✓	✓

The closest representative AQMS with data available for the year 2020 (the selected representative year consistent with the meteorological modelling [refer Appendix B]) is noted to be located at St Marys. However, Table 9 indicates that concentrations of CO and SO_2 are not monitored at St Marys AQMS and correspondingly, air quality data from Prospect for the year 2020 have been adopted for use in this assessment.

Appendix C provides a detailed assessment of the background air quality monitoring data used in this AQIA.

It is noted that neither of the AQMS identified in Table 9 measure concentrations of TSP. This pollutant is of relevance to the expected emissions from the Proposal. Other sources of data have been adopted to allow representation of the TSP environment in the area surrounding the Proposal site, and a full discussion is provided in Appendix C.

It is noted that a number of AQMS in NSW metropolitan and regional population centres recorded particulate matter concentrations above the national standard on a number of days towards the start of 2020. This was mainly driven by intense drought conditions and a high frequency of bushfires occurring across NSW in early 2020 (NSW DPIE, 2021).

A summary of the air quality monitoring data and assumptions used to produce this AQIA are presented in Table 10. It is noted that although impacts of ozone (O_3) have not been considered in this assessment, O_3 data have been adopted to assist in calculating the conversion of NO_X to NO_2 for the dispersion modelling assessment (refer Section 5.2.5).

Table 10 Summary of background air quality data used in the AQIA

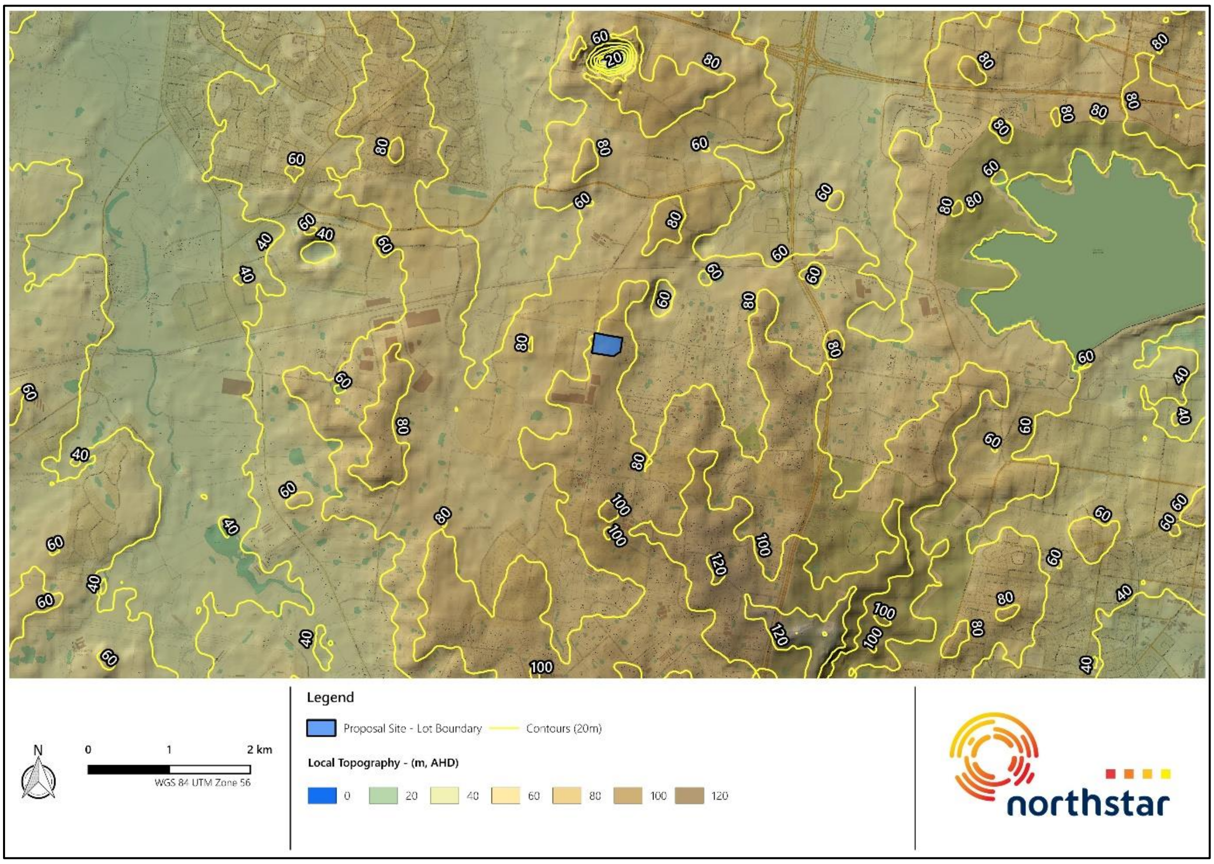
Pollutant	Averaging period	Units	Measured value	Notes
Particles (as TSP)	Annual	$\mu g \cdot m^{-3}$	41.4	Estimated on a TSP:PM_{10} ratio of 2.0551: 1
Particles (as PM_{10})	24-hour	$\mu g \cdot m^{-3}$	Daily varying	The 24-hour maximum PM_{10} concentration in 2020 was 245.8 $\mu g \cdot m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	20.2	
Particles (as $PM_{2.5}$)	24-hour	$\mu g \cdot m^{-3}$	Daily varying	The 24-hour maximum $PM_{2.5}$ concentration in 2020 was 114.8 $\mu g \cdot m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	8.6	
Nitrogen dioxide (NO_2)	1-hour	$\mu g \cdot m^{-3}$	80.8	Hourly maximum 1-hr average in 2020
	Annual	$\mu g \cdot m^{-3}$	13.8	Annual average in 2020
Carbon monoxide (CO)	15-minutes	$mg \cdot m^{-3}$	3.2	Calculated from 1-hr data as per Section 5.2.6
	1-hour	$mg \cdot m^{-3}$	2.4	Hourly maximum 1-hr average in 2020
	8-hour	$mg \cdot m^{-3}$	2.1	Maximum 8-hr average in 2020
Sulfur dioxide (SO_2)	1-hour	$\mu g \cdot m^{-3}$	47.2	Hourly maximum 1-hr average in 2020
	24-hour	$\mu g \cdot m^{-3}$	Daily varying	The 24-hour maximum SO_2 concentration in 2020 was 0.4 $\mu g \cdot m^{-3}$

Note: Reference should be made to Appendix C

4.5. Topography

The elevation of the Proposal site ranges between approximately 80 metres (m) and 100 m Australian Height Datum (AHD). The topography between the Proposal site and nearest sensitive receptor locations is uncomplicated (from an AQIA perspective). A representation of the topography surrounding the Proposal site is presented in Figure 4.

Figure 4 Topography surrounding the Proposal site



Source: Northstar

4.6. Potential for Cumulative Impacts

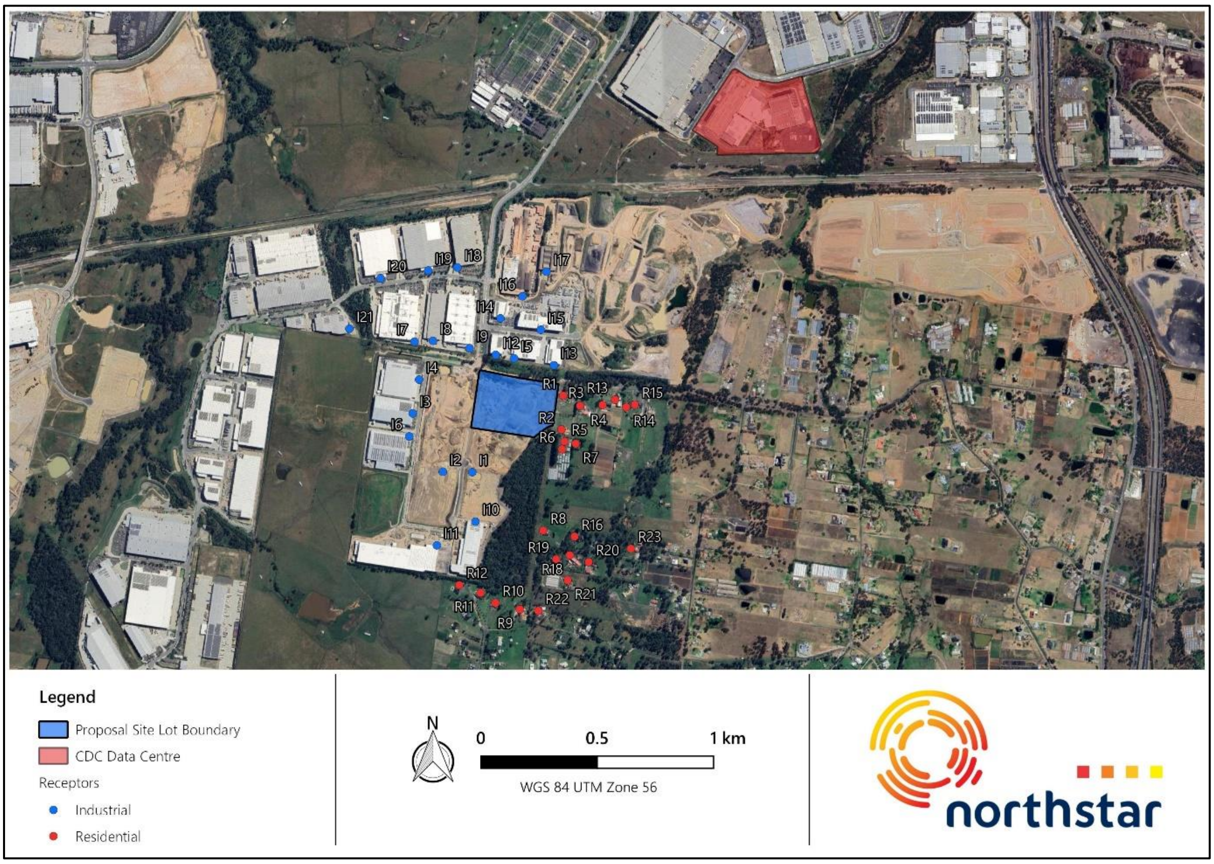
Cumulative impacts are required to be considered as part of the guidance provided in the Approved Methods and may occur when similar air quality impacts may be experienced at receptor locations from different emission sources.

The Proposal site is located proximate to another data centre as summarised in Table 11 and illustrated in Figure 5.

Table 11 Proximate data centre to the Proposal site

Facility	Location	Approximate distance to Proposal site (km)
CDC Data Centre	17 Roberts Road, Eastern Creek	1.3

Figure 5 Location of proximate data centre



Source: Northstar

A desktop exercise has been performed to assess the potential for cumulative impacts to be experienced at sensitive receptors in the event of a power outage, resulting in the emergency generators operating across all three data centres (including the Proposal).

The wind rose for the meteorological data used for the AQIA (resulting from the meteorological modelling exercise [refer Appendix B]) has also been included in Figure 5 to show the frequency of wind directions and wind speeds likely to occur at the Proposal site.

Given the location of the CDC data centre in relation to the Proposal site, cumulative air quality impacts could potentially be experienced at receptors located to the south-west of the Proposal site, specifically at the following receptors:

- I1;
- I2;
- I3;
- I6;
- I10;
- I11;
- R11; and,
- R12

A GIS mapping exercise performed indicated that potential cumulative impacts may occur at the abovementioned receptors during winds from northeast vectors of 26°-56°. It is noted that winds from these vectors are expected to occur during approximately 9.2 % of hours each year on average.

Given the frequency of power outages (see Section 8.2) and winds travelling across the CDC Data Centre and the Proposal site towards sensitive receptors (see Section 4.3 and Appendix B) , it is considered that potential cumulative impacts are not expected to result in frequent, significant air quality impacts at surrounding land uses.

5. METHODOLOGY

5.1. Construction Phase

Construction phase activities have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and are typically experienced by neighbours as amenity impacts, such as dust deposition and visible dust plumes, rather than associated with health-related impacts. Localised engine-exhaust emissions from construction machinery and vehicles may also be experienced but given the 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 *Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (IAQM, 2024). Reference should be made to Appendix D for the methodology. For clarity, and as discussed in Section 2.2, the construction phase assessment has been performed assuming that all buildings would be constructed at the same time. This is a conservative approach and ensures that the highest level of emission controls are adopted during all stages of construction.

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 outlined in Appendix D.

5.2. Operational Phase

5.2.1. Modelling Approach

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF Atmospheric Dispersion Model. The modelling has been performed in CALPUFF 3-dimensional (3-D) mode.

The 3-D meteorological dataset has been developed using The Air Pollution Model (TAPM, v 4.0.5) (see Appendix B for further information).

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

5.2.2. Modelling Scenarios

The following modelling scenarios were undertaken to determine the potential impact under the anticipated operational conditions of the emergency standby generators.

- **Stage 1 – Buildings A, B, and C**
  - **Stage 1, Scenario 1 (S1.1) – justified worst case scenario** – Emergency operation with 50 (50 no.) generators (40 no. 3 MW generators and 10 no. 2 MW generators) operating at 100 % load.
    - This scenario reflects a catastrophic failure in the electricity supply system. However, given that this stage includes 50 no. generators, this scenario has assessed the potential impact of those generators operating concurrently.
    - In reality, a component of the installed capacity of 50 no. generators is provided as design redundancy, and a full load would be equivalent to 80 % of the installed capacity. As such this scenario is highly conservative in this assumption that all 50 no generators would be operating.
    - All 50 no. generators have been modelled as operating for all 8 760 hours of the year. Should such a catastrophic failure in the electricity supply system occur, this is likely to be for a period of 10 to 15 minutes, and therefore the modelling presents a conservative assessment of the potential impacts to account for all meteorological conditions.
    - Given that the likely up-time of the generators would be short-term in nature, only assessment of impacts against short-term criteria has been performed, and no assessment against annual average criteria is presented, as the results would be essentially meaningless.
    - This scenario provides context around how likely any exceedances of air quality criteria would be, given the likelihood of such catastrophic failure.
  - **Stage 1, Scenario 2 (S1.2)- realistic operations (annual testing)** – Two (2 no.) generator operating at 100 % load for each operating hour, representing the generator maintenance testing regime performed annually.
    - This is a scenario which would regularly occur, as detailed in Table 2. Two 3 MW generators located on the south-western side of Building C at the Proposal site (refer

Figure 2) have been modelled to be tested at any one time (between the hours of 7 am and 6 pm), for each hour. Given the high frequency of winds anticipated to occur from the south-west (refer Appendix B), the location of the modelled generators was chosen as increased impacts would be expected at receptor locations northeast of the Proposal site. This provides a level of conservatism to the assessment.

- Comparison of impacts against >1-hour criteria are performed, providing another level of conservatism, as the testing schedule is modelled as occurring for every one of the hours between 7 am and 6 pm, on each and every day of the year. Additionally, Table 2 indicates that only 50 testing events under the annual testing schedule would be required each year and the modelling has assumed 4 015 events (11 hours testing available per day × 365 days). Modelling is required to be performed in this manner to account for all potential combinations of emissions and meteorology.

- **Stage 2 – Stage 1 plus Building D**
  - **Stage 2, Scenario 1 (S2.1) – justified worst case scenario** – Emergency operation with 70 (70 no.) generators (60 no. 3 MW generators and 10 no. 2 MW generators) operating at 100 % load.
    - This scenario reflects a catastrophic failure in the electricity supply system. However, given that this scenario includes 70 no. generators, this AQIA has assessed the potential impact of those generators operating concurrently.
    - In reality, a component of the installed capacity of 70 no. generators is provided as design redundancy, and a full load would be equivalent to 80 % of the installed capacity. As such this scenario is highly conservative in this assumption that all 70 no generators would be operating.
    - All 70 no. generators have been modelled as operating for all 8 760 hours of the year. Should such a catastrophic failure in the electricity supply system occur, this is likely to be for a period of 10 to 15 minutes, and therefore the modelling presents a conservative assessment of the potential impacts to account for all meteorological conditions.
    - Given that the likely up-time of the generators would be short-term in nature, only assessment of impacts against short-term criteria has been performed, and no assessment against annual average criteria is presented, as the results would be essentially meaningless.
    - This scenario provides context around how likely any exceedances of air quality criteria would be, given the likelihood of such catastrophic failure.
  - **Stage 2, Scenario 2 (S2.2)- realistic operations (annual testing)** – Two (2 no.) generator operating at 100 % load for each operating hour, representing the generator maintenance testing regime performed annually.

- This is a scenario which would regularly occur, as detailed in Table 3. Two 3 MW generators located on the south-western side of Building D at the Proposal site (refer Figure 2) have been modelled to be tested at any one time (between the hours of 7 am and 6 pm), for each hour. Given the high frequency of winds anticipated to occur from the south-west (refer Appendix B), the location of the modelled generators was chosen as increased impacts would be expected at receptor locations northeast of the Proposal site. This provides a level of conservatism to the assessment.
- Comparison of impacts against >1-hour criteria are performed, providing another level of conservatism, as the testing schedule is modelled as occurring for every one of the hours between 7 am and 6 pm, on each and every day of the year. Additionally, Table 3 indicates that only 70 testing events under the annual testing schedule would be required each year and the modelling has assumed 4 015 events (11 hours testing available per day × 365 days). Modelling is required to be performed in this manner to account for all potential combinations of emissions and meteorology.

- **Stage 3 – Stage 2 plus Building E**

  - **Stage 3, Scenario 1 (S3.1) – justified worst case scenario** – Emergency operation with 98 (98 no.) generators (88 no. 3 MW generators and 10 no. 2 MW generators) operating at 100 % load.

    - This scenario reflects a catastrophic failure in the electricity supply system. However, given that the application includes 98 no. generators, this scenario has assessed the potential impact of those generators operating concurrently.
    - In reality, a component of the installed capacity of 98 no. generators is provided as design redundancy, and a full load would be equivalent to 80 % of the installed capacity. As such this scenario is highly conservative in this assumption that all 98 no generators would be operating.
    - All 98 no. generators have been modelled as operating for all 8 760 hours of the year. Should such a catastrophic failure in the electricity supply system occur, this is likely to be for a period of 10 to 15 minutes, and therefore the modelling presents a conservative assessment of the potential impacts to account for all meteorological conditions.
    - Given that the likely up-time of the generators would be short-term in nature, only assessment of impacts against short-term criteria has been performed, and no assessment against annual average criteria is presented, as the results would be essentially meaningless.
    - This scenario provides context around how likely any exceedances of air quality criteria would be, given the likelihood of such catastrophic failure.

- **Stage 3, Scenario 2 (S3.2)- realistic operations (annual testing)** – Two (2 no.) generator operating at 100 % load for each operating hour, representing the generator maintenance testing regime performed annually.
  - This is a scenario which would regularly occur, as detailed in Table 4. Two 3 MW generators located on the south-western side of Building D at the Proposal site (refer Figure 2) have been modelled to be tested at any one time (between the hours of 7 am and 6 pm), for each hour. Given the high frequency of winds anticipated to occur from the south-west (refer Appendix B), the location of the modelled generator was chosen as increased impacts would be expected at receptor locations northeast of the Proposal site. This provides a level of conservatism to the assessment.
  - Comparison of impacts against >1-hour criteria are performed, providing another level of conservatism, as the testing schedule is modelled as occurring for every one of the hours between 7 am and 6 pm, on each and every day of the year. Additionally, Table 4 indicates that only 98 testing events under the annual testing schedule would be required each year and the modelling has assumed 4 015 events (11 hours testing available per day × 365 days). Modelling is required to be performed in this manner to account for all potential combinations of emissions and meteorology.

A summary of the emergency standby generator stack design components used to model each scenario is provided in Table 12. Details of the emissions testing data for the proposed engines are provided in Appendix E.

Table 12 Emergency standby generator emissions and stack parameters

Parameter	Units	Scenarios 1.1, 2.1, and 3.1 (justified worst case)		Scenarios 1.2, 2.2, and 3.2 (realistic case)	
		Emergency		Annual testing	
Hour start	hr	00:00		07:00	
Hour end	hr	23:00		18:00	
% load[e]	%	100		100	
Emergency generator model		MTU 16V 4000	MTU 20V 4000	MTU 16V 4000	MTU 20V 4000
Number of generators active[f]	no.	All scenarios - 10	S1.1 – 40 S2.1 – 60 S3.1 - 88	All scenarios - 0	All scenarios - 2
Diesel consumption rate (per generator)	$L{\cdot}hr^{-1}$	513.3	806	-	806
Stack height	m AGL	33.5	38.5	-	38.5
Stack diameter	mm	600	600	-	600
Stack CSA	m^2	0.283	0.283	-	0.283
Normalised discharge rate	$Nm^3{\cdot}s^{-1}$	2.36	4.16	-	4.16
Exit temperature	°C	490	481	-	481
Exit velocity	$m{\cdot}s^{-1}$	23.3	40.7	-	40.7
CO emission[a]	$g{\cdot}s^{-1}$	5.22E-01	7.89E-01	-	7.89E-01
SO_2 emission[c]	$g{\cdot}s^{-1}$	7.85E+00	9.52E-07	-	9.52E-07
NO_x emission[a]	$g{\cdot}s^{-1}$	9.03E+00	9.56+00	-	9.56E+00
Benzene emission[b]	$g{\cdot}s^{-1}$	1.30E-03	1.27E-03	-	1.27E-03
PAH emission[b]	$g{\cdot}s^{-1}$	3.51E-01	4.25E-08	-	4.25E-08
PM emission (PM_{10} and $PM_{2.5}$) [a][d]	$g{\cdot}s^{-1}$	3.57E-02	3.24E-02	-	3.24E-02
Formaldehyde emission[b]	$g{\cdot}s^{-1}$	2.40E+03	2.91E-04	-	2.91E-04

Notes: (a): Emission rates based on values contained in technical specifications (refer Appendix E)

(b): Emission rates based on emission factors from Table 43 of (NPI, 2008)

(c) Based on sulfur content of fuel

(d) 100 % of PM is emitted as $PM_{2.5}$, and $PM_{2.5}$ = PM_{10}

(e) Both assessment scenarios assume that each and every back-up generator assessed within the scenario is operating at 100 % load, consistent with the emission data within the technical specifications presented in Appendix E

(f) A component of the installed capacity of the generators is provided as design redundancy, and a full load would be equivalent to 80 % of the installed capacity. As such the AQIA is highly conservative in this assumption

Air pollutant emission concentrations for the MTU16V4000 generator are provided at the following reference gas conditions (see Appendix E).

- Standard temperature and pressure (STP), actual O_2 (although this value is not stated); and
- STP, 5% O_2.

For example, NO_X is reported as 3 823 $mg{\cdot}Nm^{-3}$ $_{(STP,\ actual\ O2)}$ and 5 115 $mg{\cdot}Nm^{-3}$ $_{(STP,\ 5\ \%\ O2)}$.

Using these two data points, the measured O_2 concentration of 9.0 % can be calculated:

$$O_{2(actual)} = 21 - \left(\frac{3828 \times (21 - 5)}{5115}\right)$$

Air pollutant concentrations for the MTU20V4000 generator are only presented at reference conditions of STP, 5% O_2. Correspondingly, the calculated stack O_2 concentration of 9.0 % has been used to adjust pollutant emissions concentrations from the MTU20V4000 engine from 5 % O_2 to actual O_2 conditions.

5.2.3. Speciated VOCs

The technical specification documents presented in Appendix E presents data for total VOCs, which includes a range of speciated VOCs. To appropriately factor the emissions for benzene, toluene and xylene, reference has been made to the emission factors (EF) presented in Table 43 of (NPI, 2008) which relate to stationary large (>450 kW) diesel engines and fuel consumption rate of 806 $m^3 \cdot hr^{-1}$. The emission factors for TVOC and the respective speciated VOCs have been factored to calculate the mass fractions of those species within TVOC. Table 13 presents the speciated VOC fraction assumptions that are utilised in this assessment.

The impacts of odorants (toluene and xylene) have been similarly assessed on a *pro-rata* basis as a fraction of TVOC as published in the NPI (NPI, 2008) multiplied by the measured source-specific TVOC emission rate.

Table 13 Speciated VOC fractions

Substance	EF $kg \cdot m^{-3}$ (fuel)	EF $kg \cdot hr^{-1}$	EF % TVOC (NPI, 2008)	ER $g \cdot s^{-1}$	
				MTU 16V 4000	MTU20V 4000
Total volatile organic compounds (TVOC)	1.32E+00	1.06E+00	100%	1.34E-01	1.31E-01
Benzene	1.28E-02	1.03E-02	0.97 %	1.30E-03	1.27E-03
Toluene (odour)	4.62E-03	3.72E-03	0.35 %	4.68E-04	4.59E-04
Xylene (odour)	3.22E-03	2.60E-03	0.24 %	3.26E-04	2.52E-01

5.2.4. Particle Size Fractions

In regard to particulates from diesel, virtually 100 % of diesel particles are less than 1 µm in diameter (i.e. PM_1) and consequently particulates from diesel combustion are assessed as $PM_{2.5}$. In this study, the emission rate of $PM_{2.5}$ will be the same as PM_{10}, as all of the PM_{10} particles are assessed as being ≤ 2.5 µm in diameter ($PM_{2.5}$).

5.2.5. NO_x to NO_2 Conversion

Emissions of NO_X have been calculated, with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_X is a mixture of NO_2 and nitric oxide (NO), conversion of NO_X predictions to NO_2 concentrations may be performed.

Approximately 90 % - 95 % of NO_X from a combustion process will be emitted as NO, with the remaining 5 % - 10 % emitted directly as NO_2. Over time and after the point of discharge, NO in ambient air will be transformed by secondary atmospheric reactions to form NO_2, and this reaction often occurs at a considerable distance downwind from the point of emission, and by which time the plume will have dispersed and diluted significantly from the concentration at point of discharge.

Air quality impact assessments need to account for the conversion of NO to NO_2 to enable a comparison against the air quality criterion for NO_2. To perform this, various techniques are common, which are briefly outlined below:

- **100 % conversion**: the most conservative assumption is to assume that 100 % of the total NO_X emitted is discharged as NO_2, and that further reactions do not occur.
- **Jansen method**: where the location is represented by good monitoring data for NO and NO_X, the empirical relationship between NO and NO_2 may be used to derive 'steady state' relationships.
- **Ozone limiting method**: this method uses contemporaneous ozone data to estimate that rate at which NO is oxidised to NO_2 hour-on-hour using an established relationship.

This AQIA has used the ozone limiting method (OLM) to approximate the conversion of NO_X to NO_2, in accordance with the methodology described in (NSW EPA, 2022).

5.2.6. Short Term Pollutant Concentrations

With reference to criteria air pollutants with sub-hourly criteria (CO, refer Section 3.3), hourly dispersion model outputs are required to be adjusted to allow provision of data on those timescales. The following Power Law adjustment has been applied:

$$C_{p,t} = C_{p,60}\left[\frac{60}{t}\right]^{0.2}$$

Where:

$C_{p,t}$ = concentration of pollutant (p) at averaging time (mins) (t)

$C_{p,60}$ = concentration of pollutant (p) at averaging time ($60\ mins$)

t = time (mins)

6. CONSTRUCTION PHASE AIR QUALITY RISK ASSESSMENT

The methodology adapted by Northstar from IAQM (2024) *Guidance on the assessment of dust from demolition and construction* has been used to assess construction phase risk and is provided in Appendix D.

Briefly, the adapted method uses a six-step process for assessing dust impact risks from construction activities as a function (product) of receptor sensitivity and potential impact magnitude and identifies key activities for control.

As outlined in Section 2.3.1 no demolition activities are proposed for the Proposal and correspondingly, have not been considered in the construction phase risk assessment.

6.1. Risk (Pre-Mitigation)

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

Table 14 Risk of air quality impacts from construction activities

Sensitivity of area	Dust emission magnitude					Preliminary risk				
	Demolition	Earthworks	Construction	Track-out	Const. traffic	Demolition	Earthworks	Construction	Track-out	Const. traffic
Dust soiling										
Med.	N/A	Med.	Large	Large	Large	N/A	Med.	Med.	Med.	Med.
Human health										
Low	N/A	Med.	Large	Large	Large	N/A	Low	Low	Low	Low

Note: Med. = Medium, N/A = Not Applicable

The risks summarised in Table 14 show that there are medium risks of dust soiling and low risks of human health impacts associated with all proposed construction phase activities 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, commensurate with those identified risks as provided in Appendix D.

6.2. Risk (Post-Mitigation)

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

Given the size of the Proposal site, the distance to sensitive receptors and the activities to be performed, residual impacts associated with fugitive dust emissions from the Proposal would be anticipated to be 'negligible', should the implementation of the mitigation measures outlined in Appendix D be performed appropriately.

7. OPERATIONAL PHASE AIR QUALITY IMPACT ASSESSMENT

This section presents the results of the dispersion modelling assessment and uses the following terminology:

- **Incremental impact** – relates to the concentrations predicted as a result of the construction and operation of the Proposal in isolation.
- **Cumulative impact** – relates to the incremental concentrations predicted as a result of the operation of the Proposal PLUS the background air quality concentrations discussed in Section 4.4.

The results are presented in this manner to allow examination of the likely impact of the facility in isolation and the contribution to air quality impacts in a broader sense. In the presentation of results, the tables included shaded cells which represent the following:

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

The following abbreviations are used in the result tables:

- Incr. = increment
- Bg. = background
- Cum. = cumulative

Details of each scenario under each Stage of operation are provided in Section 5.2.2.

7.1. Stage 1

7.1.1. Stage 1, Scenario 1 - Justified Worst-Case

The following presents the results of the modelling assessment under the assumptions of Stage 1, Scenario 1 (refer Section 5.2.2), with all 50 no. emergency standby generators operating at 100 % load.

Results are presented in this section for short term criteria only (i.e. ≤ 24 hours). The assessment against annual average criteria is essentially meaningless, given that the generators would only be operational for a small number of hours, during that emergency scenario. Operation of those generators over an entire year would not occur.

Assessment of potential impacts against annual average criteria is presented under Stage 1, Scenario 2 (realistic operations).

7.1.1.1. Particulate Matter

Results are presented in this section for the predictions of particulate matter (PM_{10}, and $PM_{2.5}$) associated with Stage 1, Scenario 1. The averaging periods associated with the criteria for these pollutants is 24-hour as specified in Table 5. The emissions adopted for Stage 1; Scenario 1 reflect the operational profile of the Proposal over that averaging period (refer Section 5.2.2).

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

Table 15 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the assumptions under Stage 1, Scenario 1. No background concentrations are included within this table.

Table 15 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – Stage 1, Scenario 1

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	41.4	82.8
R1	11.9	11.9
R2	8.7	8.7
R3	9.5	9.5
R4	7.6	7.6
R5	8.2	8.2
R6	7.4	7.4
R7	7.4	7.4
R8	2.2	2.2
R9	1.8	1.8
R10	2.6	2.6
R11	3.9	3.9
R12	4.6	4.6
R13	6.5	6.5
R14	6.1	6.1
R15	5.7	5.7
R16	2.6	2.6
R17	2.3	2.3
R18	2.0	2.0
R19	2.3	2.3
R20	2.0	2.0
R21	1.8	1.8
R22	3.0	3.0
I1	5.2	5.2

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
I2	4.5	4.5
I3	4.8	4.8
I4	3.6	3.6
I5	11.6	11.6
I6	5.2	5.2
I7	6.4	6.4
I8	8.4	8.4
I9	11.8	11.8
I10	5.8	5.8
I11	3.5	3.5
I12	20.7	20.7
I13	10.1	10.1
I14	10.1	10.1
I15	11.2	11.2
I16	7.4	7.4
I17	4.6	4.6
I18	4.9	4.9
I19	5.0	5.0
I20	5.3	5.3
I21	3.5	3.5

Note: all PM is assumed to be <1 µg in diameter, and therefore assessed as $PM_{2.5}$. In this instance, emissions of $PM_{2.5}$ will be the same as PM_{10} ($PM_{2.5}$ is a subset of PM_{10}) and therefore the results will be consistent between PM_{10} and $PM_{2.5}$.

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from Stage 1, Scenario 1, with background included are presented in Table 16 and Table 17 respectively.

Results are presented in Table 16 and Table 17 for those receptors at which the greatest impacts have been predicted (see Table 15).

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

Table 16 Summary of contemporaneous 24-hour PM_{10} concentrations – Stage 1, Scenario 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor R10			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor I12		
	Incr.	Bg.	Cumul.		Incr.	Bg.	Cumul.
23/01/2020	2.2	245.8	248.0	26/10/2020	20.7	12.8	33.5
24/01/2020	< 0.1	105.6	105.7	5/01/2020	18.2	81.1	99.3
8/01/2020	< 0.1	97.8	97.9	26/03/2020	18.1	17.7	35.8
5/01/2020	< 0.1	81.1	81.2	25/12/2020	17.1	17.1	34.2
12/01/2020	< 0.1	69.7	69.8	16/03/2020	16.6	9.3	25.9
4/01/2020	0.5	68.4	68.9	10/08/2020	16.4	14.6	31.0
25/01/2020	< 0.1	61.5	61.6	11/01/2020	15.8	58.0	73.8
11/01/2020	< 0.1	58.0	58.1	11/12/2020	14.4	18.3	32.7
1/01/2020	< 0.1	57.4	57.5	25/10/2020	14.2	7.3	21.5
2/01/2020	< 0.1	54.0	54.1	4/02/2020	12.5	37.6	50.1
27/01/2020	< 0.1	48.7	48.8	19/12/2020	11.7	19.7	31.4
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the Proposal				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the Proposal.			

Table 17 Summary of contemporaneous 24-hour $PM_{2.5}$ concentrations – Stage 1, Scenario 1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor I12			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor I12		
	Incr.	Bg.	Cumul.		Incr.	Bg.	Cumul.
8/01/2020	6.6	70.8	77.4	26/10/2020	20.7	4.6	25.3
5/01/2020	18.2	41.7	59.9	5/01/2020	18.2	41.7	59.9
12/01/2020	7.2	47.2	54.4	26/03/2020	18.1	5.5	23.6
11/01/2020	15.8	33.4	49.2	25/12/2020	17.1	3.7	20.8
24/01/2020	6.5	37.5	44.0	16/03/2020	16.6	3.2	19.8
17/01/2020	8.4	31.3	39.7	10/08/2020	16.4	4.1	20.5
29/08/2020	< 0.1	37.1	37.2	11/01/2020	15.8	33.4	49.2
2/01/2020	3.1	30.4	33.5	11/12/2020	14.4	5.2	19.6
1/01/2020	6.7	25.8	32.5	25/10/2020	14.2	2.1	16.3
7/06/2020	2.9	29.3	32.2	4/02/2020	12.5	19.7	32.2
4/02/2020	12.5	19.7	32.2	19/12/2020	11.7	6.0	17.7
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Proposal.			

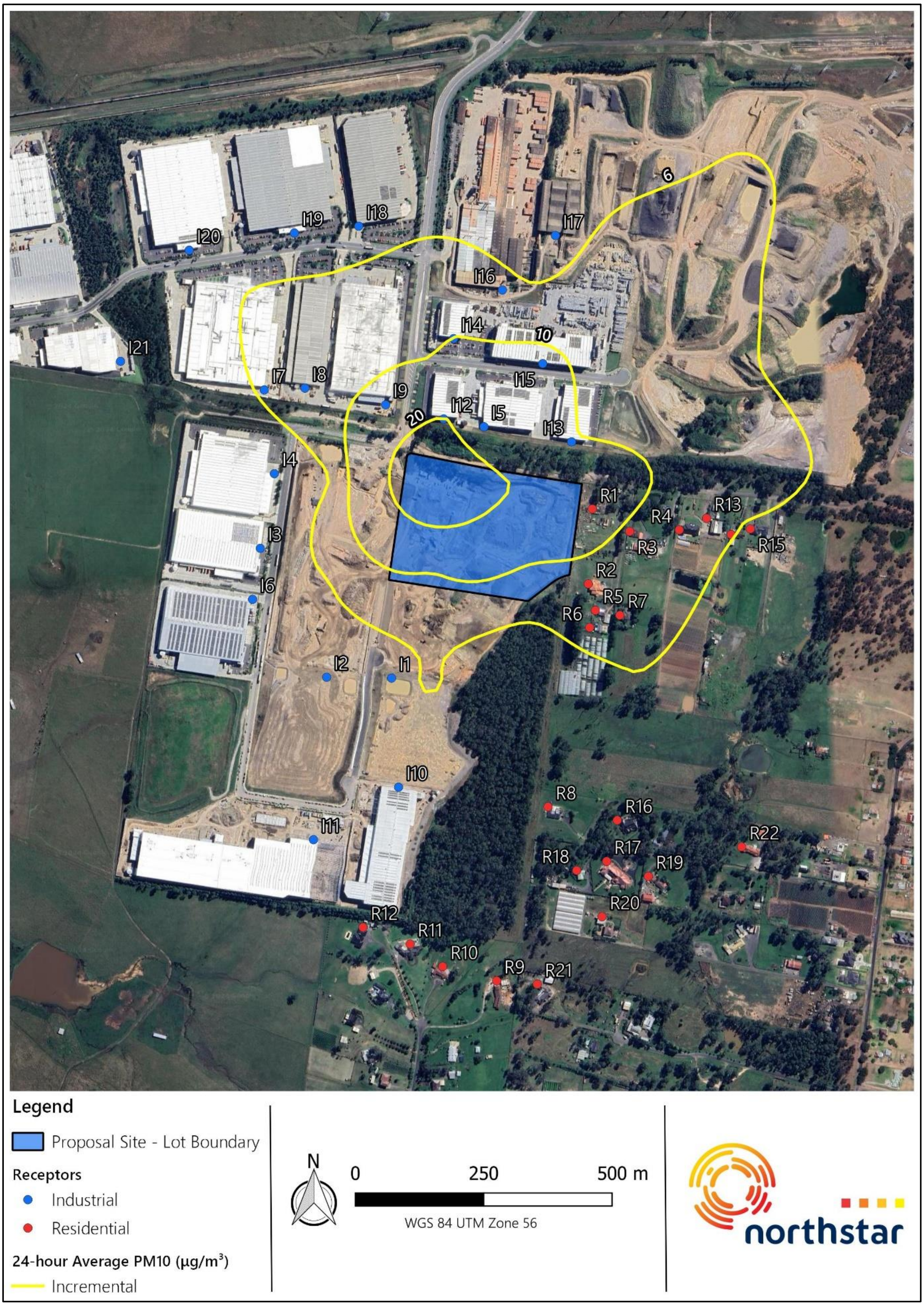
For PM_{10} the maximum cumulative impact (the left-hand side of Table 16) is predicted at receptor R10, and the maximum incremental impact (the right-hand side of Table 16) is predicted at receptor I12. Table 16 indicates that the highest cumulative impacts are driven by elevated background concentrations. It can be seen in Table 16 that the highest cumulative impacts correspond with background concentrations during early 2020 which are associated with exceptional events including bushfires and intense drought conditions (NSW DPIE, 2021). It is noted that the highest incremental impacts are also predicted to result in exceedances of the relevant criterion, with the addition of background concentrations at receptor I12.

For $PM_{2.5}$, the maximum cumulative impact (the left-hand side of Table 17) and the maximum incremental impact (the right-hand side of Table 17) is predicted at receptor I12. Table 17 indicates that exceedances associated with the highest cumulative impacts are driven by elevated background air quality concentrations while exceedances associated with the highest incremental impacts are driven by significant incremental contributions from the Proposal under an emergency scenario.

Contour plots of the predicted incremental 24-hour PM_{10} concentrations associated with the Proposal are presented in Figure 6 to allow examination of the distribution of particulate matter in the area surrounding the Proposal.

The number of additional exceedances of the 24-hour PM_{10} and $PM_{2.5}$ criteria predicted at various receptors resulting from emergency generator operation is presented in Section 7.4.1. These values are discussed further in Section 8.2.

Figure 6 Predicted maximum incremental 24-hour PM_{10} impacts – Stage 1, Scenario 1



Source: Northstar

7.1.1.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2) under the assumptions of Stage 1, Scenario 1 (refer Section 5.2.2). The averaging period associated with the criterion for NO_2 is 1-hour as specified in Table 5.

Emissions of NO_X have been calculated, with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_X is a mixture of NO_2 and nitric oxide (NO), conversion of NO_X predictions to NO_2 concentrations may be performed. Within this assessment, the OLM method has been adopted as outlined in Section 5.2.5.

The predicted maximum 1-hour average NO_2 concentrations resulting from the Proposal operations are presented in Table 18.

Table 18 Predicted 1-hour NO_2 concentrations – Stage 1, Scenario 1

Receptor	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})		
	1-hour average		
	Incr.	Bg.	Cumul.
Criterion		164	
Max % of criterion	831.4	35.5	829.1
R1	758.2	16.9	775.1
R2	732.3	9.4	741.7
R3	798.4	0.0	798.4
R4	755.8	18.8	774.6
R5	674.4	9.4	683.8
R6	523.6	0.0	523.6
R7	722.6	9.4	732.0
R8	578.3	3.8	582.1
R9	448.5	0.0	448.5
R10	490.1	9.4	499.5
R11	536.4	5.6	542.0
R12	516.9	7.5	524.4
R13	698.0	18.8	716.8
R14	688.8	18.8	707.6
R15	664.6	18.8	683.4
R16	504.4	18.8	523.2
R17	503.2	5.6	508.8
R18	503.9	3.8	507.7
R19	470.7	18.8	489.5
R20	488.7	1.9	490.6
R21	445.9	9.4	455.3
R22	439.5	28.2	467.7

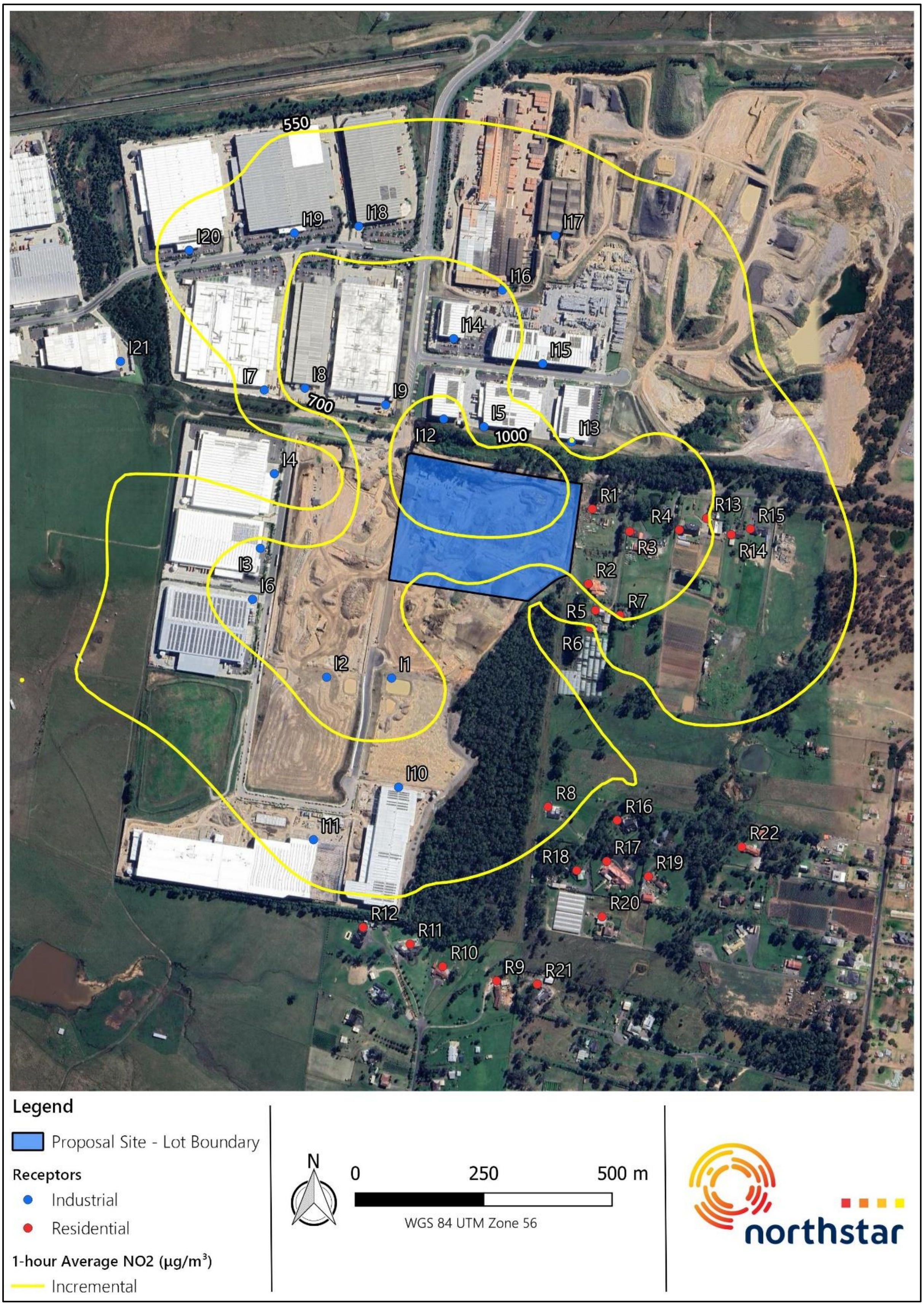
Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)		
	1-hour average		
	Incr.	Bg.	Cumul.
I1	757.2	1.9	759.1
I2	727.5	5.6	733.2
I3	743.7	9.4	753.1
I4	473.3	35.7	509.1
I5	688.1	1.9	689.9
I6	753.0	16.9	769.9
I7	627.4	47.0	674.4
I8	795.1	16.9	812.0
I9	821.7	13.2	834.9
I10	637.4	7.5	644.9
I11	605.2	1.9	607.0
I12	1 363.5	-3.8	1 359.8
I13	537.1	0.0	537.1
I14	777.0	3.8	780.7
I15	658.9	41.4	700.3
I16	705.8	15.0	720.8
I17	625.5	24.4	649.9
I18	647.8	16.9	664.7
I19	691.5	0.0	691.5
I20	582.0	0.0	582.0
I21	426.4	58.3	484.6

The results indicate that predicted incremental concentrations of NO_2 under Stage 1, Scenario 1 are significantly above the criteria at all surrounding receptor locations.

A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 7.

The number of additional exceedances of the 1-hour NO_2 criterion predicted at each receptor resulting from emergency generator operation is presented in Section 7.4.1. These values are discussed further in Section 8.2.

Figure 7 Predicted maximum incremental 1-hour NO_2 impacts – Stage 1, Scenario 1



Source: Northstar

7.1.1.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Stage 1, Scenario 1 for all other pollutants assessed in this study (refer Section 5.2.2). Presented in Table 19 to Table 21 are the predicted concentrations of CO, SO_2, PAHs, VOCs and formaldehyde at varying averaging periods (≤ 24 hours) at the surrounding receptors.

The predicted cumulative concentrations for CO are significantly below the relevant criteria for all averaging periods at all receptors as shown in Table 19.

The results presented in Table 20 indicate that predicted incremental impacts of SO_2 at all receptors are less than 0.1 % of the relevant criteria for all averaging periods. The addition of background concentrations does not result in any exceedances at any receptor.

Results presented in Table 21 show no exceedances of the 1-hour criteria for benzene are predicted at any identified receptors. The maximum predicted impact for benzene is experienced at receptor I12 (4.9 % of the relevant criterion).

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 8.

Table 19 Predicted 15-minutes, 1-hour and 8-hour average CO concentrations – Stage 1, Scenario 1

Receptor	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	1.1	3.2	4.3	2.7	8.0	10.7	4.9	21.0	25.9
R1	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
R2	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
R3	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
R4	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
R5	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
R6	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
R7	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
R8	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R9	0.3	3.2	3.5	0.2	2.4	2.6	0.1	2.1	2.2
R10	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R11	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R12	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R13	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
R14	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
R15	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
R16	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R17	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R18	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R19	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R20	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2

Receptor	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R21	0.3	3.2	3.5	0.2	2.4	2.6	0.1	2.1	2.2
R22	0.3	3.2	3.5	0.3	2.4	2.7	0.2	2.1	2.3
I1	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
I2	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I3	0.6	3.2	3.8	0.4	2.4	2.8	0.2	2.1	2.3
I4	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
I5	0.5	3.2	3.7	0.4	2.4	2.8	0.3	2.1	2.4
I6	0.6	3.2	3.8	0.4	2.4	2.8	0.2	2.1	2.3
I7	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I8	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
I9	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
I10	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I11	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
I12	1.1	3.2	4.3	0.8	2.4	3.2	0.5	2.1	2.6
I13	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
I14	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
I15	0.5	3.2	3.7	0.4	2.4	2.8	0.3	2.1	2.4
I16	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I17	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I18	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I19	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I20	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
I21	0.3	3.2	3.5	0.3	2.4	2.7	0.1	2.1	2.2

Table 20 Predicted 1-hour and 24-hour SO_2 concentrations – Stage 1, Scenario 1

Receptor	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	286			57		
Max. % of criterion	< 0.1	16.5	16.5	< 0.1	0.7	0.8
R1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R12	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R21	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R22	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I12	< 0.1	47.2	47.3	< 0.1	0.4	0.5

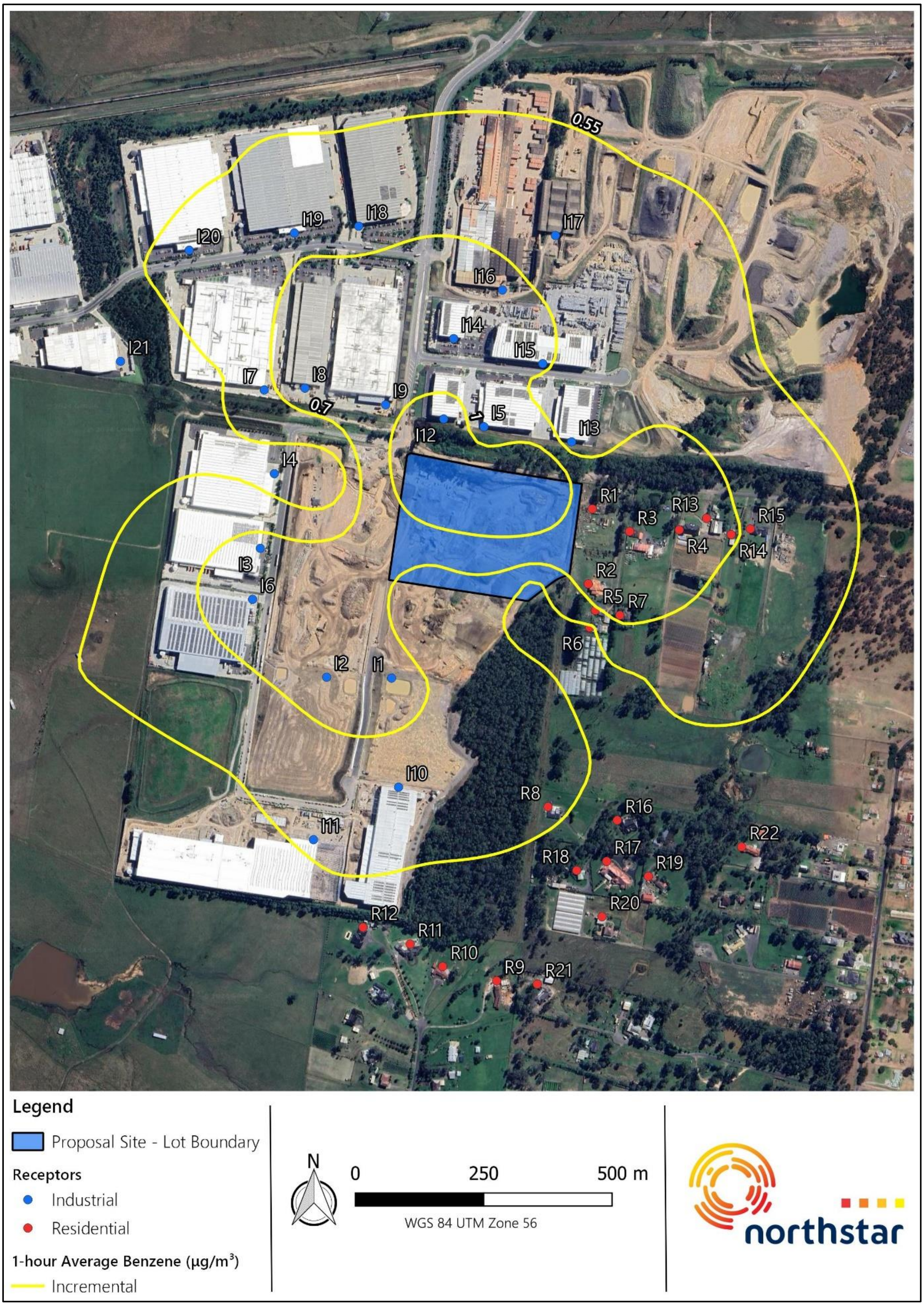
Receptor	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
I13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I21	< 0.1	47.2	47.3	< 0.1	0.4	0.5

Table 21 Predicted maximum incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Stage 1, Scenario 1

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	4.9	0.1	0.2	0.7
R1	1.16E-08	7.84E-04	1.97E-04	1.97E-04	7.96E-05
R2	1.12E-08	7.56E-04	1.90E-04	1.90E-04	7.67E-05
R3	1.20E-08	8.10E-04	2.04E-04	2.04E-04	8.22E-05
R4	1.17E-08	7.85E-04	1.97E-04	1.97E-04	7.97E-05
R5	1.03E-08	6.93E-04	1.74E-04	1.74E-04	7.04E-05
R6	7.69E-09	5.18E-04	1.30E-04	1.30E-04	5.26E-05
R7	1.11E-08	7.45E-04	1.87E-04	1.87E-04	7.57E-05
R8	8.51E-09	5.73E-04	1.44E-04	1.44E-04	5.82E-05
R9	6.34E-09	4.27E-04	1.07E-04	1.07E-04	4.34E-05
R10	7.10E-09	4.78E-04	1.20E-04	1.20E-04	4.86E-05
R11	7.57E-09	5.10E-04	1.28E-04	1.28E-04	5.18E-05
R12	7.50E-09	5.05E-04	1.27E-04	1.27E-04	5.13E-05
R13	1.07E-08	7.23E-04	1.82E-04	1.82E-04	7.34E-05
R14	1.06E-08	7.13E-04	1.79E-04	1.79E-04	7.24E-05
R15	1.02E-08	6.87E-04	1.73E-04	1.73E-04	6.97E-05
R16	7.54E-09	5.08E-04	1.28E-04	1.28E-04	5.16E-05
R17	7.25E-09	4.88E-04	1.23E-04	1.23E-04	4.96E-05
R18	7.32E-09	4.93E-04	1.24E-04	1.24E-04	5.01E-05
R19	7.01E-09	4.72E-04	1.19E-04	1.19E-04	4.79E-05
R20	7.01E-09	4.73E-04	1.19E-04	1.19E-04	4.80E-05
R21	6.48E-09	4.36E-04	1.10E-04	1.10E-04	4.43E-05
R22	6.64E-09	4.48E-04	1.13E-04	1.13E-04	4.54E-05
I1	1.11E-08	7.49E-04	1.88E-04	1.88E-04	7.61E-05
I2	1.09E-08	7.36E-04	1.85E-04	1.85E-04	7.48E-05
I3	1.15E-08	7.72E-04	1.94E-04	1.94E-04	7.84E-05
I4	7.46E-09	5.03E-04	1.26E-04	1.26E-04	5.10E-05
I5	1.02E-08	6.86E-04	1.72E-04	1.72E-04	6.96E-05
I6	1.16E-08	7.82E-04	1.97E-04	1.97E-04	7.94E-05
I7	9.87E-09	6.65E-04	1.67E-04	1.67E-04	6.75E-05
I8	1.20E-08	8.09E-04	2.04E-04	2.04E-04	8.22E-05
I9	1.26E-08	8.48E-04	2.13E-04	2.13E-04	8.61E-05
I10	9.43E-09	6.35E-04	1.60E-04	1.60E-04	6.45E-05
I11	8.46E-09	5.70E-04	1.43E-04	1.43E-04	5.79E-05
I12	2.11E-08	1.42E-03	3.58E-04	3.58E-04	1.45E-04

Receptor	Maximum 1-hour average concentration ($mg \cdot m^{-3}$)				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
I13	7.87E-09	5.30E-04	1.33E-04	1.33E-04	5.38E-05
I14	1.18E-08	7.92E-04	1.99E-04	1.99E-04	8.04E-05
I15	1.07E-08	7.21E-04	1.81E-04	1.81E-04	7.33E-05
I16	1.09E-08	7.35E-04	1.85E-04	1.85E-04	7.47E-05
I17	9.61E-09	6.48E-04	1.63E-04	1.63E-04	6.58E-05
I18	9.74E-09	6.56E-04	1.65E-04	1.65E-04	6.67E-05
I19	1.02E-08	6.87E-04	1.73E-04	1.73E-04	6.98E-05
I20	8.56E-09	5.77E-04	1.45E-04	1.45E-04	5.86E-05
I21	6.90E-09	4.65E-04	1.17E-04	1.17E-04	4.72E-05

Figure 8 Predicted maximum incremental 1-hour benzene impacts – Stage 1, Scenario 1



Source: Northstar

7.1.2. Stage 1, Scenario 2 – Realistic Case

Presented below are the results of the modelling assessment under the assumptions of Stage 1, Scenario 2 (refer Section 5.2.2) with 2 no. generators operating at 100 % load for each testing hour. Annual average increments under this scenario have been factored according to the anticipated number of hours of testing each year (refer Section 2.3.2).

7.1.2.1. Particulate Matter

7.1.2.1.1. Annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from Stage 1, Scenario 2 operations are presented in Table 22. Table 22 shows that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at all receptor locations are low (less than 0.1 % of the annual average TSP, PM_{10} and $PM_{2.5}$ criteria).

The Proposal operation under the testing regime is predicted to not result in any exceedances of the relevant criteria.

Table 22 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Stage 1, Scenario 2

Receptor	Annual average concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	90			25			8		
Max. % of criterion	< 0.1	46.0	46.1	< 0.1	80.8	81.0	< 0.1	107.5	108.1
R1	< 0.1	41.4	41.5	< 0.1	20.2	20.2	< 0.1	8.6	8.7
R2	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R3	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R4	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R5	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R6	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R7	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R8	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R9	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R10	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R11	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R12	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R13	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R14	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R15	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R16	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7

Receptor	Annual average concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R17	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R18	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R19	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R20	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R21	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R22	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I1	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I2	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I3	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I4	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I5	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I6	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I7	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I8	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I9	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I10	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I11	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I12	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I13	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I14	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I15	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I16	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I17	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I18	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I19	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I20	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I21	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7

7.1.2.1.2. Maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations

Table 23 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the Proposal operations under Stage 1, Scenario 2. No background concentrations are included within this table.

Table 23 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – Stage 1, Scenario 2

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	1.6	3.2
R1	0.6	0.6
R2	0.4	0.4
R3	0.4	0.4
R4	0.3	0.3
R5	0.3	0.3
R6	0.3	0.3
R7	0.3	0.3
R8	< 0.1	< 0.1
R9	< 0.1	< 0.1
R10	< 0.1	< 0.1
R11	0.1	0.1
R12	0.1	0.1
R13	0.3	0.3
R14	0.3	0.3
R15	0.2	0.2
R16	< 0.1	< 0.1
R17	< 0.1	< 0.1
R18	< 0.1	< 0.1
R19	< 0.1	< 0.1
R20	< 0.1	< 0.1
R21	< 0.1	< 0.1
R22	0.1	0.1
I1	0.2	0.2
I2	0.2	0.2
I3	0.2	0.2
I4	0.1	0.1
I5	0.6	0.6
I6	0.2	0.2
I7	0.2	0.2
I8	0.3	0.3
I9	0.4	0.4
I10	0.2	0.2
I11	0.1	0.1
I12	0.8	0.8
I13	0.4	0.4
I14	0.4	0.4

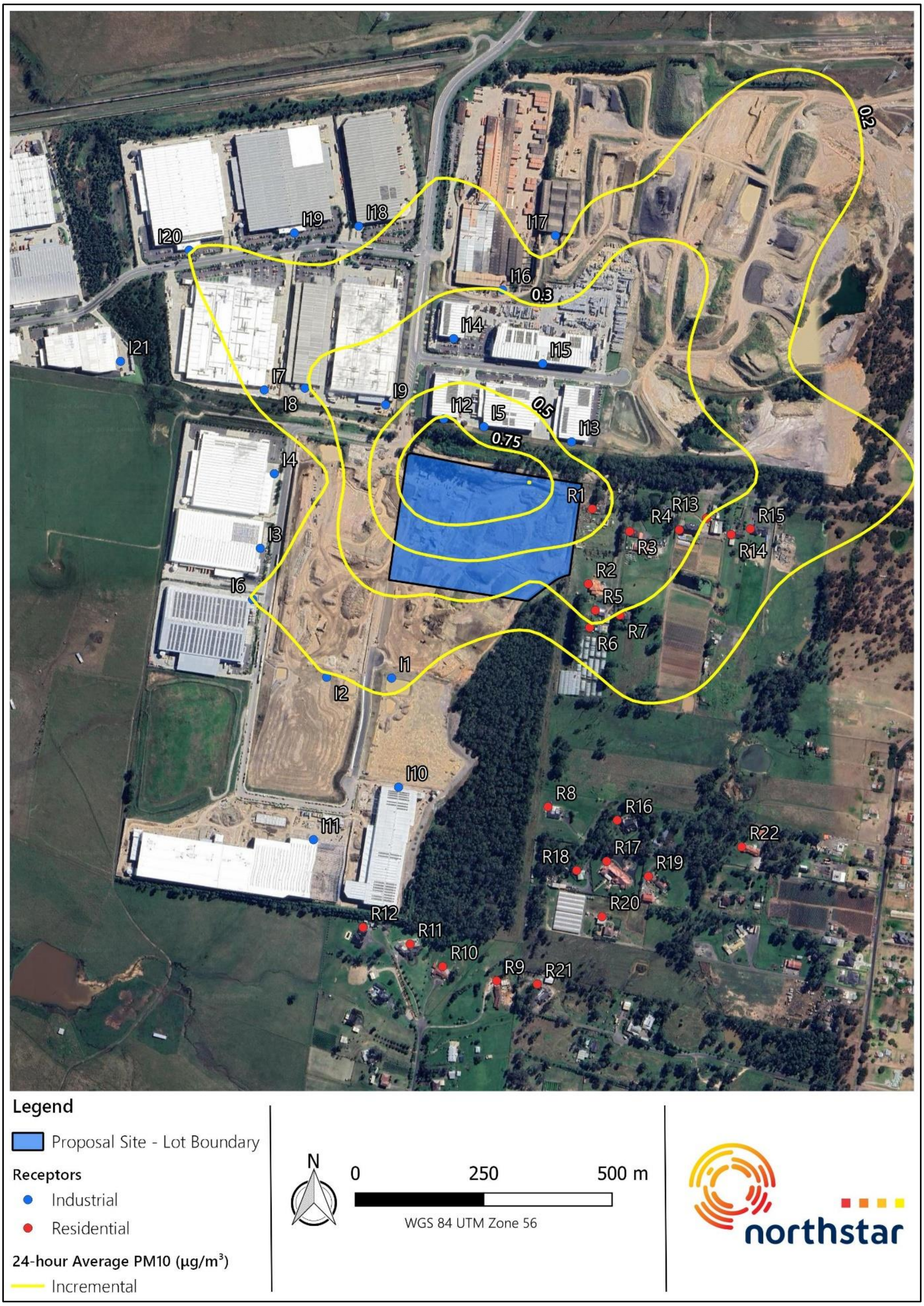
Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
I15	0.4	0.4
I16	0.3	0.3
I17	0.2	0.2
I18	0.2	0.2
I19	0.2	0.2
I20	0.2	0.2
I21	0.1	0.1

The predicted incremental concentrations of PM_{10} and $PM_{2.5}$ are demonstrated to be minor at all receptor locations.

An assessment of the 24-hour PM_{10} and $PM_{2.5}$ concentrations with background included is not presented, as the concentrations are all driven by background. The addition of the predicted increments presented in Table 23 do not result in any additional exceedances of the criteria.

Contour plots of the predicted incremental 24-hour PM_{10} concentrations associated with the Proposal under Stage 1, Scenario 2 are presented in Figure 9 to allow examination of the distribution of particulate matter in the area surrounding the Proposal site.

Figure 9 Predicted maximum incremental 24-hour PM_{10} impacts – Stage 1, Scenario 2



Source: Northstar

7.1.2.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2) under Stage 1, Scenario 2. The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in Table 5.

The predicted maximum 1-hour and annual average NO_2 concentrations resulting from the assumptions under Stage 1, Scenario 2, are presented in Table 24.

The results indicate that predicted incremental and cumulative NO_2 concentrations are below the criteria at all surrounding receptor locations.

The performance of the Proposal under Stage 1, Scenario 2 does not result in any exceedances of the criteria for NO_2.

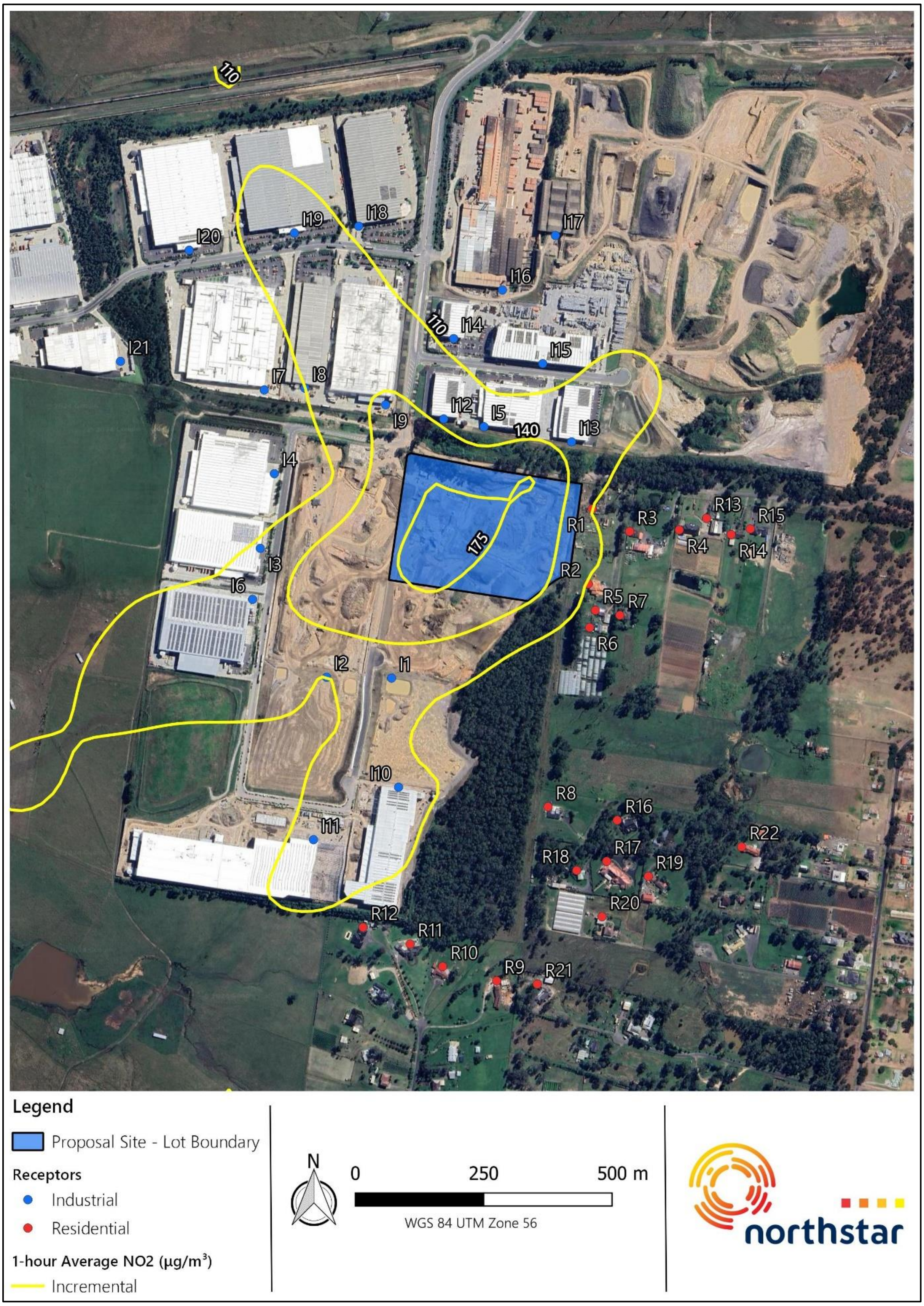
A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 10.

Table 24 Predicted 1-hour and annual average NO_2 concentrations – Stage 1, Scenario 2

Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour average			Annual average		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	164			31		
Max. % of criterion	90.3	49.3	92.6	0.9	44.6	45.5
R1	102.1	9.4	111.5	0.1	13.8	13.9
R2	81.2	24.4	105.6	< 0.1	13.8	13.9
R3	99.6	9.4	109.0	< 0.1	13.8	13.9
R4	93.9	9.4	103.3	< 0.1	13.8	13.9
R5	103.4	-1.9	101.5	< 0.1	13.8	13.9
R6	101.2	-1.9	99.3	< 0.1	13.8	13.9
R7	102.0	0.0	102.0	< 0.1	13.8	13.9
R8	74.1	13.2	87.2	< 0.1	13.8	13.9
R9	< 0.1	80.8	80.9	< 0.1	13.8	13.9
R10	102.2	1.9	104.1	< 0.1	13.8	13.9
R11	107.3	1.9	109.2	< 0.1	13.8	13.9
R12	99.3	5.6	105.0	< 0.1	13.8	13.9
R13	90.1	9.4	99.5	< 0.1	13.8	13.9
R14	90.7	9.4	100.1	< 0.1	13.8	13.9
R15	85.9	11.3	97.2	< 0.1	13.8	13.9
R16	79.9	5.6	85.5	< 0.1	13.8	13.9
R17	80.3	5.6	85.9	< 0.1	13.8	13.9
R18	74.1	13.2	87.3	< 0.1	13.8	13.9
R19	80.6	5.6	86.3	< 0.1	13.8	13.9

Receptor	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})					
	1-hour average			Annual average		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R20	79.9	5.6	85.6	< 0.1	13.8	13.9
R21	71.5	15.0	86.6	< 0.1	13.8	13.9
R22	66.0	18.8	84.8	< 0.1	13.8	13.9
I1	113.3	13.2	126.4	< 0.1	13.8	13.9
I2	107.9	13.2	121.0	< 0.1	13.8	13.9
I3	94.3	30.1	124.4	< 0.1	13.8	13.9
I4	88.5	15.0	103.6	< 0.1	13.8	13.9
I5	113.4	9.4	122.8	0.2	13.8	14.0
I6	129.8	16.9	146.7	< 0.1	13.8	13.9
I7	86.5	22.6	109.0	< 0.1	13.8	13.9
I8	109.4	7.5	116.9	< 0.1	13.8	13.9
I9	148.1	3.8	151.9	0.1	13.8	14.0
I10	111.0	1.9	112.9	< 0.1	13.8	13.9
I11	106.8	13.2	119.9	< 0.1	13.8	13.9
I12	135.4	1.9	137.3	0.3	13.8	14.1
I13	130.1	9.4	139.5	0.1	13.8	14.0
I14	105.4	3.8	109.2	0.1	13.8	13.9
I15	99.7	1.9	101.5	0.1	13.8	14.0
I16	107.6	3.8	111.4	< 0.1	13.8	13.9
I17	92.1	1.9	94.0	< 0.1	13.8	13.9
I18	106.0	9.4	115.4	< 0.1	13.8	13.9
I19	118.1	9.4	127.5	< 0.1	13.8	13.9
I20	102.5	7.5	110.1	< 0.1	13.8	13.9
I21	24.0	71.4	95.4	< 0.1	13.8	13.9

Figure 10 Predicted maximum incremental 1-hour NO_2 impacts – Stage 1, Scenario 2



Source: Northstar

7.1.2.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Stage 1, Scenario 2 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 25 to Table 27 are the predicted concentrations of CO, SO_2, PAHs, VOCs and formaldehyde at varying averaging periods at the surrounding receptors.

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 11.

The predicted incremental concentrations for all of the abovementioned pollutants are below the relevant criteria for all averaging periods at all receptors.

Table 25 Predicted 15-minute, 1-hour and 8-hour average CO concentrations – Stage 1, Scenario 2

Receptor	Carbon monoxide (CO) concentration ($mg{\cdot}m^{-3}$)								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	< 0.1	3.2	3.3	< 0.1	8.0	8.2	< 0.1	21.0	21.5
R1	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R2	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R3	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R4	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R5	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R6	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R7	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R8	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R9	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R10	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R11	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R12	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R13	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R14	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R15	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R16	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R17	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R18	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R19	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R20	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2

Receptor	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R21	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R22	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I1	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I2	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I3	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I4	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I5	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I6	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I7	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I8	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I9	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I10	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I11	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I12	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I13	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I14	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I15	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I16	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I17	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I18	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I19	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I20	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I21	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2

Table 26 Predicted 1-hour and 24-hour SO_2 concentrations – Stage 1, Scenario 2

Rec.	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	286			57		
Max. % of criterion	<0.1	16.5	16.5	<0.1	0.7	0.8
R1	<0.1	47.2	47.3	<0.1	0.4	0.5
R2	<0.1	47.2	47.3	<0.1	0.4	0.5
R3	<0.1	47.2	47.3	<0.1	0.4	0.5
R4	<0.1	47.2	47.3	<0.1	0.4	0.5
R5	<0.1	47.2	47.3	<0.1	0.4	0.5
R6	<0.1	47.2	47.3	<0.1	0.4	0.5
R7	<0.1	47.2	47.3	<0.1	0.4	0.5
R8	<0.1	47.2	47.3	<0.1	0.4	0.5
R9	<0.1	47.2	47.3	<0.1	0.4	0.5
R10	<0.1	47.2	47.3	<0.1	0.4	0.5
R11	<0.1	47.2	47.3	<0.1	0.4	0.5
R12	<0.1	47.2	47.3	<0.1	0.4	0.5
R13	<0.1	47.2	47.3	<0.1	0.4	0.5
R14	<0.1	47.2	47.3	<0.1	0.4	0.5
R15	<0.1	47.2	47.3	<0.1	0.4	0.5
R16	<0.1	47.2	47.3	<0.1	0.4	0.5
R17	<0.1	47.2	47.3	<0.1	0.4	0.5
R18	<0.1	47.2	47.3	<0.1	0.4	0.5
R19	<0.1	47.2	47.3	<0.1	0.4	0.5
R20	<0.1	47.2	47.3	<0.1	0.4	0.5
R21	<0.1	47.2	47.3	<0.1	0.4	0.5
R22	<0.1	47.2	47.3	<0.1	0.4	0.5
I1	<0.1	47.2	47.3	<0.1	0.4	0.5
I2	<0.1	47.2	47.3	<0.1	0.4	0.5
I3	<0.1	47.2	47.3	<0.1	0.4	0.5
I4	<0.1	47.2	47.3	<0.1	0.4	0.5
I5	<0.1	47.2	47.3	<0.1	0.4	0.5
I6	<0.1	47.2	47.3	<0.1	0.4	0.5
I7	<0.1	47.2	47.3	<0.1	0.4	0.5
I8	<0.1	47.2	47.3	<0.1	0.4	0.5
I9	<0.1	47.2	47.3	<0.1	0.4	0.5
I10	<0.1	47.2	47.3	<0.1	0.4	0.5
I11	<0.1	47.2	47.3	<0.1	0.4	0.5
I12	<0.1	47.2	47.3	<0.1	0.4	0.5

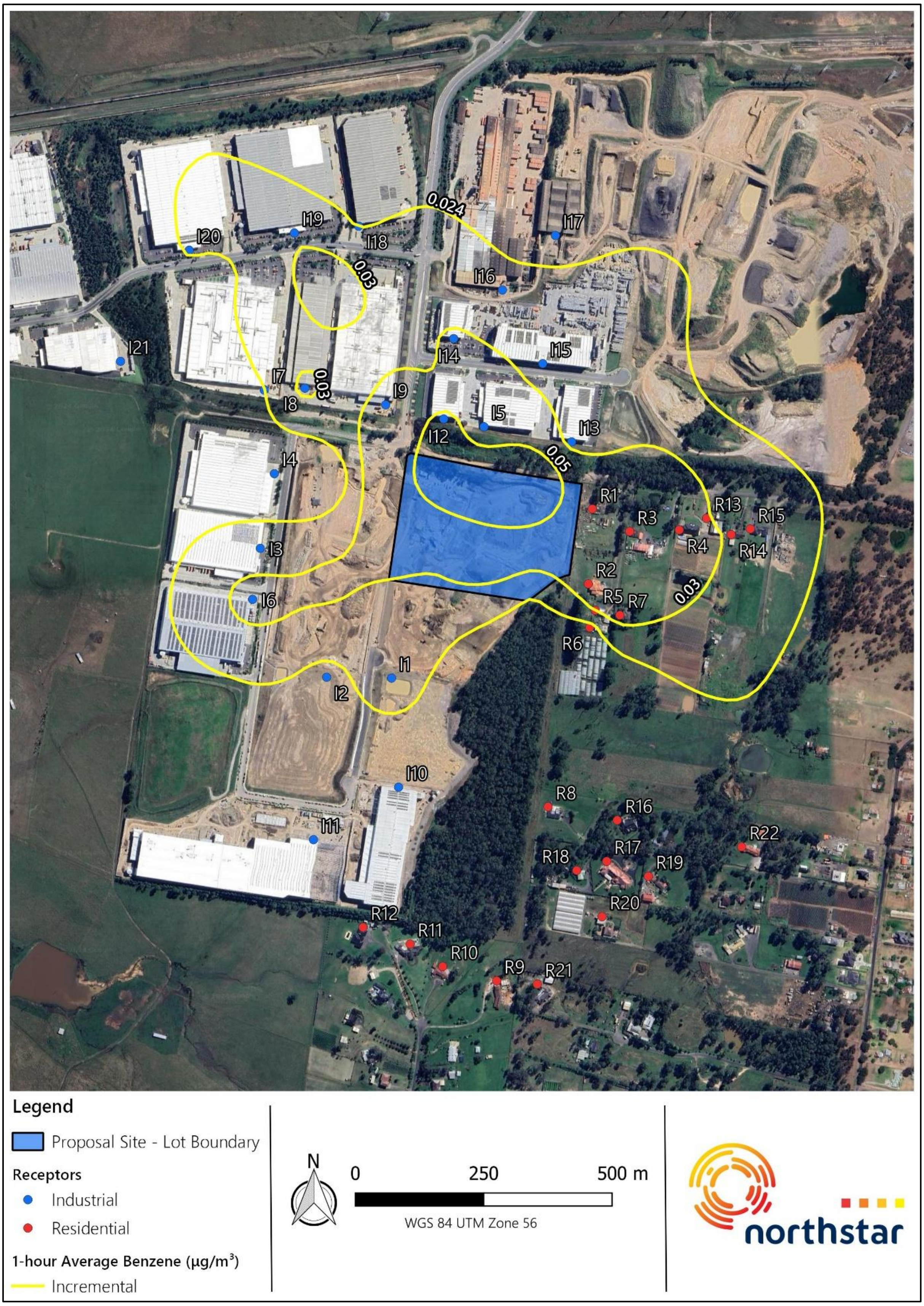
Rec.	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
I13	<0.1	47.2	47.3	<0.1	0.4	0.5
I14	<0.1	47.2	47.3	<0.1	0.4	0.5
I15	<0.1	47.2	47.3	<0.1	0.4	0.5
I16	<0.1	47.2	47.3	<0.1	0.4	0.5
I17	<0.1	47.2	47.3	<0.1	0.4	0.5
I18	<0.1	47.2	47.3	<0.1	0.4	0.5
I19	<0.1	47.2	47.3	<0.1	0.4	0.5
I20	<0.1	47.2	47.3	<0.1	0.4	0.5
I21	<0.1	47.2	47.3	<0.1	0.4	0.5

Table 27 Predicted maximum incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Stage 1, Scenario 2

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	0.2	< 0.1	< 0.1	< 0.1
R1	5.33E-10	3.59E-05	9.03E-06	9.03E-06	3.64E-06
R2	5.06E-10	3.41E-05	8.58E-06	8.58E-06	3.46E-06
R3	5.31E-10	3.58E-05	9.00E-06	9.00E-06	3.64E-06
R4	4.93E-10	3.32E-05	8.36E-06	8.36E-06	3.37E-06
R5	4.56E-10	3.07E-05	7.73E-06	7.73E-06	3.12E-06
R6	3.21E-10	2.16E-05	5.44E-06	5.44E-06	2.19E-06
R7	4.86E-10	3.27E-05	8.23E-06	8.23E-06	3.32E-06
R8	3.01E-10	2.02E-05	5.09E-06	5.09E-06	2.06E-06
R9	2.27E-10	1.53E-05	3.85E-06	3.85E-06	1.56E-06
R10	2.28E-10	1.54E-05	3.87E-06	3.87E-06	1.56E-06
R11	2.56E-10	1.72E-05	4.34E-06	4.34E-06	1.75E-06
R12	2.62E-10	1.77E-05	4.44E-06	4.44E-06	1.79E-06
R13	4.47E-10	3.01E-05	7.58E-06	7.58E-06	3.06E-06
R14	4.39E-10	2.96E-05	7.44E-06	7.44E-06	3.00E-06
R15	4.07E-10	2.74E-05	6.90E-06	6.90E-06	2.79E-06
R16	2.95E-10	1.99E-05	4.99E-06	4.99E-06	2.02E-06
R17	2.75E-10	1.85E-05	4.67E-06	4.67E-06	1.88E-06
R18	2.69E-10	1.81E-05	4.55E-06	4.55E-06	1.84E-06
R19	2.68E-10	1.81E-05	4.55E-06	4.55E-06	1.84E-06
R20	2.56E-10	1.73E-05	4.34E-06	4.34E-06	1.75E-06
R21	2.46E-10	1.66E-05	4.16E-06	4.16E-06	1.68E-06
R22	2.57E-10	1.73E-05	4.36E-06	4.36E-06	1.76E-06
I1	3.88E-10	2.61E-05	6.57E-06	6.57E-06	2.65E-06
I2	3.23E-10	2.18E-05	5.47E-06	5.47E-06	2.21E-06
I3	3.90E-10	2.63E-05	6.61E-06	6.61E-06	2.67E-06
I4	3.27E-10	2.20E-05	5.54E-06	5.54E-06	2.23E-06
I5	5.87E-10	3.96E-05	9.95E-06	9.95E-06	4.02E-06
I6	4.91E-10	3.30E-05	8.31E-06	8.31E-06	3.36E-06
I7	3.50E-10	2.36E-05	5.93E-06	5.93E-06	2.40E-06
I8	4.74E-10	3.20E-05	8.04E-06	8.04E-06	3.25E-06
I9	4.72E-10	3.18E-05	7.99E-06	7.99E-06	3.23E-06
I10	3.28E-10	2.21E-05	5.56E-06	5.56E-06	2.25E-06
I11	2.83E-10	1.91E-05	4.80E-06	4.80E-06	1.94E-06
I12	8.30E-10	5.59E-05	1.41E-05	1.41E-05	5.68E-06

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
I13	3.66E-10	2.46E-05	6.19E-06	6.19E-06	2.50E-06
I14	4.61E-10	3.10E-05	7.81E-06	7.81E-06	3.15E-06
I15	4.24E-10	2.85E-05	7.18E-06	7.18E-06	2.90E-06
I16	3.73E-10	2.51E-05	6.32E-06	6.32E-06	2.55E-06
I17	3.31E-10	2.23E-05	5.61E-06	5.61E-06	2.26E-06
I18	3.50E-10	2.36E-05	5.94E-06	5.94E-06	2.40E-06
I19	4.40E-10	2.96E-05	7.45E-06	7.45E-06	3.01E-06
I20	3.63E-10	2.44E-05	6.14E-06	6.14E-06	2.48E-06
I21	2.83E-10	1.91E-05	4.79E-06	4.79E-06	1.94E-06

Figure 11 Predicted maximum incremental 1-hour benzene impacts – Stage 1, Scenario 2



Source: Northstar

7.2. Stage 2

7.2.1. Stage 2, Scenario 1 - Justified Worst-Case

The following presents the results of the modelling assessment under the assumptions of Stage 2, Scenario 1 (refer Section 5.2.2), with all 70 no. emergency standby generators operating at 100 % load.

Results are presented in this section for short term criteria only (i.e. ≤ 24 hours). The assessment against annual average criteria is essentially meaningless, given that the generators would only be operational for a small number of hours, during that emergency scenario. Operation of those generators over an entire year would not occur.

Assessment of potential impacts against annual average criteria is presented under Stage 2, Scenario 2 (realistic operations).

7.2.1.1. Particulate Matter

Results are presented in this section for the predictions of particulate matter (PM_{10}, and $PM_{2.5}$) associated with Stage 2, Scenario 1. The averaging periods associated with the criteria for these pollutants is 24-hour as specified in Table 5. The emissions adopted for Stage 2; Scenario 1 reflect the operational profile of the Proposal over that averaging period (refer Section 5.2.2).

7.2.1.1.1. Maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations

Table 28 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the assumptions under Stage 2, Scenario 1. No background concentrations are included within this table.

Table 28 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – Stage 2, Scenario 1

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	44.8	89.6
R1	12.7	12.7
R2	10.1	10.1
R3	11.3	11.3
R4	9.6	9.6
R5	9.3	9.3
R6	8.1	8.1
R7	9.2	9.2

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
R8	2.9	2.9
R9	2.5	2.5
R10	4.2	4.2
R11	5.3	5.3
R12	5.4	5.4
R13	8.2	8.2
R14	8.1	8.1
R15	7.4	7.4
R16	3.3	3.3
R17	2.7	2.7
R18	2.4	2.4
R19	3.0	3.0
R20	2.3	2.3
R21	2.4	2.4
R22	3.3	3.3
I1	6.8	6.8
I2	6.6	6.6
I3	6.5	6.5
I4	5.4	5.4
I5	15.3	15.3
I6	6.9	6.9
I7	9.1	9.1
I8	11.7	11.7
I9	14.1	14.1
I10	6.7	6.7
I11	4.4	4.4
I12	22.4	22.4
I13	11.3	11.3
I14	11.4	11.4
I15	12.1	12.1
I16	10.1	10.1
I17	6.1	6.1
I18	6.7	6.7
I19	6.5	6.5
I20	7.2	7.2
I21	5.1	5.1

Note: all PM is assumed to be <1 µg in diameter, and therefore assessed as $PM_{2.5}$. In this instance, emissions of $PM_{2.5}$ will be the same as PM_{10} ($PM_{2.5}$ is a subset of PM_{10}) and therefore the results will be consistent between PM_{10} and $PM_{2.5}$.

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from Stage 2, Scenario 1, with background included are presented in Table 29 and Table 30 respectively.

Results are presented in Table 29 and Table 30 for those receptors at which the greatest impacts have been predicted (see Table 28).

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

Table 29 Summary of contemporaneous 24-hour PM_{10} concentrations – Stage 2, Scenario 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor R10			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor I12		
	Incr.	Bg.	Cumul.		Incr.	Bg.	Cumul.
23/01/2020	2.8	245.8	248.6	26/10/2020	22.4	12.8	35.2
24/01/2020	< 0.1	105.6	105.7	5/01/2020	21.8	81.1	102.9
8/01/2020	< 0.1	97.8	97.9	25/12/2020	20.8	17.1	37.9
5/01/2020	< 0.1	81.1	81.2	11/01/2020	19.8	58.0	77.8
12/01/2020	< 0.1	69.7	69.8	26/03/2020	19.1	17.7	36.8
4/01/2020	0.7	68.4	69.1	11/12/2020	18.6	18.3	36.9
25/01/2020	< 0.1	61.5	61.6	16/03/2020	18.1	9.3	27.4
11/01/2020	< 0.1	58.0	58.1	10/08/2020	17.1	14.6	31.7
1/01/2020	< 0.1	57.4	57.5	25/10/2020	14.9	7.3	22.2
2/01/2020	< 0.1	54.0	54.1	4/02/2020	14.3	37.6	51.9
27/01/2020	< 0.1	48.7	48.8	15/03/2020	13.9	11.3	25.2
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the Proposal				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the Proposal.			

Table 30 Summary of contemporaneous 24-hour $PM_{2.5}$ concentrations – Stage 2, Scenario 1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor I12			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor I12		
	Incr.	Bg.	Cumul.		Incr.	Bg.	Cumul.
8/01/2020	8.9	70.8	79.7	26/10/2020	22.4	4.6	27.0
5/01/2020	21.8	41.7	63.5	5/01/2020	21.8	41.7	63.5
12/01/2020	9.2	47.2	56.4	25/12/2020	20.8	3.7	24.5
11/01/2020	19.8	33.4	53.2	11/01/2020	19.8	33.4	53.2
24/01/2020	8.3	37.5	45.8	26/03/2020	19.1	5.5	24.6
17/01/2020	8.5	31.3	39.8	11/12/2020	18.6	5.2	23.8
29/08/2020	<0.1	37.1	37.2	16/03/2020	18.1	3.2	21.3
2/01/2020	5.2	30.4	35.6	10/08/2020	17.1	4.1	21.2
1/01/2020	9.4	25.8	35.2	25/10/2020	14.9	2.1	17.0
4/02/2020	14.3	19.7	34.0	4/02/2020	14.3	19.7	34.0
7/06/2020	4.0	29.3	33.3	15/03/2020	13.9	3.8	17.7
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Proposal.			

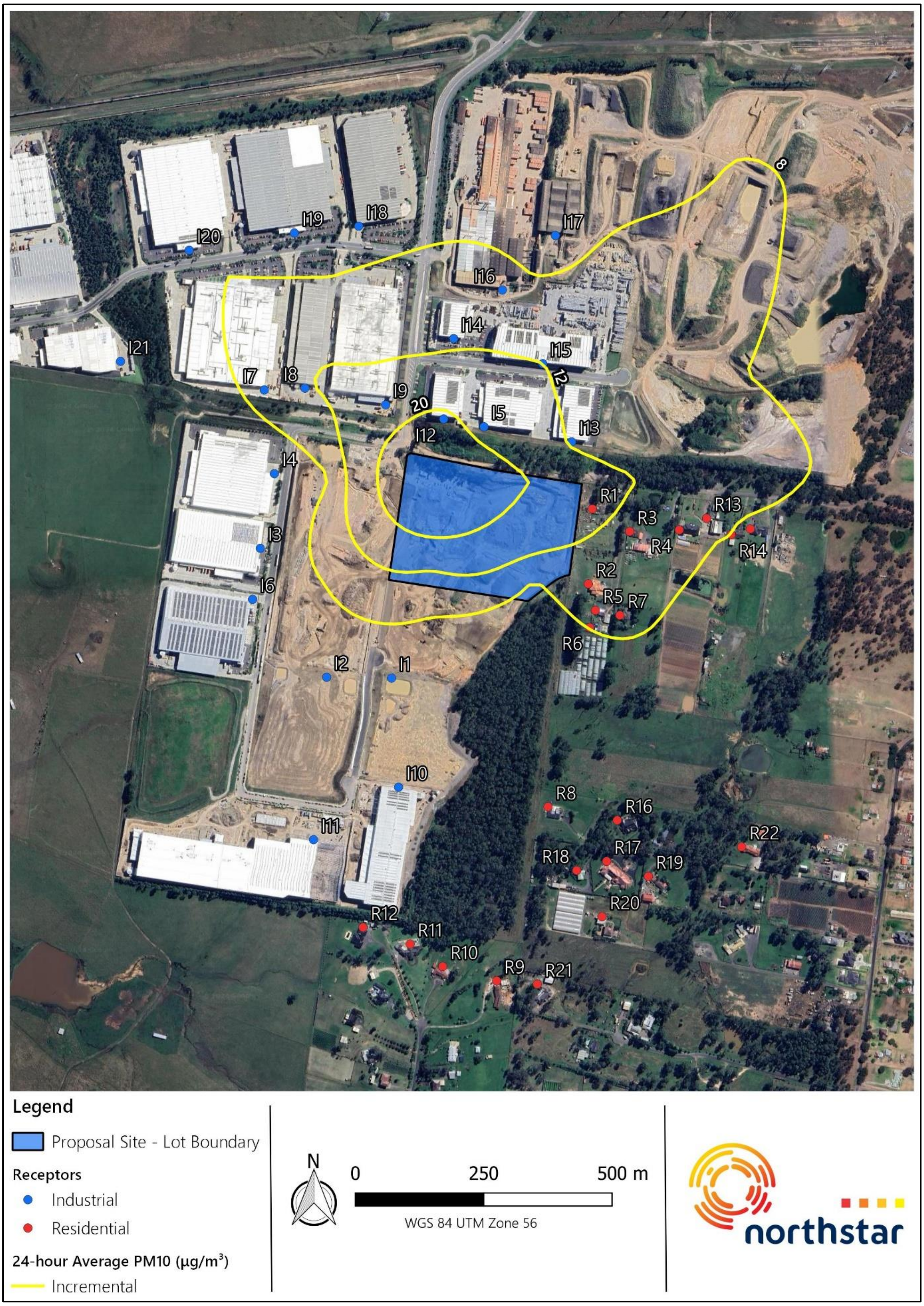
For PM_{10} the maximum cumulative impact (the left-hand side of Table 29) is predicted at receptor R10, and the maximum incremental impact (the right-hand side of Table 29) is predicted at receptor I12. Table 29 indicates that the highest cumulative impacts are driven by elevated background concentrations. It can be seen in Table 29 that the highest cumulative impacts correspond with background concentrations during early 2020 which are associated with exceptional events including bushfires and intense drought conditions (NSW DPIE, 2021). It is noted that the highest incremental impacts are also predicted to result in exceedances of the relevant criterion, with the addition of background concentrations at receptor I12.

For $PM_{2.5}$, the maximum cumulative impact (the left-hand side of Table 30) and the maximum incremental impact (the right-hand side of Table 30) is predicted at receptor I12. Table 30 indicates that exceedances associated with the highest cumulative impacts are driven by elevated background air quality concentrations while exceedances associated with the highest incremental impacts are driven by significant incremental contributions from the Proposal under an emergency scenario.

Contour plots of the predicted incremental 24-hour PM_{10} concentrations associated with the Proposal are presented in Figure 12 to allow examination of the distribution of particulate matter in the area surrounding the Proposal.

The number of additional exceedances of the 24-hour PM_{10} and $PM_{2.5}$ criteria predicted at various receptors resulting from emergency generator operation is presented in Section 7.4.2. These values are discussed further in Section 8.2.

Figure 12 Predicted maximum incremental 24-hour PM_{10} impacts – Stage 2, Scenario 1



Source: Northstar

7.2.1.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2) under the assumptions of Stage 2, Scenario 1 (refer Section 5.2.2). The averaging period associated with the criterion for NO_2 is 1-hour as specified in Table 5.

Emissions of NO_X have been calculated, with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_X is a mixture of NO_2 and nitric oxide (NO), conversion of NO_X predictions to NO_2 concentrations may be performed. Within this assessment, the OLM method has been adopted as outlined in Section 5.2.5.

The predicted maximum 1-hour average NO_2 concentrations resulting from the Proposal operations are presented in Table 31.

Table 31 Predicted 1-hour NO_2 concentrations – Stage 2, Scenario 1

Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)		
	1-hour average		
	Incr.	Bg.	Cumul.
Criterion		164	
Max % of criterion	899.4	35.5	897.1
R1	770.5	16.9	787.4
R2	742.5	9.4	751.9
R3	858.6	0.0	858.6
R4	863.8	18.8	882.6
R5	678.2	9.4	687.6
R6	582.9	28.2	611.1
R7	746.6	9.4	756.0
R8	671.2	1.9	673.1
R9	539.5	16.9	556.4
R10	564.2	9.4	573.6
R11	626.8	1.9	628.6
R12	590.1	18.8	608.9
R13	851.4	16.9	868.3
R14	839.9	18.8	858.7
R15	824.5	18.8	843.3
R16	592.1	5.6	597.8
R17	610.6	1.9	612.5
R18	618.4	3.8	622.1
R19	550.9	18.8	569.7
R20	595.9	3.8	599.7
R21	490.6	33.8	524.4
R22	598.3	28.2	626.5

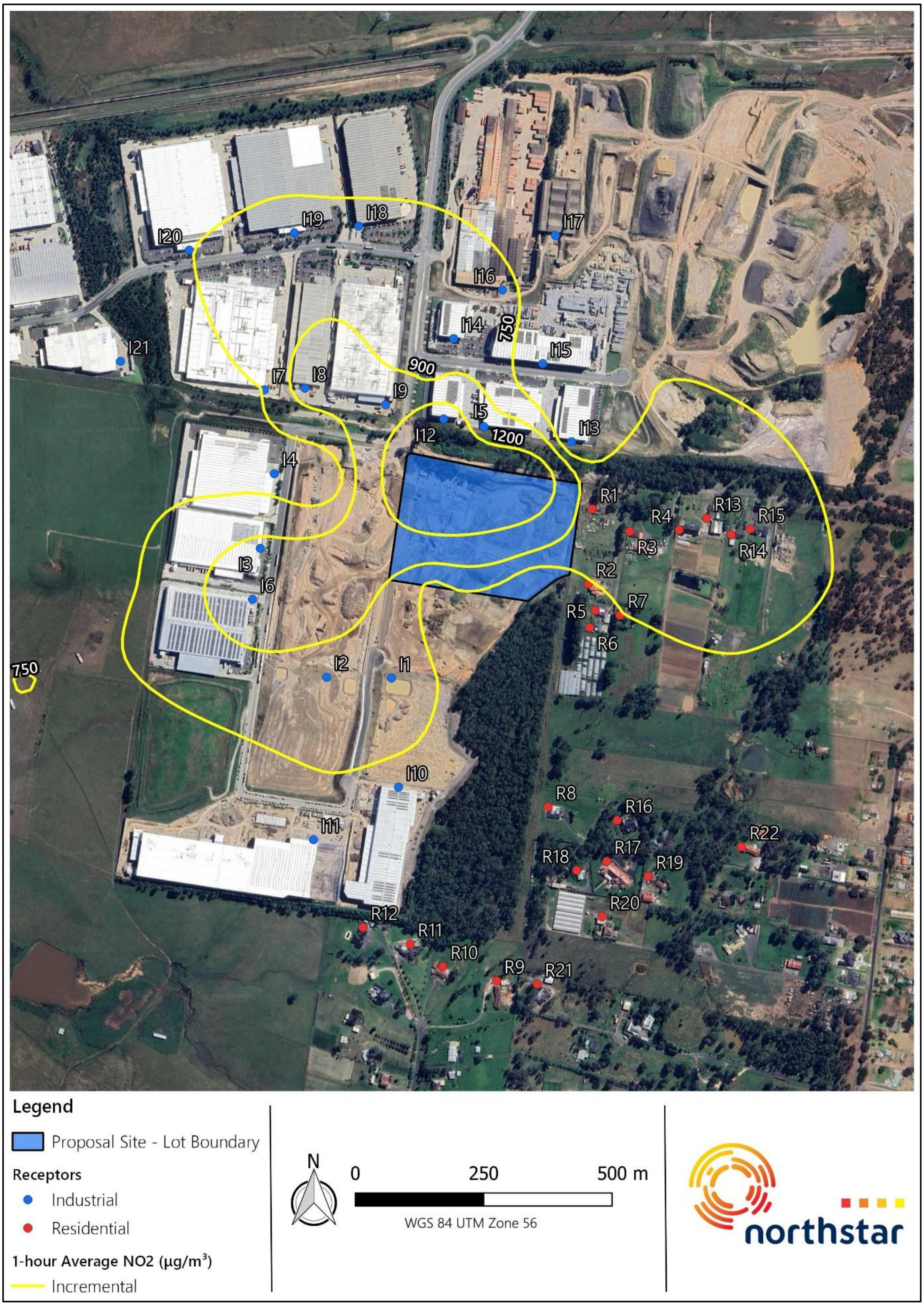
Receptor	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})		
	1-hour average		
	Incr.	Bg.	Cumul.
I1	828.3	1.9	830.1
I2	812.7	5.6	818.3
I3	948.5	9.4	957.9
I4	706.9	35.7	742.7
I5	979.0	1.9	980.9
I6	994.9	7.5	1 002.4
I7	750.4	47.0	797.4
I8	959.5	47.0	1 006.5
I9	979.0	13.2	992.1
I10	715.5	1.9	717.4
I11	676.9	20.7	697.6
I12	1 475.1	-3.8	1 471.3
I13	574.4	9.4	583.8
I14	854.5	26.3	880.8
I15	706.6	13.2	719.7
I16	765.2	15.0	780.2
I17	697.5	24.4	721.9
I18	793.3	16.9	810.2
I19	814.9	0.0	814.9
I20	747.3	13.2	760.5
I21	613.7	58.3	671.9

The results indicate that predicted incremental concentrations of NO_2 under Stage 2, Scenario 1 are significantly above the criteria at all surrounding receptor locations.

A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 13.

The number of additional exceedances of the 1-hour NO_2 criterion predicted at each receptor resulting from emergency generator operation is presented in Section 7.4.2. These values are discussed further in Section 8.2.

Figure 13 Predicted maximum incremental 1-hour NO_2 impacts – Stage 2, Scenario 1



Source: Northstar

7.2.1.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Stage 2, Scenario 1 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 32 to Table 34 are the predicted concentrations of CO, SO_2, PAHs, VOCs and formaldehyde at varying averaging periods (≤24 hours) at the surrounding receptors.

The predicted cumulative concentrations for CO are significantly below the relevant criteria for all averaging periods at all receptors as shown in Table 32.

The results presented in Table 33 indicate that predicted incremental impacts of SO_2 at all receptors are <0.1 % of the relevant criteria for all averaging periods. The addition of background concentrations does not result in any exceedances at any receptor.

Results presented in Table 34 show no exceedances of the 1-hour criteria for benzene are predicted at any identified receptors. The maximum predicted impact for benzene is experienced at receptor I12 (5.2 % of the relevant criterion).

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 14.

Table 32 Predicted 15-minutes, 1-hour and 8-hour average CO concentrations – Stage 2, Scenario 1

Receptor	Carbon monoxide (CO) concentration ($mg{\cdot}m^{-3}$)								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	1.2	3.2	4.4	2.9	8.0	10.9	5.3	21.0	26.3
R1	0.6	3.2	3.8	0.5	2.4	2.9	0.4	2.1	2.5
R2	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
R3	0.6	3.2	3.8	0.5	2.4	2.9	0.4	2.1	2.5
R4	0.7	3.2	3.9	0.5	2.4	2.9	0.3	2.1	2.4
R5	0.5	3.2	3.7	0.4	2.4	2.8	0.3	2.1	2.4
R6	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
R7	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
R8	0.5	3.2	3.7	0.4	2.4	2.8	0.1	2.1	2.2
R9	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R10	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R11	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
R12	0.5	3.2	3.7	0.3	2.4	2.7	0.2	2.1	2.3
R13	0.7	3.2	3.9	0.5	2.4	2.9	0.3	2.1	2.4
R14	0.7	3.2	3.9	0.5	2.4	2.9	0.3	2.1	2.4
R15	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
R16	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R17	0.5	3.2	3.7	0.3	2.4	2.7	0.1	2.1	2.2
R18	0.5	3.2	3.7	0.3	2.4	2.7	0.1	2.1	2.2
R19	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R20	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2

Receptor	Carbon monoxide (CO) concentration ($mg \cdot m^{-3}$)								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R21	0.4	3.2	3.6	0.3	2.4	2.7	0.1	2.1	2.2
R22	0.5	3.2	3.7	0.3	2.4	2.7	0.2	2.1	2.3
I1	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
I2	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
I3	0.7	3.2	3.9	0.6	2.4	3.0	0.2	2.1	2.3
I4	0.6	3.2	3.8	0.4	2.4	2.8	0.2	2.1	2.3
I5	0.7	3.2	3.9	0.6	2.4	3.0	0.3	2.1	2.4
I6	0.8	3.2	4.0	0.6	2.4	3.0	0.3	2.1	2.4
I7	0.6	3.2	3.8	0.5	2.4	2.9	0.2	2.1	2.3
I8	0.8	3.2	4.0	0.6	2.4	3.0	0.3	2.1	2.4
I9	0.8	3.2	4.0	0.6	2.4	3.0	0.4	2.1	2.5
I10	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I11	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I12	1.2	3.2	4.4	0.9	2.4	3.3	0.5	2.1	2.6
I13	0.4	3.2	3.6	0.3	2.4	2.7	0.2	2.1	2.3
I14	0.7	3.2	3.9	0.5	2.4	2.9	0.3	2.1	2.4
I15	0.5	3.2	3.7	0.4	2.4	2.8	0.3	2.1	2.4
I16	0.6	3.2	3.8	0.5	2.4	2.9	0.2	2.1	2.3
I17	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3
I18	0.6	3.2	3.8	0.5	2.4	2.9	0.2	2.1	2.3
I19	0.6	3.2	3.8	0.5	2.4	2.9	0.3	2.1	2.4
I20	0.6	3.2	3.8	0.4	2.4	2.8	0.3	2.1	2.4
I21	0.5	3.2	3.7	0.4	2.4	2.8	0.2	2.1	2.3

Table 33 Predicted 1-hour and 24-hour SO_2 concentrations – Stage 2, Scenario 1

Receptor	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	286			57		
Max. % of criterion	< 0.1	16.5	16.5	< 0.1	0.7	0.8
R1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R12	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R21	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R22	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I12	< 0.1	47.2	47.3	< 0.1	0.4	0.5

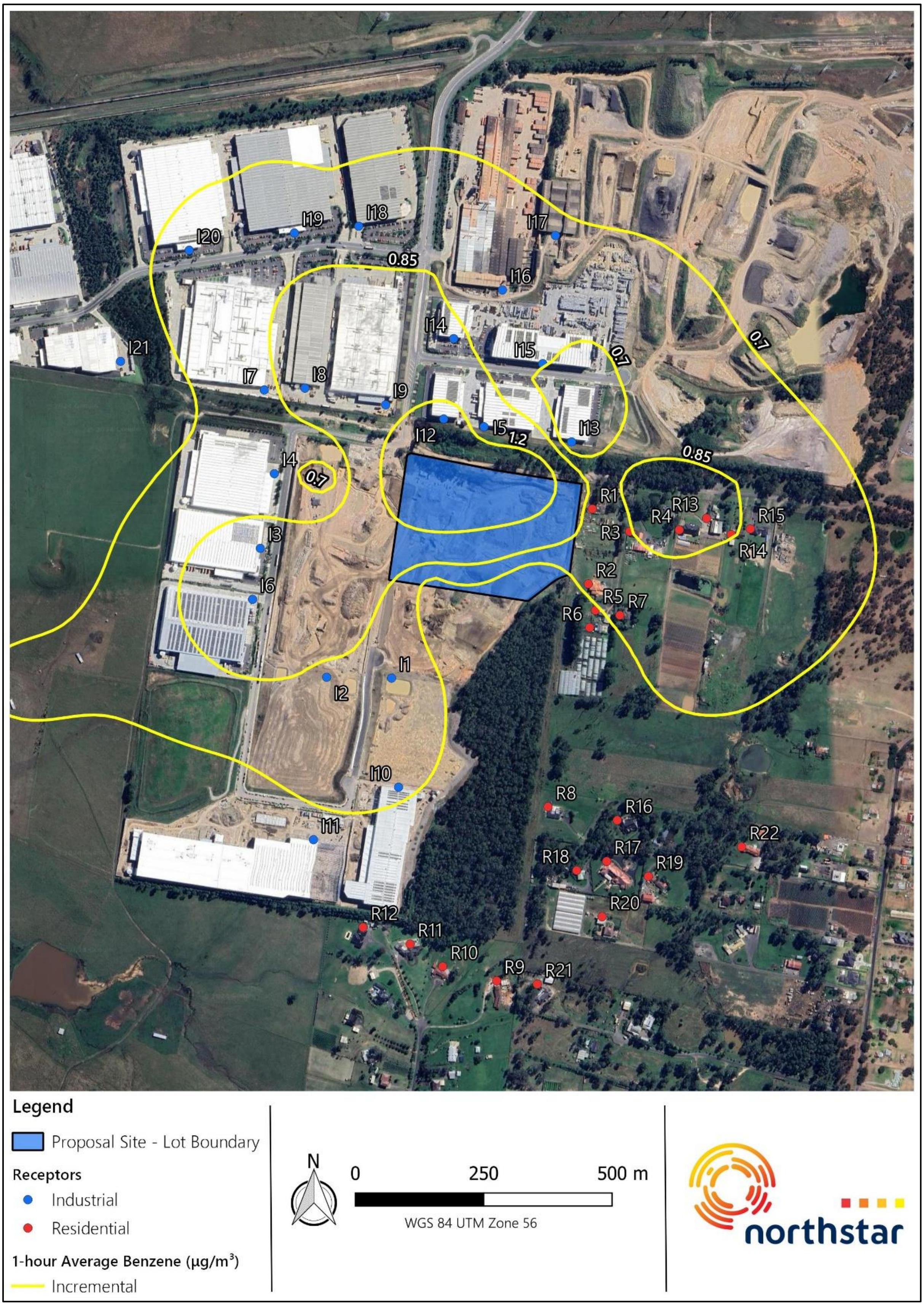
Receptor	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
I13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I21	< 0.1	47.2	47.3	< 0.1	0.4	0.5

Table 34 Predicted maximum incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Stage 2, Scenario 1

Receptor	Maximum 1-hour average concentration ($mg{\cdot}m^{-3}$)				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	0.2	< 0.1	< 0.1	< 0.1
R1	2.76E-10	1.86E-05	4.68E-06	4.68E-06	1.89E-06
R2	2.22E-10	1.50E-05	3.76E-06	3.76E-06	1.52E-06
R3	2.23E-10	1.50E-05	3.78E-06	3.78E-06	1.53E-06
R4	2.96E-10	2.00E-05	5.02E-06	5.02E-06	2.03E-06
R5	2.14E-10	1.44E-05	3.62E-06	3.62E-06	1.46E-06
R6	2.04E-10	1.38E-05	3.46E-06	3.46E-06	1.40E-06
R7	2.73E-10	1.84E-05	4.62E-06	4.62E-06	1.87E-06
R8	3.20E-10	2.16E-05	5.42E-06	5.42E-06	2.19E-06
R9	2.35E-10	1.58E-05	3.98E-06	3.98E-06	1.61E-06
R10	2.57E-10	1.73E-05	4.35E-06	4.35E-06	1.76E-06
R11	2.62E-10	1.76E-05	4.43E-06	4.43E-06	1.79E-06
R12	2.63E-10	1.77E-05	4.45E-06	4.45E-06	1.80E-06
R13	3.19E-10	2.15E-05	5.41E-06	5.41E-06	2.18E-06
R14	3.33E-10	2.25E-05	5.65E-06	5.65E-06	2.28E-06
R15	3.38E-10	2.27E-05	5.72E-06	5.72E-06	2.31E-06
R16	2.97E-10	2.00E-05	5.03E-06	5.03E-06	2.03E-06
R17	2.89E-10	1.95E-05	4.90E-06	4.90E-06	1.98E-06
R18	2.98E-10	2.01E-05	5.05E-06	5.05E-06	2.04E-06
R19	2.75E-10	1.85E-05	4.66E-06	4.66E-06	1.88E-06
R20	2.77E-10	1.86E-05	4.69E-06	4.69E-06	1.89E-06
R21	2.19E-10	1.48E-05	3.72E-06	3.72E-06	1.50E-06
R22	2.69E-10	1.82E-05	4.57E-06	4.57E-06	1.84E-06
I1	3.94E-10	2.65E-05	6.67E-06	6.67E-06	2.69E-06
I2	3.62E-10	2.44E-05	6.14E-06	6.14E-06	2.48E-06
I3	4.04E-10	2.72E-05	6.85E-06	6.85E-06	2.77E-06
I4	3.83E-10	2.58E-05	6.49E-06	6.49E-06	2.62E-06
I5	8.78E-10	5.92E-05	1.49E-05	1.49E-05	6.01E-06
I6	4.11E-10	2.77E-05	6.97E-06	6.97E-06	2.81E-06
I7	3.80E-10	2.56E-05	6.45E-06	6.45E-06	2.60E-06
I8	3.77E-10	2.54E-05	6.39E-06	6.39E-06	2.58E-06
I9	4.88E-10	3.29E-05	8.28E-06	8.28E-06	3.34E-06
I10	3.29E-10	2.21E-05	5.57E-06	5.57E-06	2.25E-06
I11	2.71E-10	1.83E-05	4.60E-06	4.60E-06	1.86E-06
I12	4.60E-10	3.10E-05	7.80E-06	7.80E-06	3.15E-06

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
I13	4.14E-10	2.79E-05	7.02E-06	7.02E-06	2.83E-06
I14	4.51E-10	3.04E-05	7.65E-06	7.65E-06	3.09E-06
I15	4.54E-10	3.06E-05	7.69E-06	7.69E-06	3.10E-06
I16	4.34E-10	2.92E-05	7.35E-06	7.35E-06	2.97E-06
I17	3.55E-10	2.39E-05	6.02E-06	6.02E-06	2.43E-06
I18	4.44E-10	2.99E-05	7.53E-06	7.53E-06	3.04E-06
I19	3.93E-10	2.65E-05	6.67E-06	6.67E-06	2.69E-06
I20	3.76E-10	2.53E-05	6.37E-06	6.37E-06	2.57E-06
I21	3.75E-10	2.53E-05	6.36E-06	6.36E-06	2.57E-06

Figure 14 Predicted maximum incremental 1-hour benzene impacts – Stage 2, Scenario 1



Source: Northstar

7.2.2. Stage 2, Scenario 2 – Realistic Case

Presented below are the results of the modelling assessment under the assumptions of Stage 2, Scenario 2 (refer Section 5.2.2) with 2 no. generators operating at 100 % load for each testing hour. Annual average increments under this scenario have been factored according to the anticipated number of hours of testing each year (refer Section 2.3.2).

7.2.2.1. Particulate Matter

7.2.2.1.1. Annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from Stage 1, Scenario 2 operations are presented in Table 35. Table 35 shows that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at all receptor locations are low (less than 0.1 % of the annual average TSP, PM_{10} and $PM_{2.5}$ criteria).

The Proposal operation under the testing regime is predicted to not result in any exceedances of the relevant criteria.

Table 35 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Stage 2, Scenario 2

Receptor	Annual average concentration (µg·m⁻³)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	90			25			8		
Max. % of criterion	< 0.1	46.0	46.1	< 0.1	80.8	81.0	< 0.1	107.5	108.1
R1	< 0.1	41.4	41.5	< 0.1	20.2	20.2	< 0.1	8.6	8.7
R2	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R3	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R4	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R5	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R6	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R7	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R8	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R9	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R10	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R11	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R12	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R13	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R14	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R15	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R16	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7

Receptor	Annual average concentration (µg·m⁻³)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R17	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R18	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R19	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R20	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R21	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R22	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I1	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I2	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I3	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I4	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I5	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I6	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I7	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I8	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I9	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I10	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I11	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I12	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I13	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I14	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I15	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I16	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I17	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I18	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I19	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I20	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I21	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7

7.2.2.1.2. Maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations

Table 36 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the Proposal operations under Stage 2, Scenario 2. No background concentrations are included within this table.

Table 36 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – Stage 2, Scenario 2

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	1.8	3.5
R1	0.2	0.2
R2	0.1	0.1
R3	0.2	0.2
R4	0.2	0.2
R5	0.1	0.1
R6	< 0.1	< 0.1
R7	0.2	0.2
R8	< 0.1	< 0.1
R9	< 0.1	< 0.1
R10	0.1	0.1
R11	0.1	0.1
R12	< 0.1	< 0.1
R13	0.2	0.2
R14	0.2	0.2
R15	0.2	0.2
R16	< 0.1	< 0.1
R17	< 0.1	< 0.1
R18	< 0.1	< 0.1
R19	< 0.1	< 0.1
R20	< 0.1	< 0.1
R21	< 0.1	< 0.1
R22	< 0.1	< 0.1
I1	0.2	0.2
I2	0.2	0.2
I3	0.2	0.2
I4	0.2	0.2
I5	0.9	0.9
I6	0.2	0.2
I7	0.3	0.3
I8	0.3	0.3
I9	0.5	0.5
I10	0.2	0.2
I11	0.1	0.1
I12	0.4	0.4
I13	0.5	0.5
I14	0.3	0.3

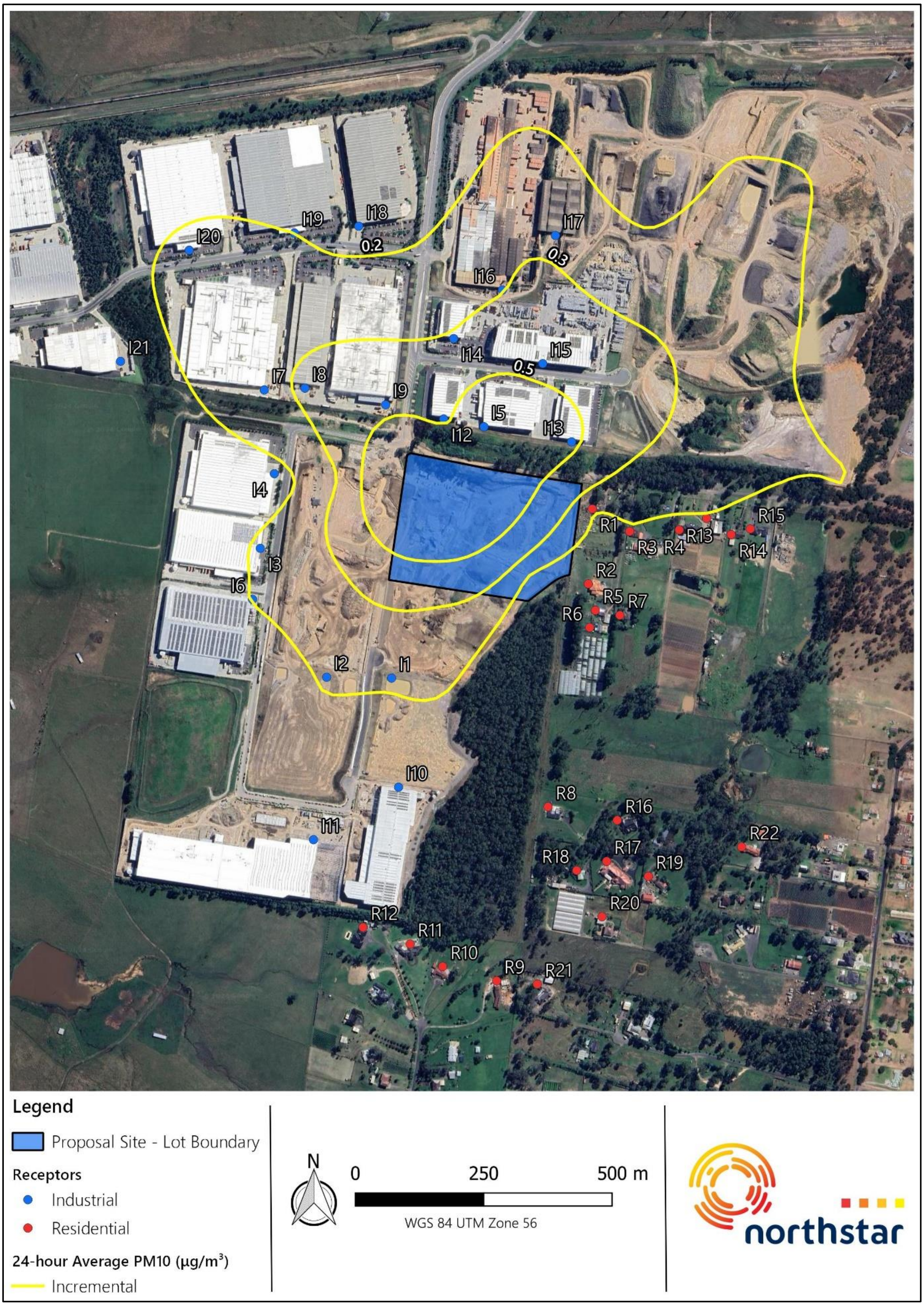
Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
I15	0.4	0.4
I16	0.3	0.3
I17	0.3	0.3
I18	0.2	0.2
I19	0.2	0.2
I20	0.2	0.2
I21	0.2	0.2

The predicted incremental concentrations of PM_{10} and $PM_{2.5}$ are demonstrated to be minor at all receptor locations.

An assessment of the 24-hour PM_{10} and $PM_{2.5}$ concentrations with background included is not presented, as the concentrations are all driven by background. The addition of the predicted increments presented in Table 36 do not result in any additional exceedances of the criteria.

Contour plots of the predicted incremental 24-hour PM_{10} concentrations associated with the Proposal under Stage 2, Scenario 2 are presented in Figure 15 to allow examination of the distribution of particulate matter in the area surrounding the Proposal site.

Figure 15 Predicted maximum incremental 24-hour PM_{10} impacts – Stage 2, Scenario 2



Source: Northstar

7.2.2.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2) under Stage 2, Scenario 2. The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in Table 5.

The predicted maximum 1-hour and annual average NO_2 concentrations resulting from the assumptions under Stage 2, Scenario 2, are presented in Table 37.

The results indicate that predicted incremental and cumulative NO_2 concentrations are below the criteria at all surrounding receptor locations.

The performance of the Proposal under Stage 2, Scenario 2 does not result in any exceedances of the criteria for nitrogen dioxide.

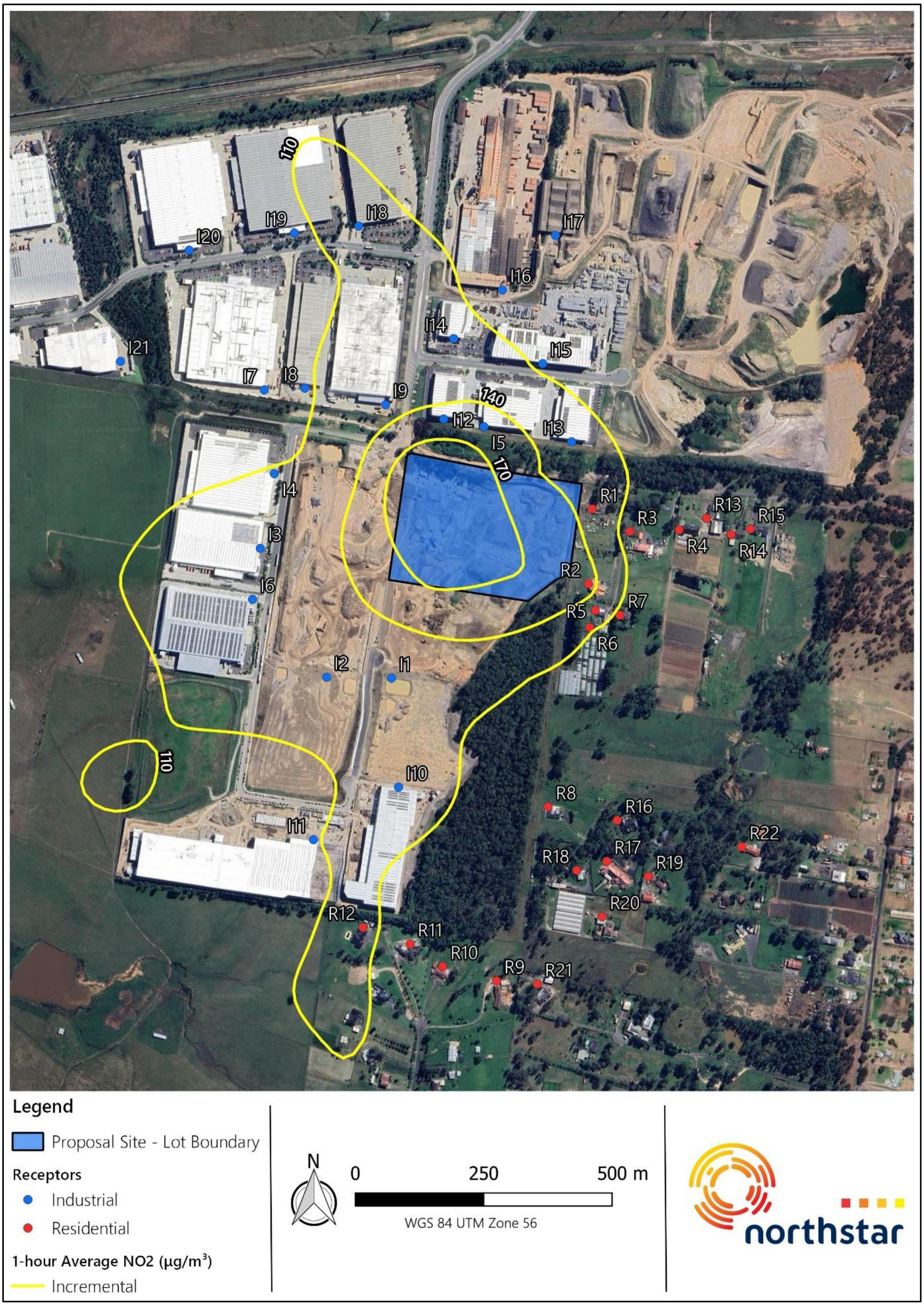
A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 16.

Table 37 Predicted 1-hour and annual average NO_2 concentrations – Stage 2, Scenario 2

Receptor	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})					
	1-hour average			Annual average		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	164			31		
Max. % of criterion	95.2	14.9	97.5	1.3	44.6	45.9
R1	131.7	16.9	148.6	<0.1	13.8	13.9
R2	150.3	1.9	152.2	<0.1	13.8	13.9
R3	98.7	5.6	104.3	<0.1	13.8	13.9
R4	95.7	3.8	99.4	<0.1	13.8	13.9
R5	127.7	1.9	129.6	<0.1	13.8	13.9
R6	112.3	1.9	114.2	<0.1	13.8	13.9
R7	87.7	24.4	112.1	<0.1	13.8	13.9
R8	71.9	15.0	86.9	<0.1	13.8	13.9
R9	102.0	1.9	103.9	<0.1	13.8	13.9
R10	106.0	1.9	107.8	<0.1	13.8	13.9
R11	99.3	5.6	105.0	<0.1	13.8	13.9
R12	114.8	1.9	116.6	<0.1	13.8	13.9
R13	89.2	3.8	93.0	<0.1	13.8	13.9
R14	84.6	3.8	88.4	<0.1	13.8	13.9
R15	80.8	3.8	84.5	<0.1	13.8	13.9
R16	72.9	13.2	86.1	<0.1	13.8	13.9
R17	75.2	13.2	88.4	<0.1	13.8	13.9
R18	75.8	15.0	90.8	<0.1	13.8	13.9
R19	79.8	5.6	85.5	<0.1	13.8	13.9

Receptor	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})					
	1-hour average			Annual average		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R20	74.3	15.0	89.4	<0.1	13.8	13.9
R21	73.8	9.4	83.2	<0.1	13.8	13.9
R22	65.3	18.8	84.1	<0.1	13.8	13.9
I1	110.7	18.8	129.5	<0.1	13.8	13.9
I2	120.9	20.7	141.6	<0.1	13.8	13.9
I3	128.5	15.0	143.6	<0.1	13.8	13.9
I4	111.6	15.0	126.6	<0.1	13.8	13.9
I5	156.1	3.8	159.9	0.4	13.8	14.2
I6	127.7	15.0	142.7	<0.1	13.8	13.9
I7	89.6	24.4	114.1	<0.1	13.8	13.9
I8	92.5	24.4	117.0	0.1	13.8	13.9
I9	126.6	3.8	130.3	0.2	13.8	14.0
I10	108.2	13.2	121.4	<0.1	13.8	13.9
I11	109.5	13.2	122.7	<0.1	13.8	13.9
I12	149.1	3.8	152.9	0.2	13.8	14.1
I13	131.8	9.4	141.2	0.2	13.8	14.0
I14	119.0	1.9	120.9	0.2	13.8	14.0
I15	108.9	3.8	112.7	0.1	13.8	14.0
I16	93.2	9.4	102.6	0.1	13.8	13.9
I17	92.3	9.4	101.7	<0.1	13.8	13.9
I18	118.4	9.4	127.8	<0.1	13.8	13.9
I19	103.7	9.4	113.1	<0.1	13.8	13.9
I20	86.2	24.4	110.7	<0.1	13.8	13.9
I21	95.0	5.6	100.6	<0.1	13.8	13.9

Figure 16 Predicted maximum incremental 1-hour NO_2 impacts – Stage 2, Scenario 2



Source: Northstar

7.2.2.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Stage 2, Scenario 2 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 38 to Table 40 are the predicted concentrations of CO, SO_2, PAHs, VOCs and formaldehyde at varying averaging periods at the surrounding receptors.

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 17.

The predicted incremental concentrations for all of the abovementioned pollutants are below the relevant criteria for all averaging periods at all receptors.

Table 38 Predicted 15-minute, 1-hour and 8-hour average CO concentrations – Stage 2, Scenario 2

Receptor	Carbon monoxide (CO) concentration ($mg \cdot m^{-3}$)								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	< 0.1	3.2	3.3	< 0.1	8.0	8.2	< 0.1	21.0	21.5
R1	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R2	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R3	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R4	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R5	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R6	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R7	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R8	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R9	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R10	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R11	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R12	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R13	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R14	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R15	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R16	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R17	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R18	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R19	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R20	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2

Receptor	Carbon monoxide (CO) concentration ($mg \cdot m^{-3}$)								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R21	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R22	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I1	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I2	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I3	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I4	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I5	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I6	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I7	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I8	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I9	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I10	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I11	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I12	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I13	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I14	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I15	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I16	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I17	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I18	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I19	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I20	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I21	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2

Table 39 Predicted 1-hour and 24-hour SO_2 concentrations – Stage 2, Scenario 2

Rec.	Sulphur dioxide (SO_2) concentration ($\mu g{\cdot}m^{-3}$)					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	286			57		
Max. % of criterion	< 0.1	16.5	16.5	< 0.1	0.7	0.8
R1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R12	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R21	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R22	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I12	< 0.1	47.2	47.3	< 0.1	0.4	0.5

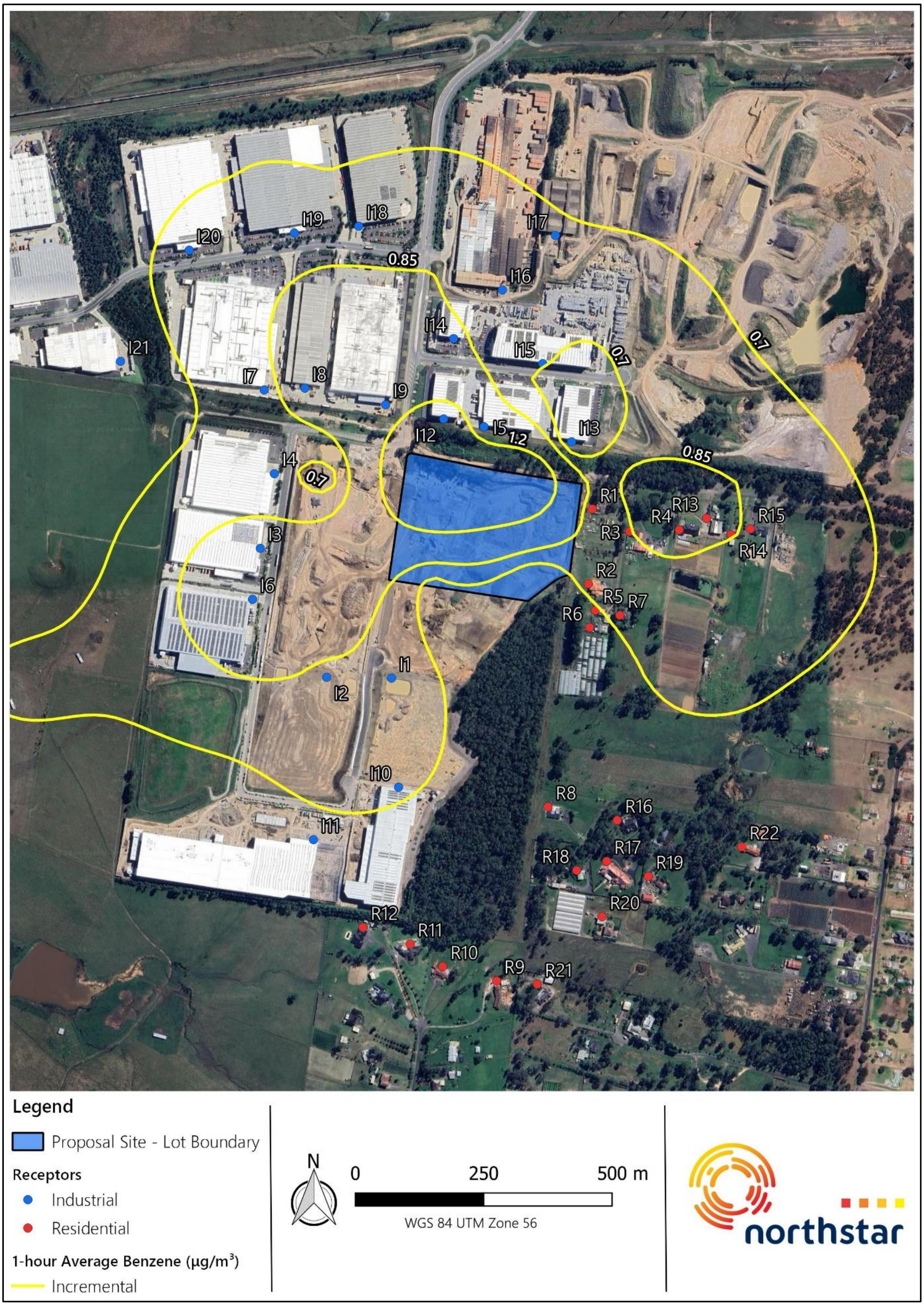
Rec.	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
I13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I21	< 0.1	47.2	47.3	< 0.1	0.4	0.5

Table 40 Predicted maximum incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Stage 2, Scenario 2

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	0.2	< 0.1	< 0.1	< 0.1
R1	2.76E-10	1.86E-05	4.68E-06	4.68E-06	1.89E-06
R2	2.22E-10	1.50E-05	3.76E-06	3.76E-06	1.52E-06
R3	2.23E-10	1.50E-05	3.78E-06	3.78E-06	1.53E-06
R4	2.96E-10	2.00E-05	5.02E-06	5.02E-06	2.03E-06
R5	2.14E-10	1.44E-05	3.62E-06	3.62E-06	1.46E-06
R6	2.04E-10	1.38E-05	3.46E-06	3.46E-06	1.40E-06
R7	2.73E-10	1.84E-05	4.62E-06	4.62E-06	1.87E-06
R8	3.20E-10	2.16E-05	5.42E-06	5.42E-06	2.19E-06
R9	2.35E-10	1.58E-05	3.98E-06	3.98E-06	1.61E-06
R10	2.57E-10	1.73E-05	4.35E-06	4.35E-06	1.76E-06
R11	2.62E-10	1.76E-05	4.43E-06	4.43E-06	1.79E-06
R12	2.63E-10	1.77E-05	4.45E-06	4.45E-06	1.80E-06
R13	3.19E-10	2.15E-05	5.41E-06	5.41E-06	2.18E-06
R14	3.33E-10	2.25E-05	5.65E-06	5.65E-06	2.28E-06
R15	3.38E-10	2.27E-05	5.72E-06	5.72E-06	2.31E-06
R16	2.97E-10	2.00E-05	5.03E-06	5.03E-06	2.03E-06
R17	2.89E-10	1.95E-05	4.90E-06	4.90E-06	1.98E-06
R18	2.98E-10	2.01E-05	5.05E-06	5.05E-06	2.04E-06
R19	2.75E-10	1.85E-05	4.66E-06	4.66E-06	1.88E-06
R20	2.77E-10	1.86E-05	4.69E-06	4.69E-06	1.89E-06
R21	2.19E-10	1.48E-05	3.72E-06	3.72E-06	1.50E-06
R22	2.69E-10	1.82E-05	4.57E-06	4.57E-06	1.84E-06
I1	3.94E-10	2.65E-05	6.67E-06	6.67E-06	2.69E-06
I2	3.62E-10	2.44E-05	6.14E-06	6.14E-06	2.48E-06
I3	4.04E-10	2.72E-05	6.85E-06	6.85E-06	2.77E-06
I4	3.83E-10	2.58E-05	6.49E-06	6.49E-06	2.62E-06
I5	8.78E-10	5.92E-05	1.49E-05	1.49E-05	6.01E-06
I6	4.11E-10	2.77E-05	6.97E-06	6.97E-06	2.81E-06
I7	3.80E-10	2.56E-05	6.45E-06	6.45E-06	2.60E-06
I8	3.77E-10	2.54E-05	6.39E-06	6.39E-06	2.58E-06
I9	4.88E-10	3.29E-05	8.28E-06	8.28E-06	3.34E-06
I10	3.29E-10	2.21E-05	5.57E-06	5.57E-06	2.25E-06
I11	2.71E-10	1.83E-05	4.60E-06	4.60E-06	1.86E-06
I12	4.60E-10	3.10E-05	7.80E-06	7.80E-06	3.15E-06

Receptor	Maximum 1-hour average concentration ($mg \cdot m^{-3}$)				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
I13	4.14E-10	2.79E-05	7.02E-06	7.02E-06	2.83E-06
I14	4.51E-10	3.04E-05	7.65E-06	7.65E-06	3.09E-06
I15	4.54E-10	3.06E-05	7.69E-06	7.69E-06	3.10E-06
I16	4.34E-10	2.92E-05	7.35E-06	7.35E-06	2.97E-06
I17	3.55E-10	2.39E-05	6.02E-06	6.02E-06	2.43E-06
I18	4.44E-10	2.99E-05	7.53E-06	7.53E-06	3.04E-06
I19	3.93E-10	2.65E-05	6.67E-06	6.67E-06	2.69E-06
I20	3.76E-10	2.53E-05	6.37E-06	6.37E-06	2.57E-06
I21	3.75E-10	2.53E-05	6.36E-06	6.36E-06	2.57E-06

Figure 17 Predicted maximum incremental 1-hour benzene impacts – Stage 2, Scenario 2



Source: Northstar

7.3. Stage 3

7.3.1. Stage 3, Scenario 1 - Justified Worst-Case

The following presents the results of the modelling assessment under the assumptions of Stage 3, Scenario 1 (refer Section 5.2.2), with all 98 no. emergency standby generators operating at 100 % load.

Results are presented in this section for short term criteria only (i.e. ≤ 24 hours). The assessment against annual average criteria is essentially meaningless, given that the generators would only be operational for a small number of hours, during that emergency scenario. Operation of those generators over an entire year would not occur.

Assessment of potential impacts against annual average criteria is presented under Stage 3, Scenario 2 (realistic operations).

7.3.1.1. Particulate Matter

Results are presented in this section for the predictions of particulate matter (PM_{10}, and $PM_{2.5}$) associated with Scenario 1. The averaging periods associated with the criteria for these pollutants is 24-hour as specified in Table 5. The emissions adopted for Scenario 1 reflect the operational profile of the Proposal over that averaging period (refer Section 5.2.2).

7.3.1.1.1. Maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations

Table 41 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the assumptions under Stage 3, Scenario 1. No background concentrations are included within this table.

Table 41 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – Stage 3, Scenario 1

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	57.5	114.9
R1	17.0	17.0
R2	14.5	14.5
R3	14.8	14.8
R4	12.3	12.3
R5	12.3	12.3
R6	11.7	11.7
R7	11.6	11.6

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
R8	3.6	3.6
R9	3.4	3.4
R10	5.7	5.7
R11	7.5	7.5
R12	7.5	7.5
R13	12.3	12.3
R14	10.4	10.4
R15	9.8	9.8
R16	4.3	4.3
R17	3.8	3.8
R18	3.3	3.3
R19	4.0	4.0
R20	3.2	3.2
R21	3.1	3.1
R22	5.1	5.1
I1	8.9	8.9
I2	8.4	8.4
I3	7.1	7.1
I4	7.4	7.4
I5	20.3	20.3
I6	7.4	7.4
I7	12.1	12.1
I8	15.0	15.0
I9	18.1	18.1
I10	9.2	9.2
I11	6.7	6.7
I12	28.7	28.7
I13	17.5	17.5
I14	15.2	15.2
I15	15.9	15.9
I16	13.1	13.1
I17	7.9	7.9
I18	8.6	8.6
I19	8.3	8.3
I20	9.2	9.2
I21	7.0	7.0

Note: all PM is assumed to be <1 µg in diameter, and therefore assessed as $PM_{2.5}$. In this instance, emissions of $PM_{2.5}$ will be the same as PM_{10} ($PM_{2.5}$ is a subset of PM_{10}) and therefore the results will be consistent between PM_{10} and $PM_{2.5}$.

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from Stage 3, Scenario 1, with background included are presented in Table 42 and Table 43 respectively.

Results are presented in Table 42 and Table 43 for those receptors at which the greatest impacts have been predicted (see Table 41).

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

Table 42 Summary of contemporaneous 24-hour PM_{10} concentrations – Stage 3, Scenario 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor R10			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) – Receptor I12		
	Incr.	Bg.	Cumul.		Incr.	Bg.	Cumul.
23/01/20	3.8	245.8	249.6	26/10/20	28.7	12.8	41.5
24/01/20	< 0.1	105.6	105.7	05/01/20	26.7	81.1	107.8
08/01/20	< 0.1	97.8	97.9	25/12/20	25.0	17.1	42.1
05/01/20	< 0.1	81.1	81.2	11/01/20	24.3	58.0	82.3
12/01/20	< 0.1	69.7	69.8	26/03/20	23.8	17.7	41.5
04/01/20	1.0	68.4	69.4	16/03/20	22.9	9.3	32.2
25/01/20	< 0.1	61.5	61.6	11/12/20	22.8	18.3	41.1
11/01/20	< 0.1	58.0	58.1	10/08/20	21.6	14.6	36.2
01/01/20	< 0.1	57.4	57.5	25/10/20	17.8	7.3	25.1
02/01/20	< 0.1	54.0	54.1	04/02/20	17.7	37.6	55.3
29/08/20	1.2	47.6	48.8	10/12/20	17.0	30.8	47.8
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the Proposal				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the Proposal.			

Table 43 Summary of contemporaneous 24-hour $PM_{2.5}$ concentrations – Stage 3, Scenario 1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor I12			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor I12		
	Incr.	Bg.	Cumul.		Incr.	Bg.	Cumul.
08-01-20	10.5	70.8	81.3	26-10-20	28.7	4.6	33.3
05-01-20	26.7	41.7	68.4	05-01-20	26.7	41.7	68.4
12-01-20	10.9	47.2	58.1	25-12-20	25.0	3.7	28.7
11-01-20	24.3	33.4	57.7	11-01-20	24.3	33.4	57.7
24-01-20	9.7	37.5	47.2	26-03-20	23.8	5.5	29.3
17-01-20	9.1	31.3	40.4	16-03-20	22.9	3.2	26.1
04-02-20	17.7	19.7	37.4	11-12-20	22.8	5.2	28.0
29-08-20	< 0.1	37.1	37.2	10-08-20	21.6	4.1	25.7
01-01-20	11.1	25.8	36.9	25-10-20	17.8	2.1	19.9
02-01-20	5.8	30.4	36.2	04-02-20	17.7	19.7	37.4
07-06-20	4.6	29.3	33.9	10-12-20	17.0	7.9	24.9
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) as a result of the operation of the Proposal.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) as a result of the operation of the Proposal.			

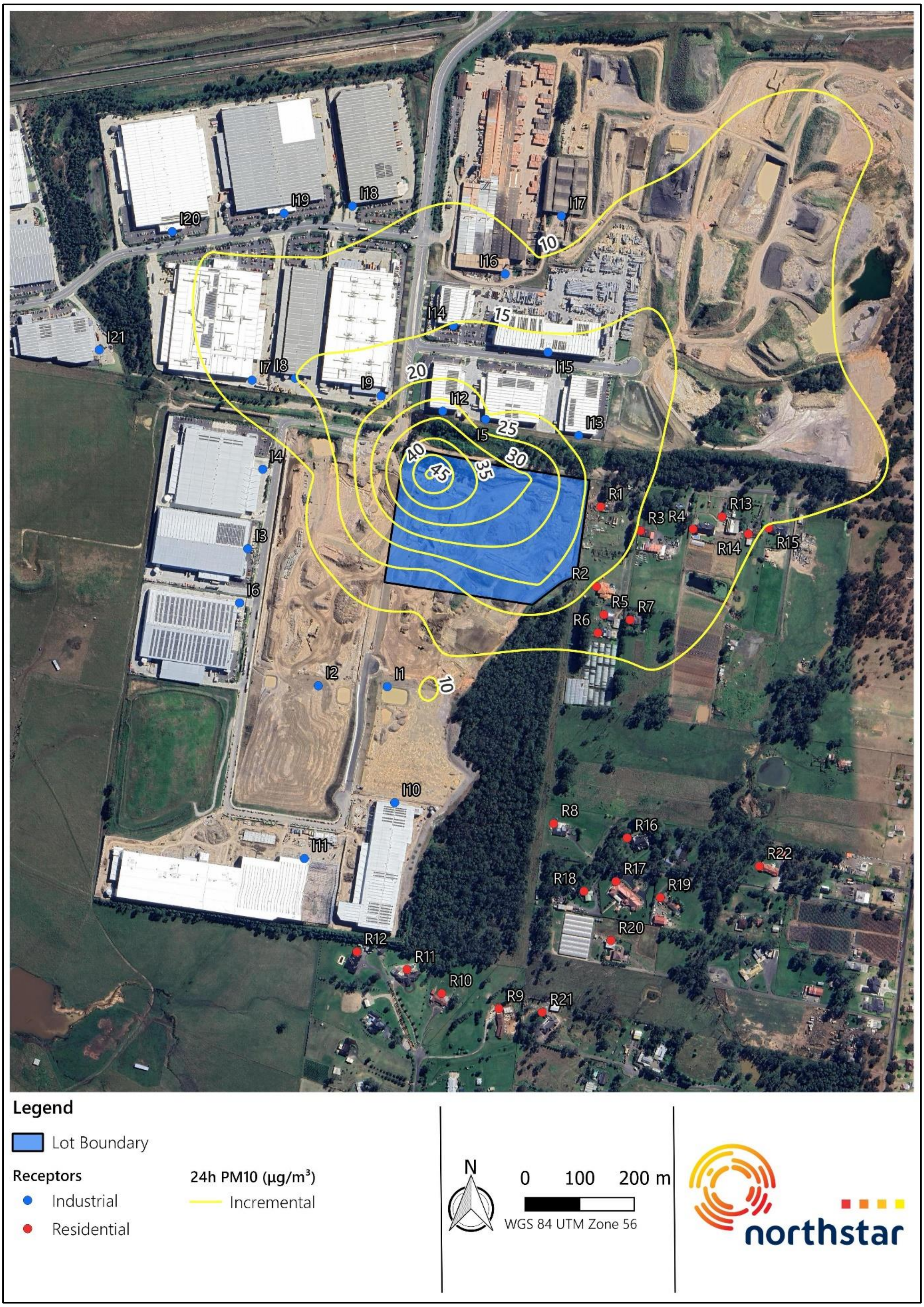
For PM_{10} the maximum cumulative impact (the left-hand side of Table 42) is predicted at receptor R10, and the maximum incremental impact (the right-hand side of Table 42) is predicted at receptor I12. Table 42 indicates that the highest cumulative impacts are driven by elevated background concentrations. It can be seen in Table 42 that the highest cumulative impacts correspond with background concentrations during early 2020 which are associated with exceptional events including bushfires and intense drought conditions (NSW DPIE, 2021). It is noted that the highest incremental impacts are also predicted to result in exceedances of the relevant criterion, with the addition of background concentrations at I12.

For $PM_{2.5}$, the maximum cumulative impact (the left-hand side of Table 43) and the maximum incremental impact (the right-hand side of Table 43) is predicted at receptor I12. Table 43 indicates that exceedances associated with the highest cumulative impacts are driven by elevated background air quality concentrations while exceedances associated with the highest incremental impacts are driven by significant incremental contributions from the Proposal under an emergency scenario.

A contour plot of the predicted incremental 24-hour PM_{10} concentrations associated with the Proposal are presented in Figure 18 to allow examination of the distribution of particulate matter in the area surrounding the Proposal.

The number of additional exceedances of the 24-hour PM_{10} and $PM_{2.5}$ criteria predicted at various receptors resulting from emergency generator operation is presented in Section 7.4.3 These values are discussed further in Section 8.2.

Figure 18 Predicted maximum incremental 24-hour PM_{10} impacts – Stage 3, Scenario 1



Source: Northstar

7.3.1.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2) under the assumptions of Stage 3, Scenario 1 (refer Section 5.2.2). The averaging period associated with the criterion for NO_2 is 1-hour as specified in Table 5.

Emissions of NO_X have been calculated, with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_X is a mixture of NO_2 and nitric oxide (NO), conversion of NO_X predictions to NO_2 concentrations may be performed. Within this assessment, the OLM method has been adopted as outlined in Section 5.2.5.

The predicted maximum 1-hour average NO_2 concentrations resulting from the Proposal operations are presented in Table 44.

Table 44 Predicted 1-hour NO_2 concentrations – Stage 3, Scenario 1

Receptor	Nitrogen dioxide (NO_2) concentration (µg·m^{-3})		
	1-hour average		
	Incr.	Bg.	Cumul.
Criterion	164		
Max % of criterion	1 146.2	35.5	1143.9
R1	966.7	16.9	983.6
R2	868.2	3.8	871.9
R3	1 044.2	18.8	1 063.0
R4	1 077.9	16.9	1 094.9
R5	890.9	9.4	900.3
R6	791.0	9.4	800.4
R7	945.1	9.4	954.5
R8	849.5	3.8	853.3
R9	698.1	16.9	715.0
R10	788.8	5.6	794.4
R11	879.9	1.9	881.8
R12	853.9	18.8	872.7
R13	1 100.3	18.8	1119.1
R14	1 039.2	18.8	1 058.0
R15	1 023.6	16.9	1 040.5
R16	796.0	28.2	824.2
R17	792.9	5.6	798.5
R18	812.7	3.8	816.5
R19	746.8	28.2	775.0
R20	765.6	1.9	767.5
R21	733.9	-1.9	732.0
R22	818.7	28.2	846.9

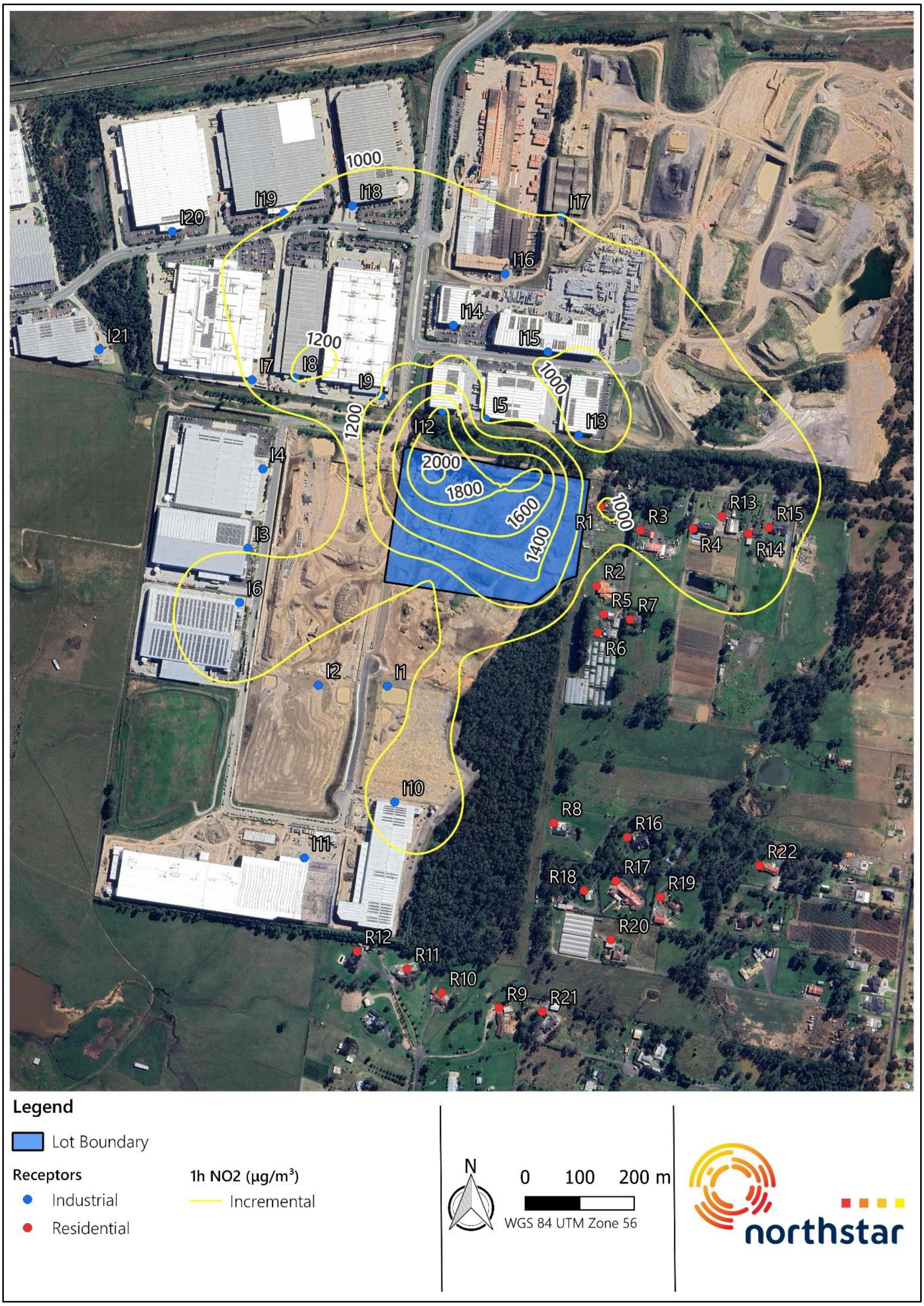
Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g{\cdot}m^{-3}$)		
	1-hour average		
	Incr.	Bg.	Cumul.
I1	898.6	5.6	904.2
I2	923.1	3.8	926.9
I3	986.6	9.4	996.0
I4	772.5	35.7	808.2
I5	1 131.5	1.9	1 133.3
I6	1 124.2	7.5	1 131.7
I7	1 029.1	47.0	1 076.1
I8	1 215.6	16.9	1 232.5
I9	1 196.1	3.8	1 199.8
I10	1 042.8	15.0	1057.8
I11	882.3	20.7	903.0
I12	1 879.7	-3.8	1 876.0
I13	889.3	7.5	896.8
I14	1 175.1	26.3	1 201.4
I15	1 013.5	13.2	1 026.7
I16	1 067.9	15.0	1 082.9
I17	1 002.7	18.8	1 021.5
I18	1 059.3	16.9	1 076.2
I19	989.6	39.5	1 029.1
I20	887.7	52.6	940.3
I21	798.5	58.3	856.8

The results indicate that predicted incremental concentrations of NO_2 under Stage 3, Scenario 1 are significantly above the criteria at all surrounding receptor locations.

A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 19.

The number of additional exceedances of the 1-hour NO_2 criterion predicted at each receptor resulting from emergency generator operation is presented in Section 7.4.3 These values are discussed further in Section 8.2.

Figure 19 Predicted maximum incremental 1-hour NO_2 impacts – Stage 3, Scenario 1



Source: Northstar

7.3.1.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Stage 3, Scenario 1 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 45 to Table 47 are the predicted concentrations of CO, SO_2, PAHs, VOCs and formaldehyde at varying averaging periods (≤ 24 hours) at the surrounding receptors.

The predicted cumulative concentrations for CO are significantly below the relevant criteria for all averaging periods at all receptors as shown in Table 45.

The results presented in Table 46 indicate that predicted incremental impacts of SO_2 at all receptors are less than 0.1 % of the relevant criteria for all averaging periods. The addition of background concentrations does not result in any exceedances at any receptor.

Results presented in Table 47 show no exceedances of the 1-hour criteria for benzene are predicted at any identified receptors. The maximum predicted impact for benzene is experienced at receptor I12 (6.7 % of the relevant criterion).

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 20.

Table 45 Predicted 15-minutes, 1-hour and 8-hour average CO concentrations – Stage 3, Scenario 1

Receptor	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	1.5	3.2	3.3	3.7	8.0	8.2	6.9	21.0	21.5
R1	0.8	3.2	3.3	0.6	2.4	2.5	0.5	2.1	2.2
R2	0.7	3.2	3.3	0.5	2.4	2.5	0.4	2.1	2.2
R3	0.8	3.2	3.3	0.6	2.4	2.5	0.4	2.1	2.2
R4	0.8	3.2	3.3	0.6	2.4	2.5	0.4	2.1	2.2
R5	0.7	3.2	3.3	0.5	2.4	2.5	0.4	2.1	2.2
R6	0.6	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
R7	0.7	3.2	3.3	0.6	2.4	2.5	0.4	2.1	2.2
R8	0.6	3.2	3.3	0.5	2.4	2.5	0.2	2.1	2.2
R9	0.5	3.2	3.3	0.4	2.4	2.5	0.1	2.1	2.2
R10	0.6	3.2	3.3	0.4	2.4	2.5	0.2	2.1	2.2
R11	0.6	3.2	3.3	0.5	2.4	2.5	0.2	2.1	2.2
R12	0.7	3.2	3.3	0.5	2.4	2.5	0.2	2.1	2.2
R13	0.9	3.2	3.3	0.7	2.4	2.5	0.4	2.1	2.2
R14	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
R15	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
R16	0.6	3.2	3.3	0.5	2.4	2.5	0.1	2.1	2.2
R17	0.6	3.2	3.3	0.5	2.4	2.5	0.2	2.1	2.2
R18	0.6	3.2	3.3	0.5	2.4	2.5	0.2	2.1	2.2
R19	0.6	3.2	3.3	0.4	2.4	2.5	0.1	2.1	2.2
R20	0.6	3.2	3.3	0.4	2.4	2.5	0.2	2.1	2.2

Receptor	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R21	0.5	3.2	3.3	0.4	2.4	2.5	0.1	2.1	2.2
R22	0.6	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
I1	0.7	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
I2	0.7	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
I3	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
I4	0.6	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
I5	0.9	3.2	3.3	0.7	2.4	2.5	0.4	2.1	2.2
I6	0.9	3.2	3.3	0.6	2.4	2.5	0.4	2.1	2.2
I7	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
I8	0.9	3.2	3.3	0.7	2.4	2.5	0.4	2.1	2.2
I9	0.9	3.2	3.3	0.7	2.4	2.5	0.5	2.1	2.2
I10	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
I11	0.7	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
I12	1.5	3.2	3.3	1.1	2.4	2.5	0.7	2.1	2.2
I13	0.7	3.2	3.3	0.5	2.4	2.5	0.4	2.1	2.2
I14	0.9	3.2	3.3	0.7	2.4	2.5	0.4	2.1	2.2
I15	0.8	3.2	3.3	0.6	2.4	2.5	0.4	2.1	2.2
I16	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
I17	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
I18	0.8	3.2	3.3	0.6	2.4	2.5	0.3	2.1	2.2
I19	0.8	3.2	3.3	0.6	2.4	2.5	0.4	2.1	2.2
I20	0.7	3.2	3.3	0.5	2.4	2.5	0.3	2.1	2.2
I21	0.6	3.2	3.3	0.5	2.4	2.5	0.2	2.1	2.2

Table 46 Predicted 1-hour and 24-hour SO_2 concentrations – Stage 3, Scenario 1

Receptor	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	286			57		
Max. % of criterion	< 0.1	16.5	16.5	< 0.1	0.7	0.8
R1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R12	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R21	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R22	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I12	< 0.1	47.2	47.3	< 0.1	0.4	0.5

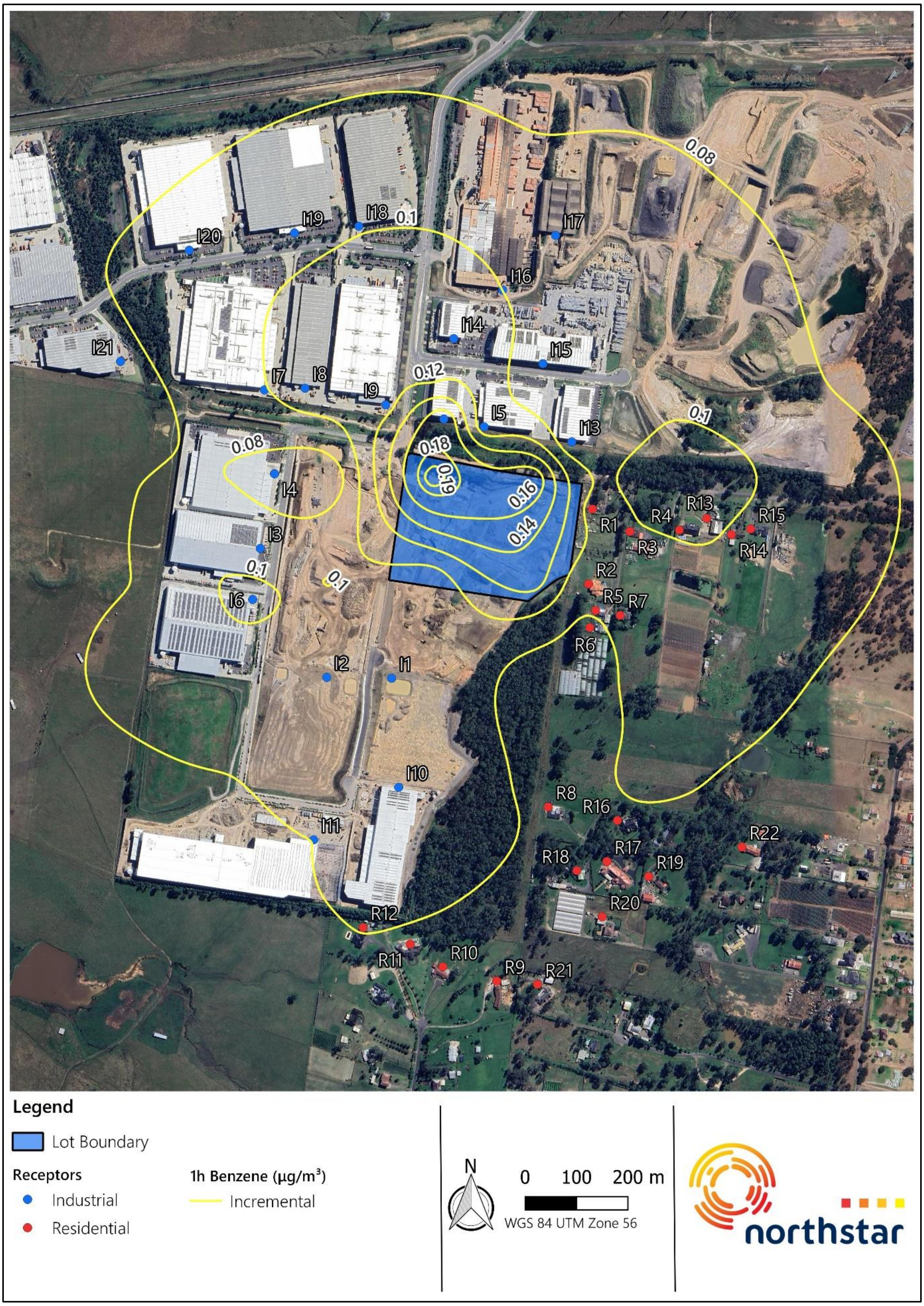
Receptor	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
I13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I21	< 0.1	47.2	47.3	< 0.1	0.4	0.5

Table 47 Predicted maximum incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Stage 3, Scenario 1

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	6.7	0.2	0.3	1.0
R1	1.48E-08	9.98E-04	3.59E-04	2.50E-04	1.01E-04
R2	1.32E-08	8.91E-04	3.21E-04	2.23E-04	9.04E-05
R3	1.59E-08	1.07E-03	3.86E-04	2.68E-04	1.09E-04
R4	1.63E-08	1.10E-03	3.95E-04	2.75E-04	1.12E-04
R5	1.35E-08	9.11E-04	3.28E-04	2.28E-04	9.25E-05
R6	1.21E-08	8.16E-04	2.94E-04	2.04E-04	8.29E-05
R7	1.42E-08	9.57E-04	3.45E-04	2.39E-04	9.72E-05
R8	1.25E-08	8.42E-04	3.03E-04	2.11E-04	8.55E-05
R9	1.03E-08	6.93E-04	2.49E-04	1.73E-04	7.04E-05
R10	1.11E-08	7.49E-04	2.70E-04	1.87E-04	7.61E-05
R11	1.24E-08	8.38E-04	3.02E-04	2.10E-04	8.51E-05
R12	1.29E-08	8.71E-04	3.13E-04	2.18E-04	8.84E-05
R13	1.69E-08	1.14E-03	4.09E-04	2.84E-04	1.15E-04
R14	1.56E-08	1.05E-03	3.79E-04	2.63E-04	1.07E-04
R15	1.54E-08	1.04E-03	3.73E-04	2.59E-04	1.05E-04
R16	1.21E-08	8.16E-04	2.94E-04	2.04E-04	8.29E-05
R17	1.15E-08	7.73E-04	2.78E-04	1.93E-04	7.86E-05
R18	1.18E-08	7.97E-04	2.87E-04	1.99E-04	8.10E-05
R19	1.13E-08	7.62E-04	2.74E-04	1.91E-04	7.74E-05
R20	1.12E-08	7.53E-04	2.71E-04	1.88E-04	7.65E-05
R21	1.07E-08	7.19E-04	2.59E-04	1.80E-04	7.31E-05
R22	1.24E-08	8.33E-04	3.00E-04	2.08E-04	8.46E-05
I1	1.32E-08	8.87E-04	3.19E-04	2.22E-04	9.01E-05
I2	1.37E-08	9.23E-04	3.32E-04	2.31E-04	9.38E-05
I3	1.49E-08	1.00E-03	3.60E-04	2.50E-04	1.02E-04
I4	1.19E-08	7.99E-04	2.88E-04	2.00E-04	8.11E-05
I5	1.67E-08	1.12E-03	4.04E-04	2.81E-04	1.14E-04
I6	1.67E-08	1.12E-03	4.05E-04	2.81E-04	1.14E-04
I7	1.62E-08	1.09E-03	3.93E-04	2.73E-04	1.11E-04
I8	1.83E-08	1.23E-03	4.43E-04	3.08E-04	1.25E-04
I9	1.76E-08	1.19E-03	4.28E-04	2.97E-04	1.21E-04
I10	1.57E-08	1.06E-03	3.80E-04	2.64E-04	1.07E-04
I11	1.30E-08	8.76E-04	3.15E-04	2.19E-04	8.89E-05
I12	2.89E-08	1.95E-03	7.02E-04	4.87E-04	1.98E-04

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
I13	1.31E-08	8.83E-04	3.18E-04	2.21E-04	8.97E-05
I14	1.78E-08	1.20E-03	4.32E-04	3.00E-04	1.22E-04
I15	1.57E-08	1.05E-03	3.80E-04	2.64E-04	1.07E-04
I16	1.58E-08	1.06E-03	3.83E-04	2.66E-04	1.08E-04
I17	1.51E-08	1.02E-03	3.66E-04	2.54E-04	1.03E-04
I18	1.58E-08	1.07E-03	3.83E-04	2.66E-04	1.08E-04
I19	1.51E-08	1.02E-03	3.66E-04	2.54E-04	1.03E-04
I20	1.38E-08	9.29E-04	3.34E-04	2.32E-04	9.43E-05
I21	1.26E-08	8.46E-04	3.04E-04	2.11E-04	8.59E-05

Figure 20 Predicted maximum incremental 1-hour benzene impacts – Stage 3, Scenario 1



Source: Northstar

7.3.2. Stage 3, Scenario 2 – Realistic Case

Presented below are the results of the modelling assessment under the assumptions of Stage 3, Scenario 2 (refer Section 5.2.2) with 2 no. generators operating at 100 % load for each testing hour. Annual average increments under this scenario have been factored according to the anticipated number of hours of testing each year (refer Section 2.3.2).

7.3.2.1. Particulate Matter

7.3.2.1.1. Annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from Stage 3, Scenario 2 operations are presented in Table 48. Table 48 shows that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at all receptor locations are low (less than 0.1 % of the annual average TSP, PM_{10} and $PM_{2.5}$ criteria).

The Proposal operation under the testing regime is predicted to not result in any exceedances of the relevant criteria.

Table 48 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Stage 3, Scenario 2

Receptor	Annual average concentration ($\mu g \cdot m^{-3}$)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	90			25			8		
Max. % of criterion	< 0.1	46.0	46.1	< 0.1	80.8	81.0	< 0.1	107.5	108.1
R1	< 0.1	41.4	41.5	< 0.1	20.2	20.2	< 0.1	8.6	8.7
R2	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R3	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R4	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R5	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R6	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R7	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R8	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R9	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R10	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R11	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R12	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R13	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R14	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R15	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R16	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7

Receptor	Annual average concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R17	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R18	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R19	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R20	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R21	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
R22	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I1	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I2	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I3	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I4	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I5	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I6	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I7	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I8	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I9	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I10	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I11	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I12	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I13	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I14	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I15	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I16	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I17	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I18	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I19	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I20	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7
I21	< 0.1	41.4	41.5	< 0.1	20.2	20.3	< 0.1	8.6	8.7

7.3.2.1.2. Maximum 24-hour PM_{10} and $PM_{2.5}$ concentrations

Table 49 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest receptors, as a result of the Proposal operations under Stage 3, Scenario 2. No background concentrations are included within this table.

Table 49 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations – Stage 3, Scenario 2

Receptor	Maximum 24-hour average concentration (µg·m^{-3})	
	PM_{10}	$PM_{2.5}$
Criterion	50	25
Max. % of criterion	1.1	2.1
R1	0.2	0.2
R2	< 0.1	< 0.1
R3	0.1	0.1
R4	0.1	0.1
R5	< 0.1	< 0.1
R6	< 0.1	< 0.1
R7	< 0.1	< 0.1
R8	< 0.1	< 0.1
R9	< 0.1	< 0.1
R10	< 0.1	< 0.1
R11	< 0.1	< 0.1
R12	< 0.1	< 0.1
R13	< 0.1	< 0.1
R14	0.1	0.1
R15	< 0.1	< 0.1
R16	< 0.1	< 0.1
R17	< 0.1	< 0.1
R18	< 0.1	< 0.1
R19	< 0.1	< 0.1
R20	< 0.1	< 0.1
R21	< 0.1	< 0.1
R22	< 0.1	< 0.1
I1	< 0.1	< 0.1
I2	< 0.1	< 0.1
I3	0.1	0.1
I4	0.1	0.1
I5	0.5	0.5
I6	0.1	0.1
I7	0.1	0.1
I8	0.2	0.2
I9	0.2	0.2
I10	< 0.1	< 0.1
I11	< 0.1	< 0.1
I12	0.3	0.3
I13	0.3	0.3
I14	0.2	0.2

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
I15	0.1	0.1
I16	0.2	0.2
I17	0.1	0.1
I18	0.1	0.1
I19	0.1	0.1
I20	0.1	0.1
I21	< 0.1	< 0.1

The predicted incremental concentrations of PM_{10} and $PM_{2.5}$ are demonstrated to be minor at all receptor locations.

An assessment of the 24-hour PM_{10} and $PM_{2.5}$ concentrations with background included is not presented, as the concentrations are all driven by background. The addition of the predicted increments presented in Table 49 do not result in any additional exceedances of the criteria.

Contour plots of the predicted incremental 24-hour PM_{10} concentrations associated with the Proposal under Stage 3, Scenario 2 are presented in Figure 21 to allow examination of the distribution of particulate matter in the area surrounding the Proposal site.

Figure 21 Predicted maximum incremental 24-hour PM_{10} impacts – Stage 3, Scenario 2

Source: Northstar

7.3.2.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO_2) under Stage 3, Scenario 2. The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in Table 5.

The predicted maximum 1-hour and annual average NO_2 concentrations resulting from the assumptions under Stage 3, Scenario 2, are presented in Table 50.

The results indicate that predicted incremental and cumulative NO_2 concentrations are below the criteria at all surrounding receptor locations.

The performance of the Proposal under Stage 3, Scenario 2 does not result in any exceedances of the criteria for nitrogen dioxide.

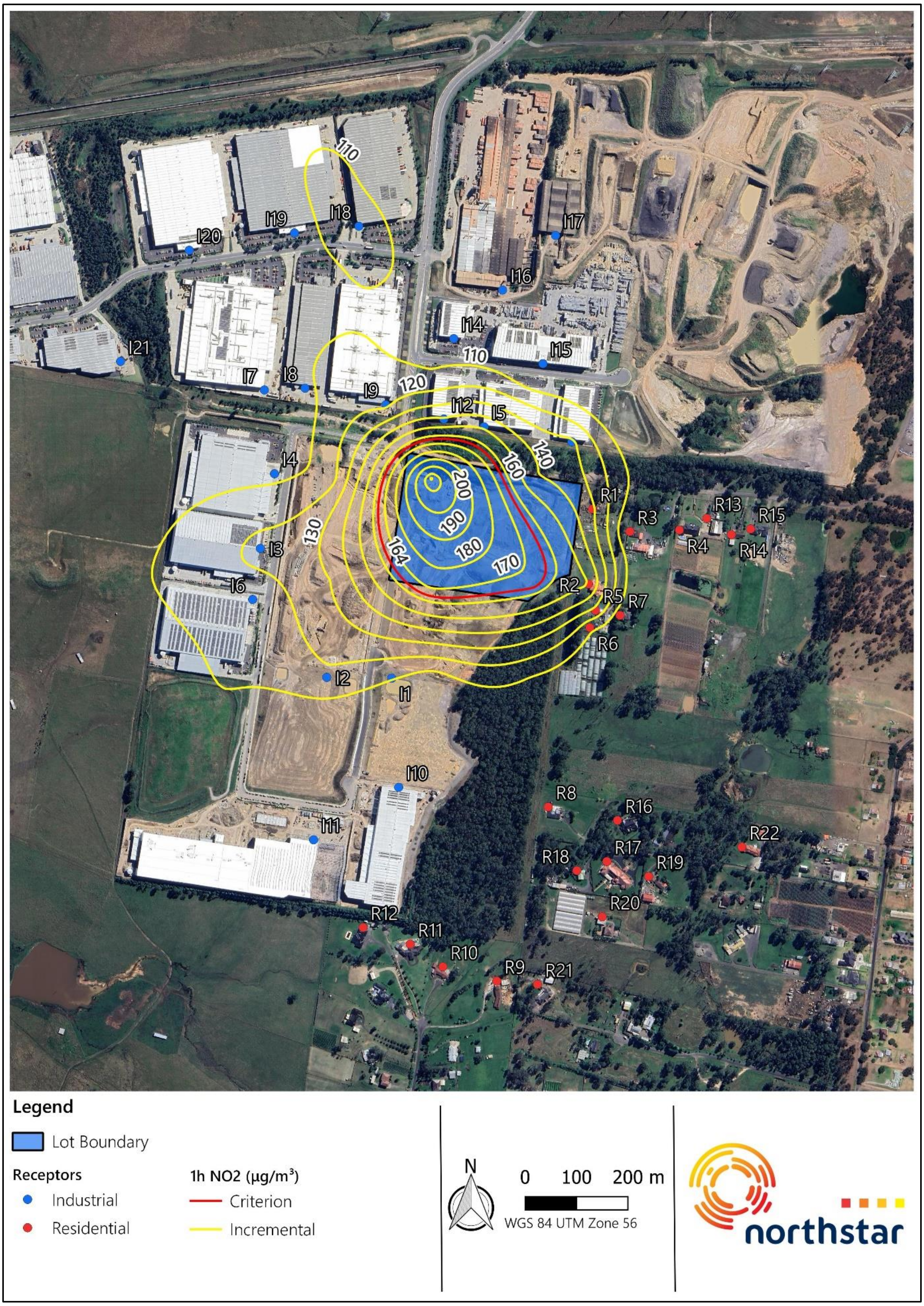
A contour plot of the predicted maximum 1-hour incremental NO_2 impact is presented in Figure 22.

Table 50 Predicted 1-hour and annual average NO_2 concentrations – Stage 3, Scenario 2

Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g{\cdot}m^{-3}$)					
	1-hour average			Annual average		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	164			31		
Max. % of criterion	91.7	49.3	92.8	0.8	44.6	45.5
R1	131.7	16.9	148.6	< 0.1	13.8	13.9
R2	150.3	1.9	152.2	< 0.1	13.8	13.9
R3	98.7	5.6	104.3	< 0.1	13.8	13.9
R4	95.7	3.8	99.4	< 0.1	13.8	13.9
R5	127.7	1.9	129.6	< 0.1	13.8	13.9
R6	112.3	1.9	114.2	< 0.1	13.8	13.9
R7	87.7	24.4	112.1	< 0.1	13.8	13.9
R8	88.7	1.9	90.5	< 0.1	13.8	13.9
R9	96.1	1.9	98.0	< 0.1	13.8	13.9
R10	96.7	5.6	102.3	< 0.1	13.8	13.9
R11	99.3	5.6	105.0	< 0.1	13.8	13.9
R12	95.2	5.6	100.8	< 0.1	13.8	13.9
R13	89.2	3.8	93.0	< 0.1	13.8	13.9
R14	84.6	3.8	88.4	< 0.1	13.8	13.9
R15	80.8	3.8	84.5	< 0.1	13.8	13.9
R16	72.9	13.2	86.1	< 0.1	13.8	13.9
R17	75.2	13.2	88.4	< 0.1	13.8	13.9
R18	< 0.1	80.8	80.9	< 0.1	13.8	13.9
R19	79.8	5.6	85.5	< 0.1	13.8	13.9

Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour average			Annual average		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R20	72.7	13.2	85.9	< 0.1	13.8	13.9
R21	79.2	1.9	81.1	< 0.1	13.8	13.9
R22	65.3	18.8	84.1	< 0.1	13.8	13.9
I1	110.7	18.8	129.5	< 0.1	13.8	13.9
I2	118.4	7.5	125.9	< 0.1	13.8	13.9
I3	123.3	9.4	132.7	< 0.1	13.8	13.9
I4	107.9	13.2	121.1	< 0.1	13.8	13.9
I5	148.4	3.8	152.2	0.3	13.8	14.1
I6	111.8	9.4	121.2	< 0.1	13.8	13.9
I7	84.6	16.9	101.5	< 0.1	13.8	13.9
I8	86.7	22.6	109.2	< 0.1	13.8	13.9
I9	116.1	3.8	119.9	0.1	13.8	14.0
I10	78.8	15.0	93.8	< 0.1	13.8	13.9
I11	81.9	15.0	97.0	< 0.1	13.8	13.9
I12	140.9	3.8	144.7	0.2	13.8	14.0
I13	131.8	9.4	141.2	< 0.1	13.8	13.9
I14	103.3	9.4	112.7	< 0.1	13.8	13.9
I15	98.9	9.4	108.3	< 0.1	13.8	13.9
I16	93.2	9.4	102.6	< 0.1	13.8	13.9
I17	92.3	9.4	101.7	< 0.1	13.8	13.9
I18	118.4	9.4	127.8	< 0.1	13.8	13.9
I19	103.7	9.4	113.1	< 0.1	13.8	13.9
I20	90.9	7.5	98.4	< 0.1	13.8	13.9
I21	98.6	1.9	100.5	< 0.1	13.8	13.9

Figure 22 Predicted maximum incremental 1-hour NO_2 impacts – Stage 3, Scenario 2



Source: Northstar

7.3.2.3. All Other Pollutants

The following presents the predicted ground level concentrations associated with Stage 3, Scenario 2 for all other pollutants assessed in this study (refer Section 5.2.2).

Presented in Table 51 to Table 53 are the predicted concentrations of CO, SO_2, PAHs, VOCs and formaldehyde at varying averaging periods at the surrounding receptors.

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 23.

The predicted incremental concentrations for all of the abovementioned pollutants are below the relevant criteria for all averaging periods at all receptors.

Table 51 Predicted 15-minute, 1-hour and 8-hour average CO concentrations – Stage 3, Scenario 2

Rec.	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	< 0.1	3.2	3.3	< 0.1	8.0	8.2	< 0.1	21.0	21.5
R1	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R2	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R3	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R4	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R5	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R6	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R7	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R8	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R9	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R10	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R11	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R12	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R13	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R14	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R15	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R16	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R17	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R18	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R19	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R20	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2

Rec.	Carbon monoxide (CO) concentration (mg·m^{-3})								
	15-minute			1-hour			8-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
R21	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
R22	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I1	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I2	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I3	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I4	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I5	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I6	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I7	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I8	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I9	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I10	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I11	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I12	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I13	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I14	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I15	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I16	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I17	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I18	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I19	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I20	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2
I21	< 0.1	3.2	3.3	< 0.1	2.4	2.5	< 0.1	2.1	2.2

Table 52 Predicted 1-hour and 24-hour SO_2 concentrations – Stage 3, Scenario 2

Receptor	Sulphur dioxide (SO_2) concentration (µg·m^{-3})					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
Criterion	286			57		
Max. % of criterion	< 0.1	16.5	16.5	< 0.1	0.7	0.8
R1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R12	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R21	< 0.1	47.2	47.3	< 0.1	0.4	0.5
R22	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I1	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I2	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I3	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I4	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I5	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I6	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I7	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I8	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I9	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I10	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I11	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I12	< 0.1	47.2	47.3	< 0.1	0.4	0.5

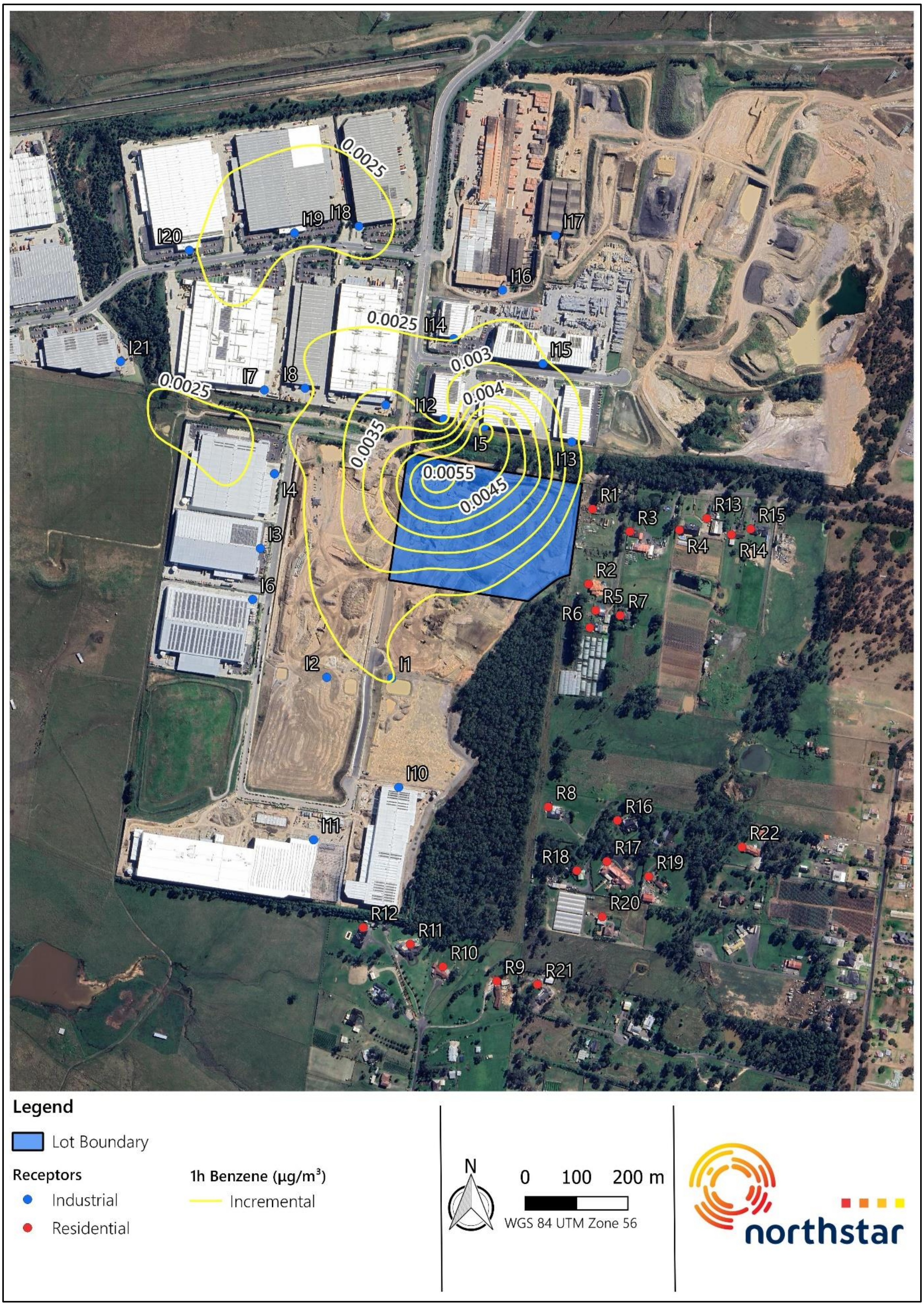
Receptor	Sulphur dioxide (SO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour			24-hour		
	Incr.	Bg.	Cumul.	Incr.	Bg.	Cumul.
I13	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I14	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I15	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I16	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I17	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I18	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I19	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I20	< 0.1	47.2	47.3	< 0.1	0.4	0.5
I21	< 0.1	47.2	47.3	< 0.1	0.4	0.5

Table 53 Predicted maximum incremental 1-hour PAH, benzene, toluene, xylene and formaldehyde concentrations – Stage 3, Scenario 2

Receptor	Maximum 1-hour average concentration ($mg \cdot m^{-3}$)				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
Criterion	0.0004	0.029	0.36	0.19	0.02
Max. % of criterion	< 0.1	0.2	0.0	< 0.1	0.0
R1	2.76E-10	1.86E-05	6.70E-06	4.65E-06	1.89E-06
R2	2.22E-10	1.49E-05	5.38E-06	3.74E-06	1.52E-06
R3	2.06E-10	1.39E-05	4.99E-06	3.46E-06	1.41E-06
R4	1.99E-10	1.34E-05	4.84E-06	3.36E-06	1.36E-06
R5	2.03E-10	1.37E-05	4.92E-06	3.41E-06	1.39E-06
R6	1.84E-10	1.24E-05	4.47E-06	3.11E-06	1.26E-06
R7	1.90E-10	1.28E-05	4.61E-06	3.20E-06	1.30E-06
R8	3.10E-10	2.09E-05	7.52E-06	5.22E-06	2.12E-06
R9	1.86E-10	1.25E-05	4.50E-06	3.13E-06	1.27E-06
R10	2.07E-10	1.40E-05	5.03E-06	3.49E-06	1.42E-06
R11	2.46E-10	1.66E-05	5.97E-06	4.14E-06	1.68E-06
R12	2.20E-10	1.48E-05	5.33E-06	3.70E-06	1.50E-06
R13	2.43E-10	1.64E-05	5.89E-06	4.09E-06	1.66E-06
R14	2.42E-10	1.63E-05	5.86E-06	4.07E-06	1.65E-06
R15	2.63E-10	1.77E-05	6.37E-06	4.42E-06	1.80E-06
R16	2.53E-10	1.71E-05	6.15E-06	4.27E-06	1.73E-06
R17	1.97E-10	1.33E-05	4.79E-06	3.32E-06	1.35E-06
R18	2.65E-10	1.79E-05	6.43E-06	4.47E-06	1.82E-06
R19	2.55E-10	1.72E-05	6.18E-06	4.29E-06	1.74E-06
R20	1.91E-10	1.29E-05	4.64E-06	3.22E-06	1.31E-06
R21	1.86E-10	1.25E-05	4.51E-06	3.13E-06	1.27E-06
R22	2.38E-10	1.60E-05	5.77E-06	4.01E-06	1.63E-06
I1	3.89E-10	2.62E-05	9.43E-06	6.55E-06	2.66E-06
I2	3.62E-10	2.44E-05	8.78E-06	6.10E-06	2.48E-06
I3	3.04E-10	2.05E-05	7.37E-06	5.12E-06	2.08E-06
I4	3.67E-10	2.47E-05	8.90E-06	6.18E-06	2.51E-06
I5	8.78E-10	5.91E-05	2.13E-05	1.48E-05	6.01E-06
I6	3.34E-10	2.25E-05	8.09E-06	5.62E-06	2.28E-06
I7	3.80E-10	2.56E-05	9.22E-06	6.40E-06	2.60E-06
I8	3.59E-10	2.42E-05	8.71E-06	6.05E-06	2.46E-06
I9	4.88E-10	3.29E-05	1.18E-05	8.22E-06	3.34E-06
I10	2.69E-10	1.81E-05	6.52E-06	4.53E-06	1.84E-06
I11	2.46E-10	1.65E-05	5.95E-06	4.13E-06	1.68E-06
I12	4.11E-10	2.77E-05	9.96E-06	6.91E-06	2.81E-06

Receptor	Maximum 1-hour average concentration (mg·m^{-3})				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
I13	3.97E-10	2.68E-05	9.64E-06	6.69E-06	2.72E-06
I14	3.78E-10	2.55E-05	9.17E-06	6.37E-06	2.59E-06
I15	3.88E-10	2.62E-05	9.42E-06	6.54E-06	2.66E-06
I16	3.67E-10	2.47E-05	8.89E-06	6.17E-06	2.51E-06
I17	3.06E-10	2.06E-05	7.42E-06	5.15E-06	2.09E-06
I18	4.44E-10	2.99E-05	1.08E-05	7.48E-06	3.04E-06
I19	3.93E-10	2.65E-05	9.54E-06	6.62E-06	2.69E-06
I20	3.76E-10	2.53E-05	9.11E-06	6.33E-06	2.57E-06
I21	3.75E-10	2.53E-05	9.10E-06	6.32E-06	2.57E-06

Figure 23 Predicted maximum incremental 1-hour benzene impacts – Stage 3, Scenario 2



Source: Northstar

7.4. Assessment of Criteria Exceedances

7.4.1. Stage 1

Presented in Table 54 is a summary of the number of additional exceedances of the short-term PM_{10}, $PM_{2.5}$ and NO_2 criteria predicted under Stage 1, Scenario 1 (justified worst case), and those values presented as a probability (0 being impossible, 1 being certain). These values are discussed further in Section 8.2.

Table 54 Assessment of the number of additional exceedances – Stage 1

Receptor	Number of additional exceedances of the criterion			Probability that an exceedance is predicted in one year		
	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2
R1	-	-	520	-	-	0.059
R2	-	1	334	-	0.003	0.038
R3	-	-	472	-	-	0.054
R4	-	-	393	-	-	0.045
R5	-	1	288	-	0.003	0.033
R6	-	1	267	-	0.003	0.030
R7	-	1	274	-	0.003	0.031
R8	-	-	153	-	-	0.017
R9	-	-	124	-	-	0.014
R10	-	-	163	-	-	0.019
R11	-	-	216	-	-	0.025
R12	-	-	276	-	-	0.031
R13	-	-	350	-	-	0.040
R14	-	-	329	-	-	0.038
R15	-	-	299	-	-	0.034
R16	-	-	137	-	-	0.016
R17	-	-	123	-	-	0.014
R18	-	-	129	-	-	0.015
R19	-	-	127	-	-	0.014
R20	-	-	112	-	-	0.013
R21	-	-	96	-	-	0.011
R22	-	-	97	-	-	0.011
I1	-	-	530	-	-	0.060
I2	-	1	460	-	0.003	0.053
I3	1	2	468	0.003	0.005	0.053
I4	1	2	447	0.003	0.005	0.051
I5	2	2	1222	0.005	0.005	0.140
I6	-	2	424	-	0.005	0.048
I7	-	1	654	-	0.003	0.075

Receptor	Number of additional exceedances of the criterion			Probability that an exceedance is predicted in one year		
	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2
I8	1	2	788	0.003	0.005	0.090
I9	2	2	1030	0.005	0.005	0.118
I10	-	-	375	-	-	0.043
I11	-	-	352	-	-	0.040
I12	4	4	1265	0.011	0.011	0.145
I13	-	-	888	-	-	0.101
I14	1	1	659	0.003	0.003	0.075
I15	-	2	830	-	0.005	0.095
I16	1	1	494	0.003	0.003	0.056
I17	-	1	446	-	0.003	0.051
I18	-	1	495	-	0.003	0.057
I19	-	1	520	-	0.003	0.059
I20	-	1	455	-	0.003	0.052
I21	-	1	272	-	0.003	0.031

7.4.2. Stage 2

Presented in Table 55 is a summary of the number of additional exceedances of the short-term PM_{10}, $PM_{2.5}$ and NO_2 criteria predicted under Stage 2, Scenario 1 (justified worst case), and those values presented as a probability (0 being impossible, 1 being certain). These values are discussed further in Section 8.2.

Table 55 Assessment of the number of additional exceedances – Stage 2

Receptor	Number of additional exceedances of the criterion			Probability that an exceedance is predicted in one year		
	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2
R1	-	-	572	-	-	0.065
R2	-	1	402	-	0.003	0.046
R3	-	-	518	-	-	0.059
R4	-	-	438	-	-	0.050
R5	-	1	355	-	0.003	0.040
R6	-	1	351	-	0.003	0.040
R7	-	1	338	-	0.003	0.039
R8	-	-	234	-	-	0.027
R9	-	-	213	-	-	0.024
R10	-	-	275	-	-	0.031
R11	-	-	346	-	-	0.039
R12	-	-	408	-	-	0.047
R13	-	-	401	-	-	0.046

Receptor	Number of additional exceedances of the criterion			Probability that an exceedance is predicted in one year		
	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2
R14	-	-	390	-	-	0.044
R15	-	-	366	-	-	0.042
R16	-	-	194	-	-	0.022
R17	-	-	187	-	-	0.021
R18	-	-	185	-	-	0.021
R19	-	-	175	-	-	0.020
R20	-	-	172	-	-	0.020
R21	-	-	174	-	-	0.020
R22	-	-	151	-	-	0.017
I1	-	1	696	-	0.003	0.079
I2	-	1	625	-	0.003	0.071
I3	1	3	621	0.003	0.008	0.071
I4	1	2	669	0.003	0.005	0.076
I5	2	4	1793	0.005	0.011	0.205
I6	1	3	555	0.003	0.008	0.063
I7	1	2	799	0.003	0.005	0.091
I8	2	3	960	0.005	0.008	0.110
I9	2	4	1285	0.005	0.011	0.147
I10	-	-	535	-	-	0.061
I11	-	-	485	-	-	0.055
I12	4	7	1680	0.011	0.019	0.192
I13	-	1	1077	-	0.003	0.123
I14	1	2	899	0.003	0.005	0.103
I15	1	2	1037	0.003	0.005	0.119
I16	1	1	686	0.003	0.003	0.078
I17	1	1	574	0.003	0.003	0.066
I18	1	1	620	0.003	0.003	0.071
I19	-	1	683	-	0.003	0.078
I20	-	2	617	-	0.005	0.071
I21	-	1	425	-	0.003	0.049

7.4.3. Stage 3

Presented in Table 56 is a summary of the number of additional exceedances of the short-term PM_{10}, $PM_{2.5}$ and NO_2 criteria predicted under Stage 3, Scenario 1 (justified worst case), and those values presented as a probability (0 being impossible, 1 being certain). These values are discussed further in Section 8.2.

Table 56 Assessment of the number of additional exceedances – Stage 3

Receptor	Number of additional exceedances of the criterion			Probability that an exceedance is predicted in one year		
	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2
R1	-	-	773	-	-	0.088
R2	-	1	607	-	0.003	0.069
R3	-	-	653	-	-	0.074
R4	-	-	561	-	-	0.064
R5	-	1	515	-	0.003	0.059
R6	-	1	493	-	0.003	0.056
R7	-	1	488	-	0.003	0.056
R8	-	-	321	-	-	0.037
R9	-	-	296	-	-	0.034
R10	-	-	387	-	-	0.044
R11	-	-	451	-	-	0.051
R12	-	-	511	-	-	0.058
R13	-	-	516	-	-	0.059
R14	-	-	475	-	-	0.054
R15	-	-	462	-	-	0.053
R16	-	-	248	-	-	0.028
R17	-	-	243	-	-	0.028
R18	-	-	256	-	-	0.029
R19	-	-	222	-	-	0.025
R20	-	-	229	-	-	0.026
R21	-	-	238	-	-	0.027
R22	-	-	206	-	-	0.024
I1	-	1	772	-	0.003	0.088
I2	-	1	731	-	0.003	0.083
I3	1	3	750	0.003	0.008	0.086
I4	1	4	876	0.003	0.011	0.100
I5	2	4	1 828	0.005	0.011	0.209
I6	1	3	693	0.003	0.008	0.079
I7	2	3	923	0.005	0.008	0.105
I8	2	4	1 047	0.005	0.011	0.120
I9	3	5	1 337	0.008	0.014	0.153
I10	-	-	646	-	-	0.074
I11	-	-	593	-	-	0.068
I12	4	13	1 713	0.011	0.036	0.196
I13	1	2	1 272	0.003	0.005	0.145
I14	1	2	967	0.003	0.005	0.111
I15	1	2	1 145	0.003	0.005	0.131
I16	1	1	780	0.003	0.003	0.089

Receptor	Number of additional exceedances of the criterion			Probability that an exceedance is predicted in one year		
	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2	24-hour PM_{10}	24-hour $PM_{2.5}$	1- hour NO_2
I17	1	1	697	0.003	0.003	0.080
I18	1	1	710	0.003	0.003	0.081
I19	1	1	767	0.003	0.003	0.088
I20	-	2	742	-	0.005	0.085
I21	-	1	601	-	0.003	0.069

8. DISCUSSION AND CONCLUSION

Northstar was engaged by Aurecon on behalf of NEXTDC Limited to perform an AQIA for the proposed construction and operation of a data centre, to be located at the Proposal site. The AQIA has considered the potential impacts on air quality associated with the construction and operation of the data centre. Operational impacts have been considered by assessing a realistic emissions scenario, and a justified worst-case scenario.

8.1. Construction Phase Risk Assessment

The construction phase risk assessment for the Proposal, presented in Section 6 showed there to be a 'medium' risk of dust soiling and 'low' risk to human health impacts associated with all proposed construction phase activities.

Based upon that assessment, a range of mitigation measures are recommended to ensure that short-term impacts associated with construction phase activities are minimised, as presented in Appendix D.

8.2. Operational Phase Impact Assessment

The predicted impacts of operational phase activities under a worst-case scenario (Scenario 1) and realistic operational scenario (Scenario 2) are presented in Section 7 for each stage of operation.

8.2.1. Scenario 1 – Justified Worst-Case

Under the justified worst-case emergency generator operational scenario for each stage (Scenario 1), a number of additional exceedances of the short-term air quality criteria for PM_{10}, $PM_{2.5}$ and NO_2 are predicted. That scenario assumes that all 50 no., 70 no., and 98 no. generators would be operational at one time under Stage 1, Stage 2, and Stage 3, respectively. The predicted incremental concentrations under Scenario 1 for each stage show exceedances of particulate matter and NO_2 at sensitive receptor locations if a power outage occurred. In relation to the worst case (Stage 3), that assumes that all 98 no. emergency generators were operating at 100 % load continuously (refer Section 7.3) with those emissions assessed under all potential meteorological conditions.

An assessment of the probability (p) of an exceedance of the relevant short-term PM_{10}, $PM_{2.5}$ and NO_2 criteria under Stage 1, 2 and 3 has been performed and is presented in Section 7.4.

As a maximum across all receptors and for each stage of operation, the probability of an exceedance of the PM_{10}, $PM_{2.5}$ or NO_2 criterion (where p=0 is an impossible event, and p=1 is a certain event) in any year is as follows:

- PM_{10}: p=0.011;
- $PM_{2.5}$: p=0.036; and,
- NO_2: p=0.209.

To predict the likelihood of exceedances under the worst-case scenario (all 98 no. generators operating continuously at 100% load), the upstream substation reliability was assessed against the NSW Transmission Reliability and Performance Standard (2017)[1], as well as the latest available Australian Energy Market Commission (AEMC) Reliability Panel Annual Report[2].

For Transmission Substations (TS) and Bulk Supply Points (BSPs), reliability is measured in 2 parts:

- Unserved Energy (USE) The unit of USE is minutes per year.
- Redundancy Category – There are 3 Redundancy categories listed in the NSW Transmission Reliability and Performance Standard (2017) as shown in the extract below:

> ***Level of redundancy*** means:
>
> (i) for category 1 bulk supply points, a supply interruption may occur following the outage of a single system element;
>
> (ii) for category 2 bulk supply points, a non-zero amount of load must be supplied following the outage of a single system element; and
>
> (iii) for category 3 bulk supply points, a non-zero amount of load must be supplied following the outage of a single system element. In addition, for Inner Sydney, a non-zero amount of load must be supplied following the simultaneous outage of a single 330 kV cable and any 132 kV feeder or 330/132 kV transformer.

The site is supplied directly from the Sydney West BSP. The Reliability characteristics of this substation as given in the Transmission Reliability standard is as follows:

- Maximum Expected USE: 1 minute per year; and,
- Redundancy category: Level 2 as defined above.

Notwithstanding the Standards requirements above, the AEMC Reliability Panel Annual Report (AEMC, 2022) indicates the actual historical USE in NSW as zero. As reported in (AEMC, 2022) the utility power to the site has maintained 100 % uptime since 2005 which means that the Sydney West BSP has had no incidents recorded where it was unable to supply energy.

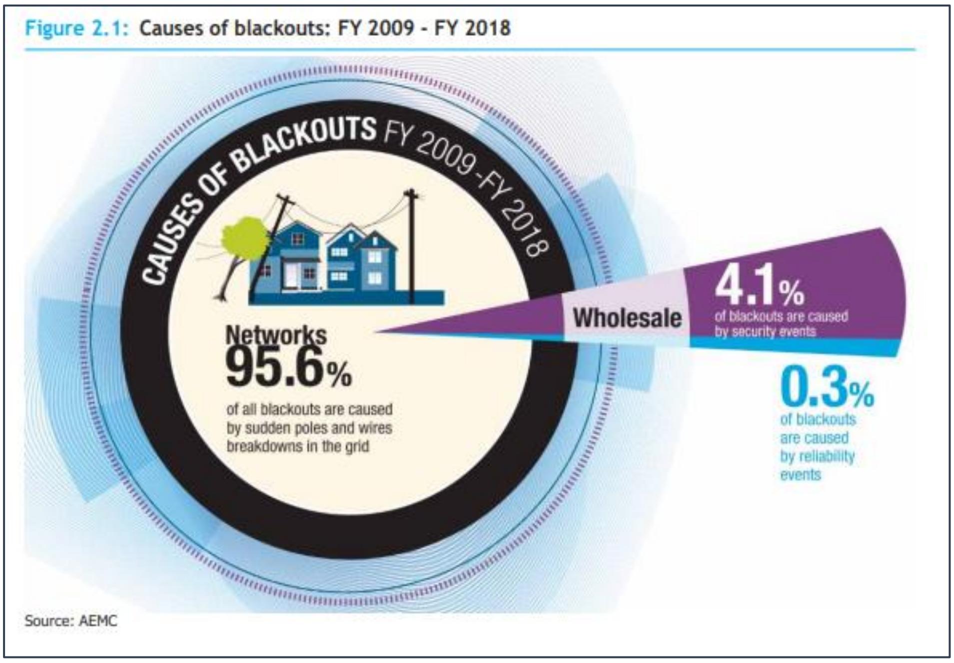
In addition, Level 2 redundancy requirements ensure that even with a single failure, some load can still be supplied from the Sydney West BSP. However, since the extent of partial power failure is unpredictable, a full system failure has been modelled.

1 nsw-electricity-transmission-reliability-and-performance-standard-2017_0.pdf

2 Policy_Portrait_Layout (aemc.gov.au)

The AEMC Reliability Standard Information Paper (AEMC, 2020)[3] breaks down the causes of blackouts at the TS and BSP level as illustrated in Figure 24.

Figure 24 AEMC causes of blackouts (FY 2009 – 2018)



Source: Figure 2.1 of (AEMC, 2020)

Based on the data presented in Figure 24, the most likely cause of a power outage at the Proposal site would be a local event impacting the supply cables/poles (e.g., a weather event). To mitigate this risk, NEXTDC has applied for dual redundant incoming supplies from Transgrid, ensuring that if one supply feeder fails, the other will fully back up the site (see Section 2.2).

Based on the above, a maximum worst case outage of 1 minute per year has been assumed for this statistical test.

Correspondingly, power interruptions could be expected for approximately 0.0002 % of the time per year (1/(8760 × 60)) or have a probability of p=0.000002.

The probability of both the interruption to the power supply, and an exceedance of the relevant air quality criteria occurring can be calculated through the multiplication of the probability of each event occurring. Those values are incredibly small and have been placed into context by calculating the percentage chance that the event could occur in a number of years. Table 57 presents the results of those calculations.

The results indicate that the chance of an additional exceedance of the air quality criteria during a power outage is low small.

3 Policy_Portrait_Layout (aemc.gov.au)

Table 57 Chance of an exceedance during a power outage under Stage 3 operations

Number of years	Percentage chance of an additional exceedance of the short-term criterion during a power outage (%)		
	PM_{10}	$PM_{2.5}$	NO_2
100	0.0002%	0.0007%	0.0040%
200	0.0004%	0.0014%	0.0079%
500	0.0010%	0.0034%	0.0199%
1 000	0.0021%	0.0068%	0.0397%
1 250	0.0026%	0.0085%	0.0496%

8.2.2. Scenario 2 – Realistic Case

Predicted incremental concentrations for Scenario 2 under each Stage show that no exceedances are predicted to occur at all surrounding receptors for all assessed pollutants. Correspondingly, it is anticipated that under operation of the testing schedules, as outlined in Section 2.3.2, that no significant air quality impacts are predicted to be experienced at sensitive receptors during any stage of operations.

8.2.3. Recommended Mitigation Measures

Based on the findings of the dispersion modelling assessment under Scenario 2 for each stage, it is considered that the operation of the testing schedule would not result in exceedances being experienced at sensitive receptor locations surrounding the Proposal site.

To ensure air quality impacts experienced at sensitive receptors resulting from the operation of the Proposal site are minimised, maintenance under the testing schedule must be performed as outlined in Section 2.3.2. Operation of the emergency generators should be minimised as practicably possible.

8.2.4. Additional Mitigation Measures

A number of additional mitigation measures considered to be Best Available Technology (BAT) have been reviewed and discussed in Appendix F.

For clarity, the Proposal is predicted to not result in any exceedances of the relevant air quality criteria under the proposed maintenance testing schedule (refer Section 7.3.2) and correspondingly, the additional controls discussed in Appendix F have been reviewed to solely provide context for how air quality impacts may be further reduced.

8.3. Conclusion

During the construction phase, the potential dust soiling and human health risks are assessed as being manageable through appropriate implementation of the recommended mitigation measures.

During the operational phase, based upon the information presented in this AQIA, the normal operation of the Proposal is not considered likely to result in additional exceedances of the relevant air quality criteria at any identified receptor location during each stage of operations. Scenarios replicating the worst-case and realistic case operations have been considered in the assessment.

The predicted incremental concentrations for all assessed pollutants are shown to be significantly below the relevant criteria under realistic operations where the back-up generators are appropriately operated under the testing schedule.

9. REFERENCES

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APPENDIX A

Commonly used units and abbreviations

Units Used in the Report

Units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units.

Commonly used SI units

The following units are commonly used in Northstar reports.

Symbol	Name	Quantity
SI base units		
K	Kelvin	thermodynamic temperature
kg	kilogram	mass
m	metre	length
mol	mole	amount of substance
s	seconds	time
Non-SI units mentioned in the SI or accepted for use		
°	degree	plane angle
d	day	time
h	hour	time
ha	hectare	area
J	joule	energy
L	litre	volume
min	minute	time
N	newton	force or weight
t	tonne	mass
V	volt	electrical potential
W	watt	power

Multiples of SI and non-SI units

The following prefixes are added to unit names to produce multiples and sub-multiples of units:

Prefix	Symbol	Factor
T	tera-	10^{12}
G	giga-	10^{9}
M	mega-	10^{6}
k	kilo-	10^{3}
h	hector-	10^{2}
da	deca-	10^{1}

Prefix	Symbol	Factor
p	pico-	10^{-12}
n	nano-	10^{-9}
µ	micro-	10^{-6}
m	milli-	10^{-3}
c	centi-	10^{-2}
d	deci-	10^{-1}

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.

Commonly used SI-derived and non-SI units

Symbol	Name	Quantity
$g \cdot m^{-2} \cdot s^{-1}$	gram per square metre per second	rate of mass deposition per unit area
$g \cdot s^{-1}$	gram per second	rate of mass emission
$kg \cdot ha^{-1} \cdot hr^{-1}$	kilogram per hectare per hour	rate of mass deposition per unit area
$kg \cdot m^{-3}$	kilogram per cubic metre	density
$L \cdot s^{-1}$	litres per second	volumetric rate
m^2	square metre	area
m^3	cubic metre	volume
$m \cdot s^{-1}$	metre per second	speed and velocity
$mg \cdot m^{-3}$	milligram per cubic metre	mass concentration per unit volume
$mg \cdot Nm^{-3}$	milligram per normalised cubic metre (of air)	mass concentration per unit volume
$\mu g \cdot m^{-3}$	microgram per cubic metre	mass concentration per unit volume
$mg \cdot m^{-3}$	milligram per cubic metre	mass concentration per unit volume
Pa	pascal	pressure
ppb	parts per billion ($1x10^{-9}$)	volumetric concentration
pphm	parts per hundred million (1×10^{-5})	volumetric concentration
ppm	parts per million ($1x10^{-6}$)	volumetric concentration

Commonly used abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
ACT	Australian Commonwealth Territory
AEMC	Australian Energy Market Commission
AGL	above ground level
AHD	Australian height datum
APC	air pollution control
AQI	air quality index
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AQRA	air quality risk assessment
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS/NZS	Australian Standard / New Zealand Standard
AWS	automatic weather station
BCA	Building Code of Australia
BGL	below ground level

Abbreviation	Term
BOM	Bureau of Meteorology
BSP	bulk supply point
CEMP	construction environment management plan
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	digital elevation model
EETM	emission estimation technique manual
EPA VIC	Environmental Protection Authority Victoria
EPBC	Environment Protection and Biodiversity Conservation Act
FIBC	flexible intermediate bulk container
GIS	geographical information system
IAQM	UK Institute of Air Quality Management
IBC	intermediate bulk container
ID	internal diameter
LLV	low level waste
LoM	life of mine
MSDS	Material Safety Data Sheet
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NH_3	ammonia
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
NORM	naturally occurring radioactive material
NSW	New South Wales
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
NSW DPE	New South Wales Department of Planning and Environment
NSW DPHI	New South Wales Department of Planning, Housing and Infrastructure
NSW EPA	New South Wales Environment Protection Authority
NT	Northern Territory
OEMP	operational environmental management plan
O_3	ozone
OU	odour unit
$OU \cdot m^3 \cdot s^{-1}$	odour units times metres cubed per second
$OU \cdot s^{-1}$	odour units per second
Pb	lead
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

Abbreviation	Term
ROM	run of mine
SA	South Australia
SEPP	State Environmental Protection Policy
SO_X	oxides of sulphur
SO_2	sulphur dioxide
SRTM3	Shuttle Radar Topography Mission
SVOC	semi-volatile organic compound
TAPM	The Air Pollution Model
TAS	Tasmania
TEU	twenty-foot equivalent unit
TS	transmission substations
TSP	total suspended particulates
TVOC	total volatile organic compounds
TWA	time weighted average
USE	unserved energy
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VIC	Victoria
VLLW	very low level waste
VOC	volatile organic compound
%	percent

APPENDIX B

Meteorology

Meteorological Stations

As discussed in Section 4.3, a meteorological modelling exercise has been performed to characterise the meteorology of the Proposal site in the absence of site-specific measurements. The meteorological monitoring has been based on measurements acquired from surrounding automatic weather stations (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

A summary of the relevant monitoring sites is provided in Table B1.

Table B1 Details of the meteorological monitoring surrounding the Proposal site

Site name	Station #	Source	Approximate location		Approximate distance (km)
			mE	mS	
Horsley Park Equestrian Centre AWS	067119	BoM	301 708	6 252 298	3.5
Badgerys Creek AWS	067108	BoM	289 920	6 246 951	11.6
Bankstown Airport AWS	066137	BoM	313 855	6 245 099	17.6

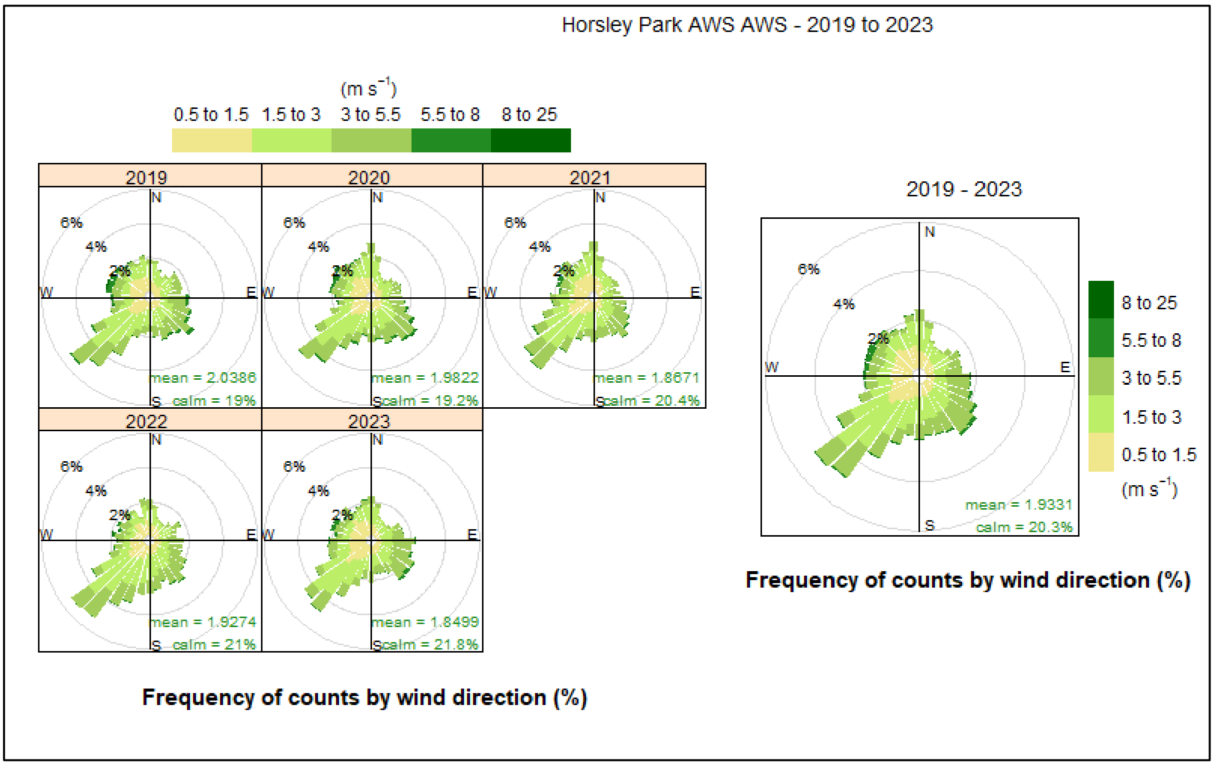
As outlined in Section 4.3, meteorological conditions at Horsley Park Equestrian Centre AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2019 to 2023) are presented in Figure B1. The annual wind speed frequency distribution for the five-year period is presented in Figure B2.

The correlation coefficient between each year and the five-year period for the distribution of wind speed and wind direction are summarised in Table B2. The correlation coefficients were ranked and aggregated to select the representative year for the meteorological modelling. The rankings are also presented in Table B2.

The wind roses indicate that from 2019 to 2023, winds at Horsley Park Equestrian Centre AWS show generally similar wind distribution patterns across the years assessed, with predominant south-westerly wind directions evident.

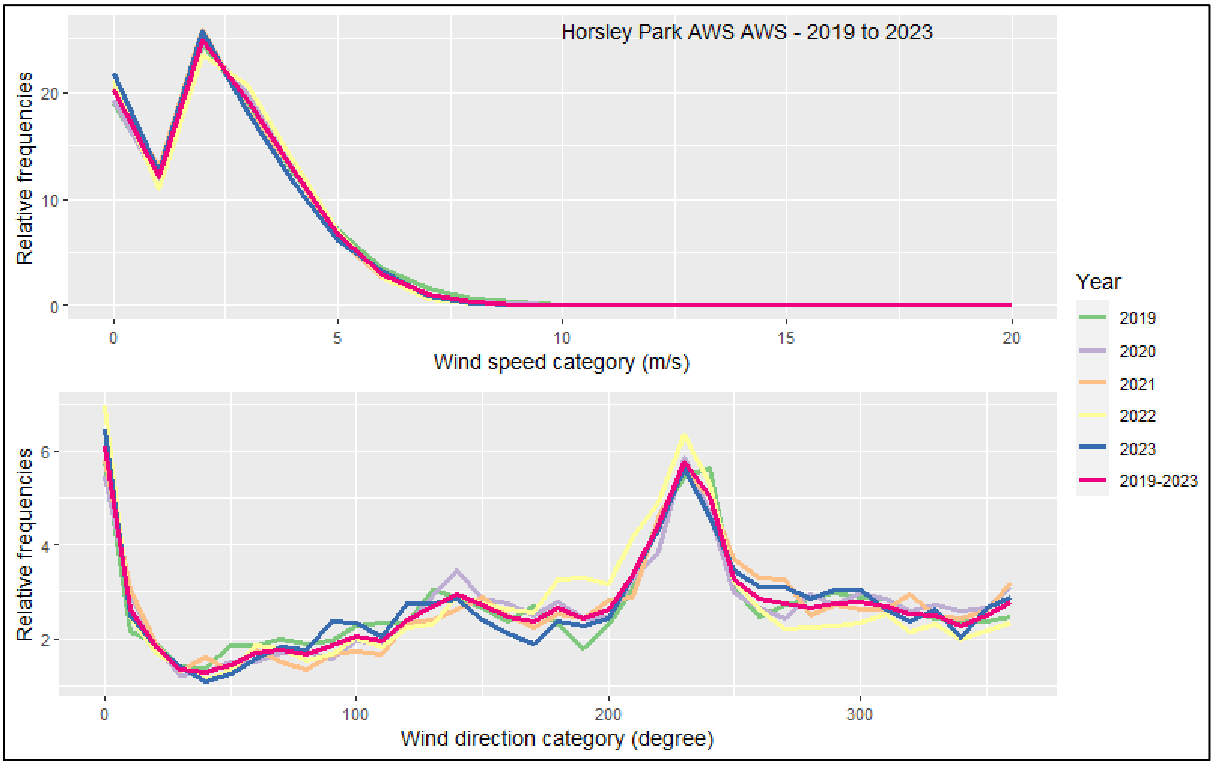
The majority of wind speeds experienced at Horsley Park Equestrian Centre AWS between 2019 and 2023 are generally in the range 0.5 meters per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from mostly north-westerly directions. Winds of this speed are rare and occur during 0.16 % of the observed hours during the years. Calm winds (less than 0.5 $m \cdot s^{-1}$) are more common and occur during 20.3 % of hours on average across the years between 2019 and 2023.

Figure B1 Annual wind roses – Horsley Park Equestrian Centre AWS (2019 to 2023)



Source: Northstar

Figure B2 Annual wind speed and direction distributions – Horsley Park Equestrian Centre AWS (2019 to 2023)



Source: Northstar

Table B2 Correlation coefficient analysis – Horsley Park Equestrian Centre AWS (2019 – 2023)

Parameter	Wind speed		Wind direction		Aggregated rank
	Corr.	Rank	Corr.	Rank	
2019	0.9992	2	0.9667	4	3.5
2020	0.9993	1	0.9782	2	1
2021	0.9990	3	0.9719	3	3.5
2022	0.9973	5	0.9653	5	5
2023	0.9980	4	0.9741	1	2
2019-2023	1	-	1	-	-

Note: Corr. = correlation

Wind speed observations for each year correlated well against the wind speed over the five-year period, with each year having a correlation coefficient greater than 0.99. The year 2020 is the highest ranked for correlation against the wind speed over the five-year period.

Wind direction observations for each year are well correlated against the wind direction over the five-year period, with each year having a correlation coefficient greater than of 0.96. The year 2023 is the highest ranked for correlation against the wind direction over the five-year period.

The correlation coefficient analysis indicates that 2020 is the most appropriate representative year for meteorological modelling. Correspondingly, 2020 has been adopted for use for meteorological modelling as it provides the more recent meteorological data of the two years.

Meteorological Processing

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

In absence of any measured onsite meteorological data, site representative meteorological data for this Proposal was generated using The Air Pollution Model (TAPM, v 4.0.5) meteorological model in a format suitable for using in the CALPUFF dispersion model (refer Section 5.2.1).

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

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

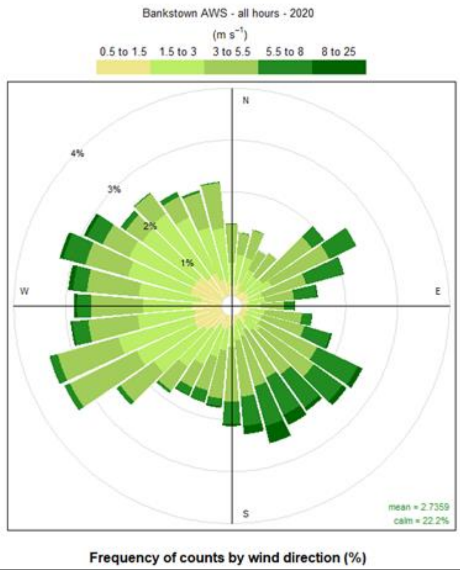
It is noted that an initial TAPM modelling run provided wind roses which did not validate well against observations at Horsley Park Equestrian Centre AWS. Given the poor validation, that initial TAPM modelling run has not been used in this AQIA. Subsequently, a second TAPM run was performed which used observations at Horsley Park Equestrian Centre AWS to 'nudge' model predictions towards those observations, and this has been used in this AQIA. To validate model outputs, a comparison of the TAPM generated meteorological data, and that observed at the Bankstown Airport AWS has been performed and is presented in Figure B3. Given the proximity to the Proposal site no validation at another AWS has been performed and the second TAPM run is considered sufficient to represent meteorological parameters at the Proposal site for use in CALPUFF.

The parameters used in TAPM modelling are presented in Table B3.

Table B3 TAPM meteorological parameters

TAPM v 4.0.5	
Modelling period	1 January 2020 to 31 December 2020
Centre of analysis	306 371 mE, 6 258 053 mS (UTM Coordinates)
Number of grid points	35 × 35 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	Horsley Park AWS

Figure B3 Modelled and observed meteorological data – Bankstown Airport AWS (2020)

TAPM generated windrose	Observations at Bankstown Airport AWS
	

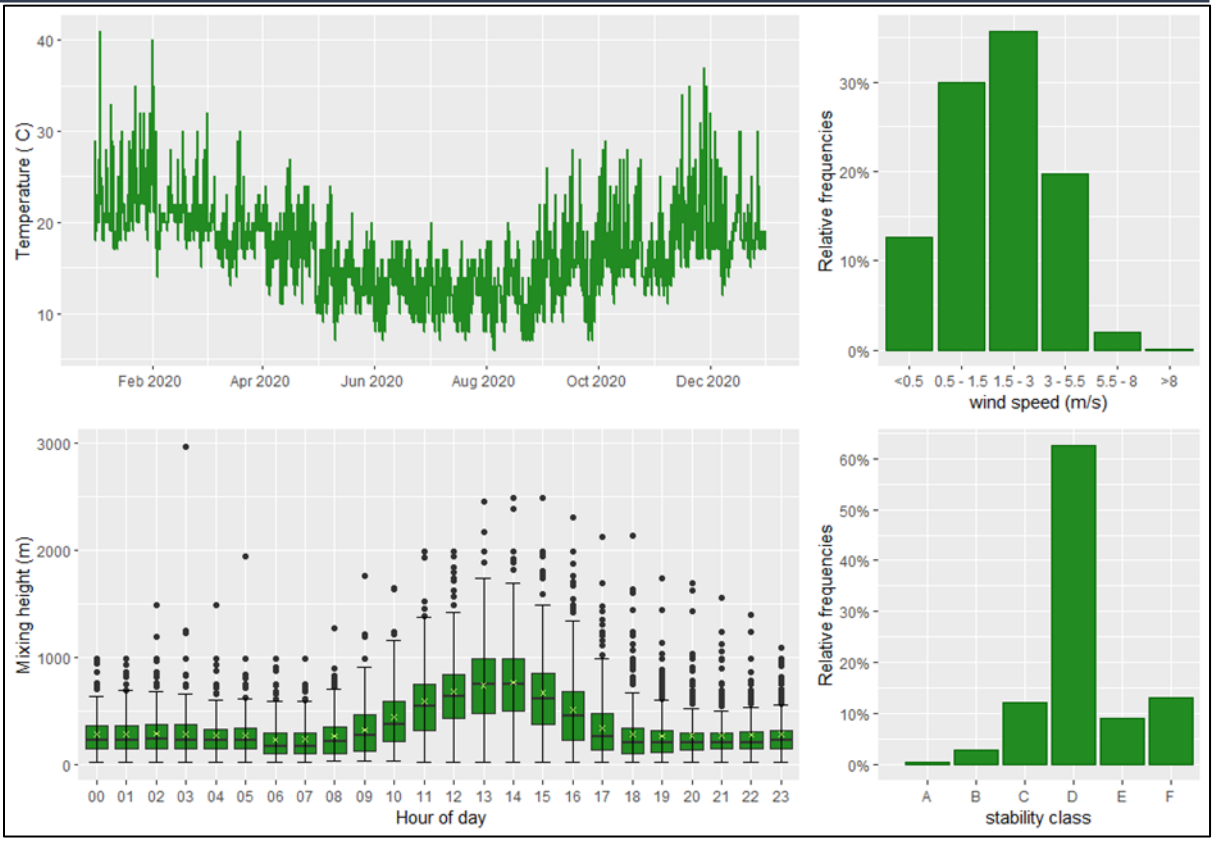
Source: Northstar

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

Diurnal variations in maximum and average mixing heights predicted by TAPM at the Proposal site during 2020 period are illustrated in Figure B4.

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

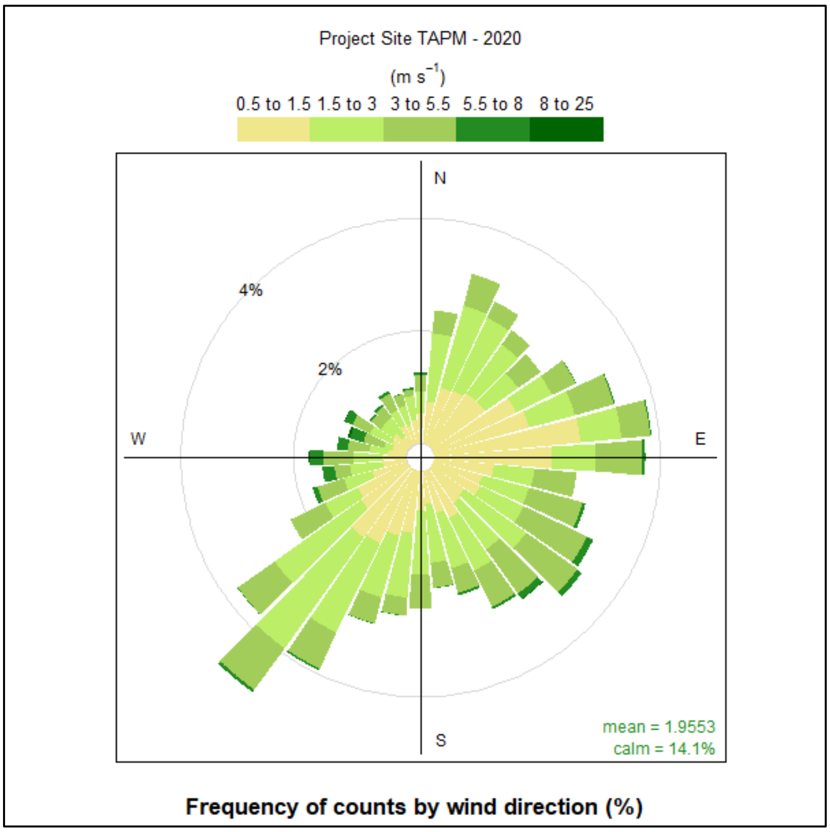
Figure B4 Predicted mixing height, wind speed and stability class frequency at the Proposal site (2020)



Source: Northstar

The modelled wind speed and direction at the Proposal site during 2020 are presented in Figure B5.

Figure B5 Predicted wind speed and direction – Proposal site (2020)



Source: Northstar

APPENDIX C

Background Air Quality

Air quality is not monitored at the Proposal site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this AQIA. 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 Climate Change, Energy, the Environment and Water (NSW DCCEEW) at air quality monitoring stations (AQMS) within 10 km of the Proposal site. Details of the monitoring performed at these AQMS is presented in Table C1.

Table C1 NSW DCCEEW AQMS within 10 km of the Proposal site

AQMS location	Distance to Proposal site (km)	2020 data	Measurements					
			PM_{10}	$PM_{2.5}$	TSP	NO_2	CO	SO_2
St Marys	6.5	✓	✓	✓	×	✓	×	×
Prospect	8.6	✓	✓	✓	×	✓	✓	✓

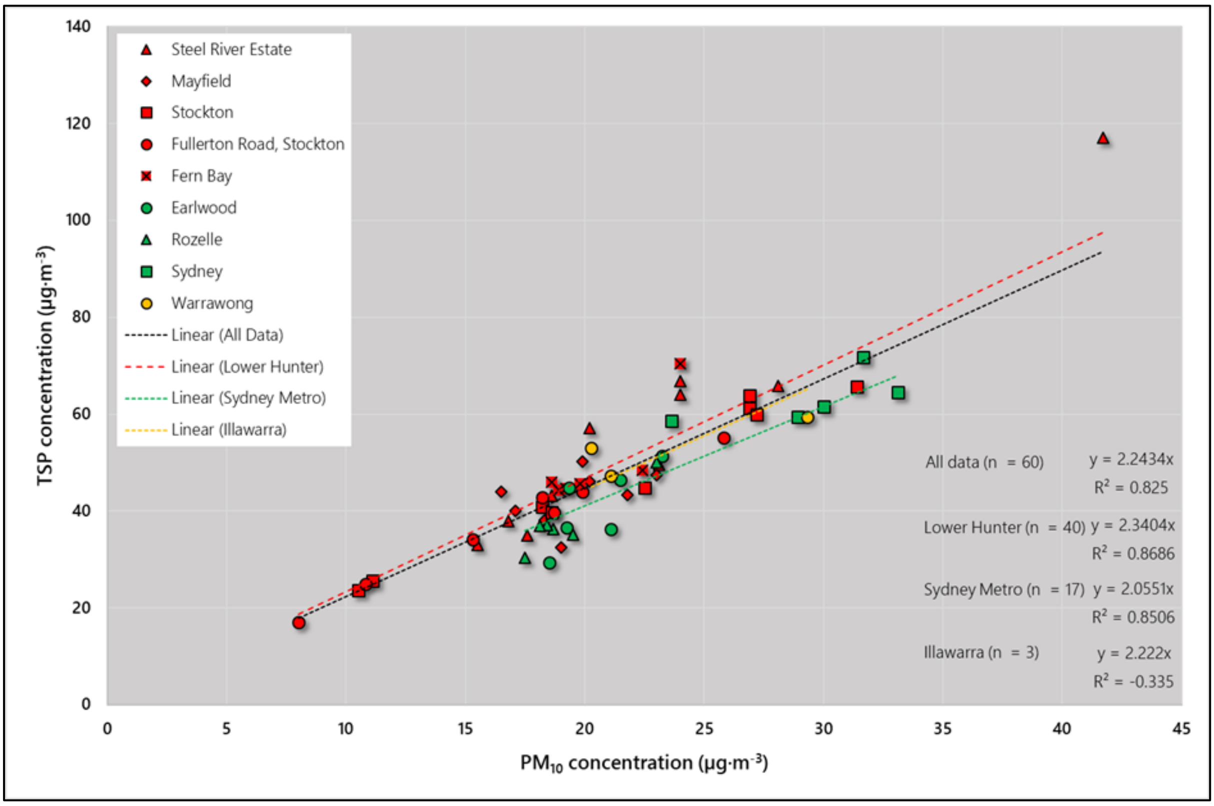
Given the availability of data and its proximity to the Proposal site, data from Prospect AQMS is considered to be the most representative air quality dataset and has correspondingly been adopted for use in this assessment. Particulate matter data for the period 2019 to 2023 has been analysed.

The results of the correlation coefficient analysis provided in Appendix B indicates that data measured in 2020 is the most appropriate dataset for use within this study.

Concentrations of TSP are not measured 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 C1. The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.0551 : 1 (i.e. PM_{10} represents ~49% of TSP) from the Sydney Metropolitan location is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA, resulting in a background annual average TSP concentration of 41.4 $\mu g \cdot m^{-3}$ being adopted.

Summary statistics for the selected data are presented in Table C2.

Figure C1 Co-located TSP and PM_{10} measurements – Lower Hunter, Sydney Metro and Illawarra



Source: Northstar

Graphs presenting the daily varying PM_{10} and $PM_{2.5}$, and hourly varying NO_2 data recorded at Prospect AQMS in 2020 are presented in Figure C2, Figure C3 and Figure C4 respectively.

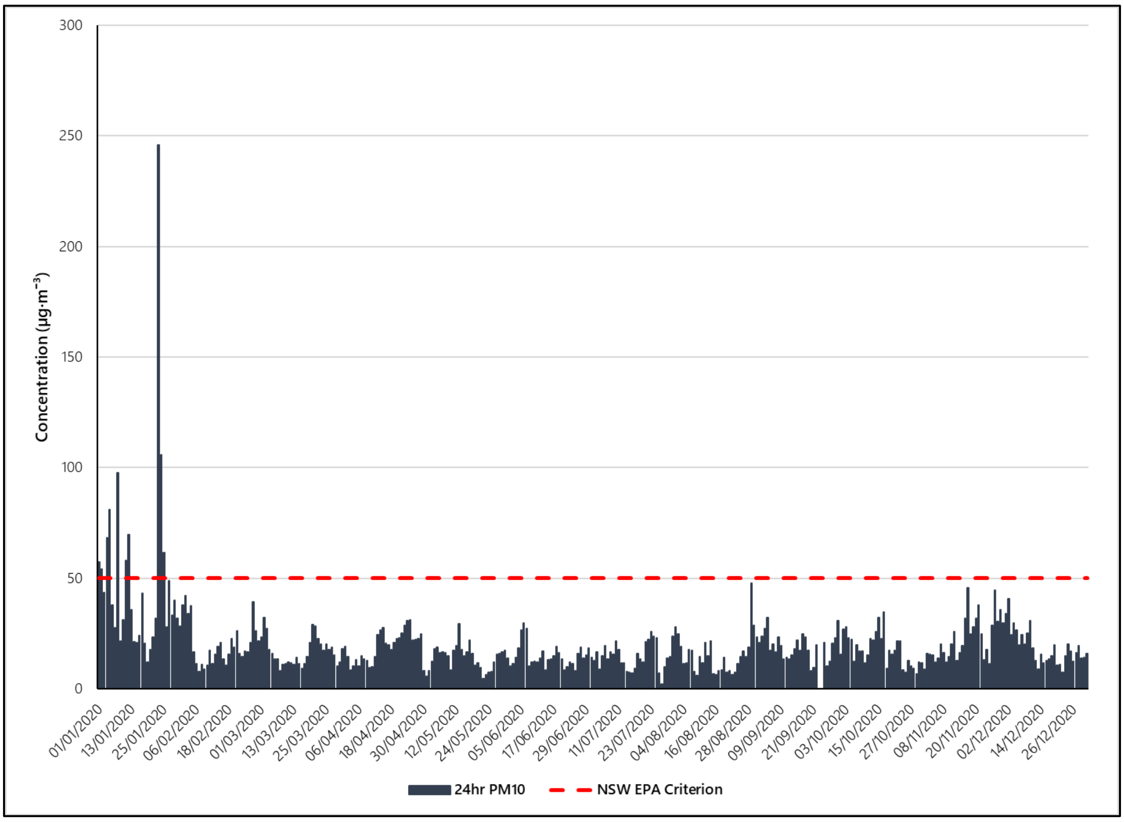
Table C2 Background air quality statistics – Prospect AQMS (2020)

Pollutant	TSP	PM_{10}	$PM_{2.5}$	SO_2	SO_2	NO_2	CO	CO	CO	O_3
Averaging period	Annual	24 hour	24 hour	24 hour	1 hour	1 hour	15 minute	1 hour	8 hour (rolling)	1 hour
Units	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$	$mg{\cdot}m^{-3}$	$mg{\cdot}m^{-3}$	$mg{\cdot}m^{-3}$	$\mu g{\cdot}m^{-3}$
Statistics										
Data Points (nb)	363	364	357	359	8270	8269	8302	8302	8700	8328
Mean	41.4	20.2	8.6	0.1	1.4	13.8	0.1	0.1	0.1	37.3
Standard deviation	-	16.9	7.1	0.1	2.8	13.7	0.3	0.2	0.2	25.6
Skew[1]	-	*7.6*	*3.7*	*1.6*	*5.4*	*1.2*	*3.5*	*3.5*	*3.5*	*0.9*
Kurtosis[2]	-	*89.5*	*21.1*	*4.1*	*50.2*	*1.1*	*19.8*	*19.8*	*22.0*	*1.7*
Minimum	-	2.1	0.8	0.0	-2.6	-5.6	-0.2	-0.1	-0.1	2.0
Percentiles										
25^{th}	-	12.1	4.2	0.0	0.0	3.8	0.0	0.0	0.0	15.7
50^{th}	-	16.9	6.0	0.0	0.0	9.4	0.0	0.0	0.0	37.2
75^{th}	-	23.0	8.6	0.1	2.6	20.7	0.2	0.1	0.1	52.9
90^{th}	-	31.6	12.3	0.1	2.6	33.8	0.5	0.3	0.3	66.6
95^{th}	-	39.9	15.9	0.2	5.2	41.4	0.6	0.5	0.5	81.6
97^{th}	-	47.7	21.7	0.2	7.9	47.0	0.9	0.7	0.6	92.1
98^{th}	-	57.8	26.0	0.2	7.9	50.8	0.9	0.7	0.7	100.0
99^{th}	-	73.9	33.7	0.3	13.1	55.1	1.2	0.9	0.8	115.6
Maximum	**-**	**245.8**	**114.8**	**0.4**	**47.2**	**80.8**	**3.2**	**2.4**	**2.1**	**199.9**
Data Capture (%)	**99.5**	**99.5**	**92.1**	**98.1**	**94.1**	**94.1**	**94.5**	**94.5**	**99.0**	**94.8**

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.

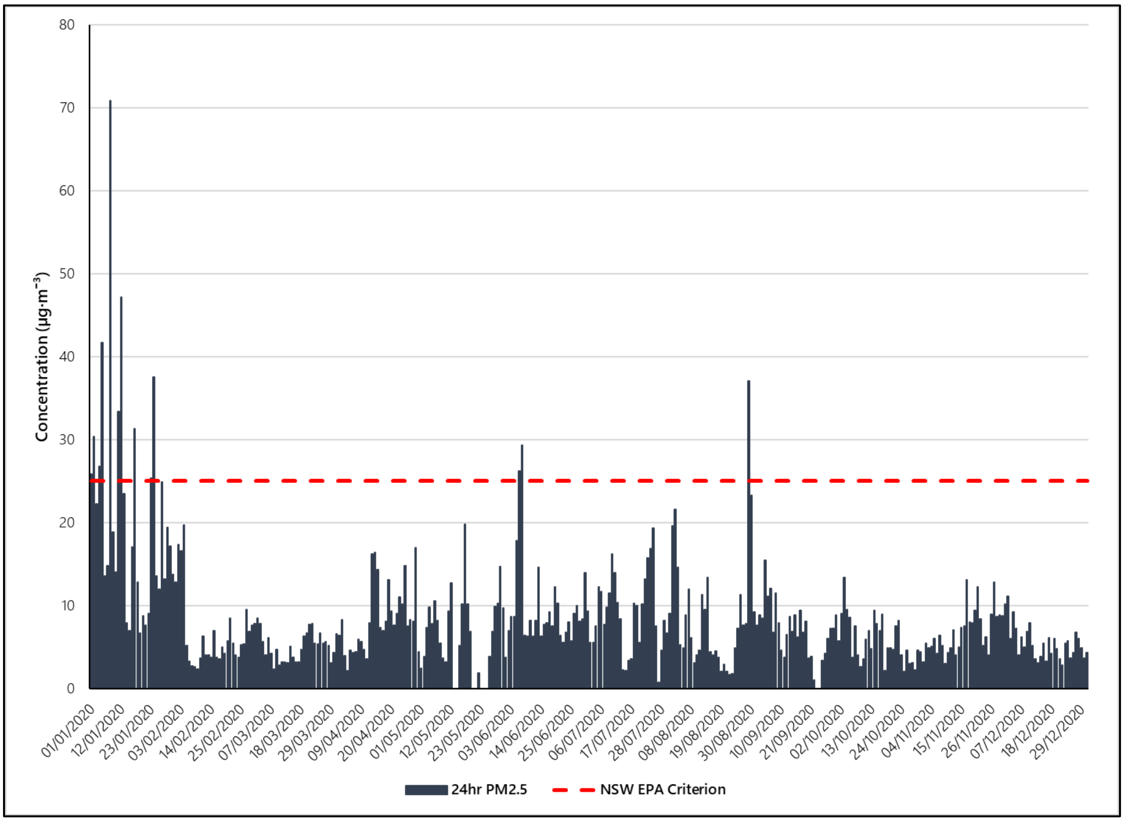
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew r epresents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure C2 Daily varying PM_{10} measurements – Prospect AQMS (2020)



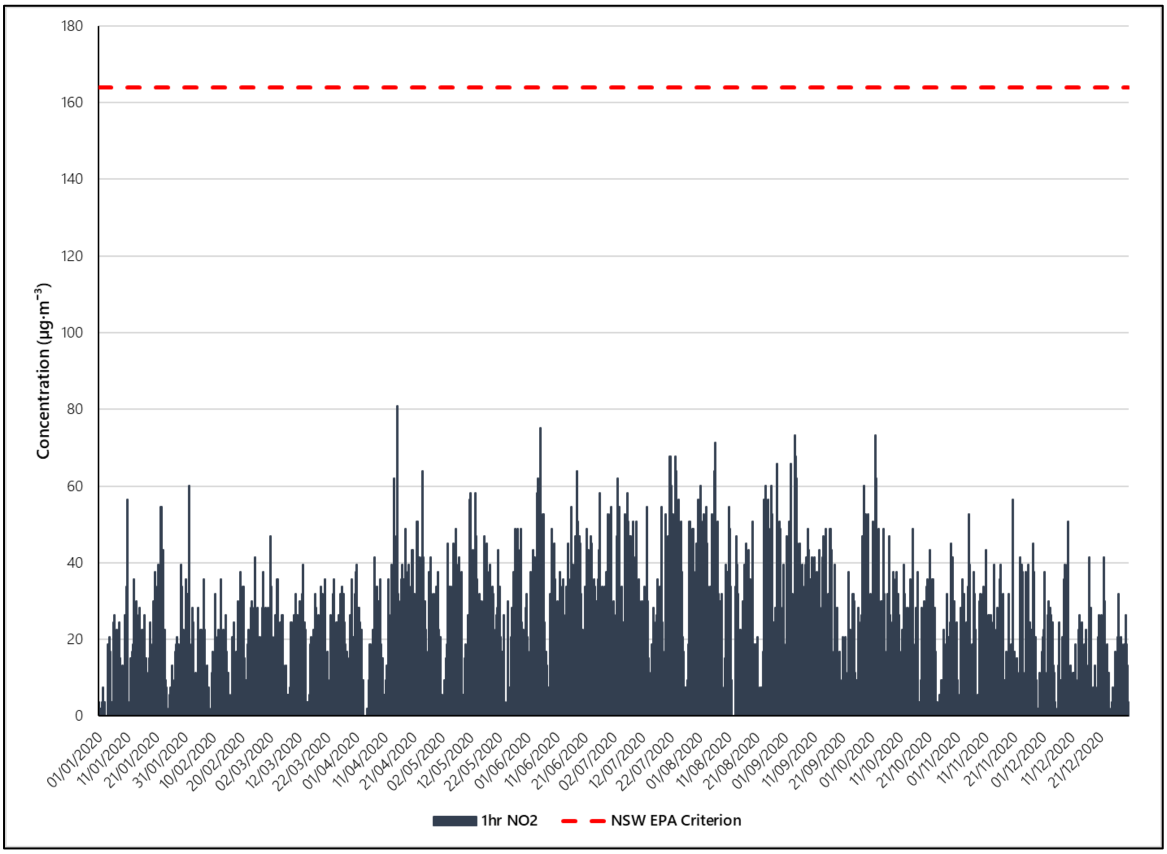
Source: Northstar

Figure C3 Daily varying $PM_{2.5}$ measurements – Prospect AQMS (2020)



Source: Northstar

Figure C4 Hourly varying NO_2 measurements – Prospect AQMS (2020)



Source: Northstar

APPENDIX D

Construction Phase Air Quality Risk Assessment

Provided below is a summary of the risk assessment methodology used in this assessment. It is based upon IAQM (2024) *Guidance on the assessment of dust from demolition and construction* (version 2.2) and adapted by Northstar.

Adaptions to the Published Methodology Made by Northstar

The adaptions made by Northstar 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 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:

- Beyond a distance of 250 m from the Proposal site boundary; and,
- At a distance greater than 50 m from the route(s) used by construction vehicles on public roads, beginning from the Proposal site entrance and extending past 250 m from the Proposal site entrance.

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

Table D1 overleaf presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table D1 Construction phase impact screening criteria distances

Receptor ID	Location	Land use	Screening distance (m)		
			Proposal site boundary (250 m)	Proposal site entrance(s) (250 m)	Construction route(s) (50m)
R1	Burley Road, Horsley Park	Residential	26	372	372
R2	Burley Road, Horsley Park	Residential	40	415	415
R3	Burley Road, Horsley Park	Residential	105	452	452
R4	Burley Road, Horsley Park	Residential	200	546	546
R5	Burley Road, Horsley Park	Residential	85	455	455
R6	Burley Road, Horsley Park	Residential	110	466	466
R7	Burley Road, Horsley Park	Residential	126	500	500
R8	Delaware Road, Horsley Park	Residential	402	703	703
R9	Greenway Place, Horsley Park	Residential	742	1 000	1 000
R10	Greenway Place, Horsley Park	Residential	729	959	959
R11	Greenway Place, Horsley Park	Residential	695	912	912
R12	Greenway Place, Horsley Park	Residential	677	883	883
R13	Burley Road, Horsley Park	Residential	250	594	594
R14	Burley Road, Horsley Park	Residential	301	647	647
R15	Burley Road, Horsley Park	Residential	337	682	682
R16	Delaware Road, Horsley Park	Residential	461	789	789
R17	Delaware Road, Horsley Park	Residential	529	848	848
R18	Delaware Road, Horsley Park	Residential	533	839	839
R19	Delaware Road, Horsley Park	Residential	585	914	914
R20	Delaware Road, Horsley Park	Residential	631	941	941
R21	Delaware Road, Horsley Park	Residential	746	1024	1024
R22	Delaware Road, Horsley Park	Residential	627	977	977
I1	Johnston Crescent, Horsley Park	Industrial	188	395	395
I2	Johnston Crescent, Horsley Park	Industrial	225	421	421
I3	Johnston Crescent, Horsley Park	Industrial	257	315	312
I4	Johnston Crescent, Horsley Park	Industrial	251	253	239
I5	Old Wallgrove Road, Horsley Park	Industrial	79	182	153
I6	Johnston Crescent, Horsley Park	Industrial	268	382	382
I7	Burley Road, Horsley Park	Industrial	306	320	278
I8	Burley Road, Horsley Park	Industrial	238	258	201
I9	Burley Road, Horsley Park	Industrial	106	143	41
I10	Johnston Crescent, Horsley Park	Industrial	396	607	607
I11	Johnston Crescent, Horsley Park	Industrial	527	731	731
I12	Old Wallgrove Road, Horsley Park	Industrial	78	134	73
I13	Old Wallgrove Road, Horsley Park	Industrial	78	332	325
I14	Old Wallgrove Road, Horsley Park	Industrial	235	284	76
I15	Old Wallgrove Road, Horsley Park	Industrial	219	347	254

Receptor ID	Location	Land use	Screening distance (m)		
			Proposal site boundary (250 m)	Proposal site entrance(s) (250 m)	Construction route(s) (50m)
I16	Old Wallgrove Road, Horsley Park	Industrial	347	409	160
I17	Old Wallgrove Road, Horsley Park	Industrial	470	553	251
I18	Millner Avenue, Horsley Park	Industrial	454	494	132
I19	Millner Avenue, Horsley Park	Industrial	485	519	255
I20	Millner Avenue, Horsley Park	Industrial	583	607	455
I21	Millner Avenue, Horsley Park	Industrial	588	596	560

With reference to Table D1, sensitive receptors are noted to be within the screening distance thresholds and therefore require further risk assessment as summarised in Table D2.

Table D2 Application of step 1 screening

Construction impact	Screening criteria	Step 1 screening	Comments
Demolition	250 m from boundary 250 m from site entrance	Not screened	Receptors identified within the screening distance
Earthworks	250 m from boundary 250 m from site entrance	Not screened	Receptors identified within the screening distance
Construction	250 m from boundary 250 m from site entrance	Not screened	Receptors identified within the screening distance
Trackout	250 m from site entrance	Not screened	Receptors identified within the screening distance
Construction Traffic	50 m from roadside	Not screened	Receptors identified within the screening distance

Step 2 – Define the Potential Dust Emission Magnitude

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.

It is noted that the Proposal does not include any demolition activities.

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

Table D3 Dust emission magnitude activities

Activity	Large	Medium	Small
Demolition			
total building volume	> 75 000 m^3	12 000 m^3 to 75 000 m^3	< 12 000 m^3
demolition height	> 12 m AGL	6 m and 12 m AGL	< 6 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	> 110 000 m^2	18 000 m^2 to 110 000 m^2	< 18 000m^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	> 6 m AGL	3 m to 6 m AGL	< 3 m AGL
Construction			
total building volume	> 75 000 m^3	12 000 m^3 to 75 000 m^3	< 12 000 m^3
concrete batching	yes	yes	no
sandblasting	yes	no	no
materials	concrete	concrete	metal cladding or timber
Trackout			
outward heavy vehicles movements per day	> 50	20 to 50	< 20
surface materials	high potential	moderate potential	low potential
unpaved road length	> 100 m	50 m to 100 m	< 50 m
Construction traffic (from construction site entrance to construction vehicle origin)			
Demolition traffic - total building volume	> 75 000 m^3	12 000 m^3 to 75 000 m^3	< 12 000 m^3
Earthworks traffic total area	> 110 000 m^2	18 000 m^2 to 110 000 m^2	< 18 000m^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)

Activity	Large	Medium	Small
Construction traffic total building volume	> 75 000 m^3	12 000 m^3 to 75 000 m^3	< 12 000 m^3
Total traffic outward heavy vehicles movements per day	> 50	20 to 50	< 20

The footprint of the Proposal site (the area affected) is estimated as being approximately 82 022 m^2 in area.

Based on review of layout provided in Figure 2, the proposed buildings are assumed to be between greater than 75 000 m^3 (threshold for large dust emission magnitude [refer Table D3]). Given the volume of construction to be performed, it is expected that the number of vehicle movements to service the Proposal site each day would be greater than 50 movements (threshold for large dust emission magnitude for trackout [refer Table D3]).

As outlined previously, no demolition activities are anticipated to be performed.

Based upon the above assumptions and the assessment criteria presented in Table D3, the dust emission magnitudes are as presented in Table D4.

Table D4 Construction phase impact categorisation of dust emission magnitude

Activity	Dust emission magnitude
Demolition	N/A
Earthworks and enabling works	Small
Construction	Medium
Track-out	Medium
Construction traffic routes	Medium

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 considers:

- 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 (IAQM, 2024) 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) are dependent on existing deposition levels.

Given the residential dwellings included in the receptor locations identified as part of this AQIA, the land use value is determined to be high.

Table D5 IAQM guidance for categorising land use value

Land use value	High	Medium	Low
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).	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).	Locations where human exposure is transient.
Examples	Residential properties, hospitals, schools and residential care homes.	Office and shop workers but would generally not include workers occupationally exposed to PM_{10}.	Public footpaths, playing fields, parks and shopping street.
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.	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	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

Land use value	High	Medium	Low
		expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.	only for limited periods of time as part of the normal pattern of use of the land.
Examples	Dwellings, museums, medium- and long-term car parks and car showrooms.	Parks and places of work.	Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.

Dust Soiling Impacts

To assess dust soiling impacts, the sensitivity of the local area is determined by considering the receptors and their quantity, as detailed in Table D6.

Table D6 IAQM guidance for categorising the sensitivity of an area to dust soiling impacts

Land use values	Number of receptors[a]	Distance from the source (m)[b]			
		< 20	< 50	< 100	< 250
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 < 20 m and < 50 m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50 m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Considering both the sensitivity of receptors and their numbers within specified distances from the footprint, the sensitivity to dust soiling impacts is assessed as 'medium'.

Human Health Impacts

The assessed land use value (as described above) is then used to assess the sensitivity of the area surrounding the active construction area, considering 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.

The IAQM guidance for assessing the sensitivity of an area of human health impacts is shown in Table D7.

The background annual average PM_{10} concentration measured at Prospect AQMS in 2020 was 20.2 $\mu g{\cdot}m^{-3}$ (refer Table C2) which together with the calculated land use value classifies the sensitivity of the area as 'low' for dust health impacts.

Table D7 IAQM guidance for categorising the sensitivity of an area of human health impacts

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	< 250
High	> 30	> 100	High	High	High	Medium
		10-100	High	High	Medium	Low
		1-10	High	Medium	Low	Low
	26 – 30	> 100	High	High	Medium	Low
		10-100	High	Medium	Low	Low
		1-10	High	Medium	Low	Low
	22 – 26	> 100	High	Medium	Low	Low
		10-100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	≤ 22	> 100	Medium	Low	Low	Low
		10-100	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Medium	> 30	>10	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	26 - 30	> 10	Medium	Low	Low	Low
		1-10	Low	Low	Low	Low
	22 – 26	> 10	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
	≤ 22	> 10	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Low	-	> 1	Low	Low	Low	Low

Note: (a) Estimate the total within the stated distance (e.g. the total within 250 m and not the number between 100 m and 250 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 < 20 m and < 50 m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50 m 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 in Table D8 for each activity determine the risk category with no mitigation applied.

Table D8 Risk of dust impacts from construction related activities

Sensitivity of area	Pre-mitigated dust emission magnitude		
	Small	Medium	Large
Demolition			
Low	Negligible	Low risk	Medium risk
Medium	Low risk	Medium risk	High risk
High	Medium risk	Medium risk	High risk
Earthworks, Construction and Trackout			
Low	Negligible	Low risk	Low risk
Medium	Low risk	Medium risk	Medium risk
High	Low risk	Medium risk	High risk
Construction traffic (from construction site entrance to origin)			
Low	Negligible	Low risk	Low risk
Medium	Negligible	Low risk	Medium risk
High	Low Risk	Medium risk	High risk

Given the sensitivity of the identified receptors is classified as medium for dust soiling and low for human health impacts, and the dust emission magnitudes for the various construction phase activities as shown in Table D4, the resulting risk of air quality impacts (without mitigation) is as presented in Table D9.

Table D9 Risk of air quality impacts from construction activities

Sensitivity of area	Dust emission magnitude					Preliminary risk				
	Demolition	Earthworks	Construction	Track-out	Const. traffic	Demolition	Earthworks	Construction	Track-out	Const. traffic
Dust soiling										
Med.	N/A	Med.	Large	Large	Large	N/A	Med.	Med.	Med.	Med.
Human health										
Low	N/A	Med.	Large	Large	Large	N/A	Low	Low	Low	Low

Note: Med. = Medium, N/A = Not Applicable

The risks summarised in Table D9 show that there are medium risks of dust soiling and low risks of human health impacts associated with all proposed construction phase activities 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, commensurate with those identified risks.

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).

Table D10 represents a selection of recommended mitigation measures recommended by the IAQM methodology for construction activities commensurate with the risks identified in Table D9.

Table D10 Site-specific management measures

Identified mitigation		Unmitigated risk
1	**Communications**	**Medium**
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	H
1.2	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
1.3	Display the head or regional office contact information.	H
1.4	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	H
2	**Site management**	**Medium**
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 relevant 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**	**Medium**
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 relevant 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 maintain an inspection log available to the relevant authority when asked.	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H
4	**Preparing and maintaining the site**	**Medium**
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

Identified mitigation		Unmitigated risk
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**	**Medium**
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 relevant 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)	D
6	**Operations**	**Medium**
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	H
6.3	Use enclosed chutes and conveyors and covered skips	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H
6.5	Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	H
7	**Waste management**	**Medium**
7.1	Avoid bonfires and burning of waste materials.	H
8	**Measures specific to earthworks**	**Medium**
8.1	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	D
8.2	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	D
8.3	Only remove the cover in small areas during work and not all at once	D
9	**Measures specific to construction**	**Medium**
9.1	Avoid scabbling (roughening of concrete surfaces) if possible	D

	Identified mitigation	Unmitigated risk
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	H
9.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	D
9.4	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**	**Medium**
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 permit.	H
10.9	Access gates to be located at least 10 m from receptors where possible.	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).

Given the size of the Proposal site, the distance to sensitive receptors and the activities to be performed, residual impacts associated with fugitive dust emissions from the Proposal would be anticipated to be 'negligible', should the implementation of the mitigation measures outlined above be performed appropriately.

APPENDIX E

Generator Technical Specifications

Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	16V4000G84F				
Applicationgroup	3D				
Legislative body	Fuel-consumption optimized				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN3 values base on residual oxygen value of [%]	Measured				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	2185	1639	1092	546	218
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1500	1500	1500	1500	1500
Engine speed relative	[-]	1	1	1	1	1
NOX+HC1 mass flow	kg/h	29.28	25.91	13.93	6.69	
NOX-Emissions specific	g/kWh	13.2	15.52	12.32	11.32	
CO-Emissions specific	g/kWh	0.8	0.43	0.87	2.18	
HC1-Emissions specific	g/kWh	0.2	0.29	0.43	0.93	
NOX+HC1-Emissions specific	g/kWh	13.4	15.81	12.75	12.25	
PM-Emissions specific (Meas.)	g/kWh	0.054	0.101	0.205	0.607	
NOX-Emissions (based on O2 meas)	mg/m3N	3823	4282	2826	1821	
NOX+HC1-Emissions (based on O2 meas)	mg/m3N	3879	4358	2920	1963	
CO-Emissions (based on O2 meas)	mg/m3N	221.2	114	189.2	334.9	
HC1-Emissions (based on O2 meas)	mg/m3N	56.6	75.8	94.4	141.8	
PM-Emissions (based on O2 meas)	mg/m3N	15.1	26.6	45	93.3	
NOX-Emissions (based on 5% O2)	mg/m3N	5115	6085	4613	3793	
NOX+HC1-Emissions (based on 5% O2)	mg/m3N	5191	6193	4768	4089	
CO-Emissions (based on 5% O2)	mg/m3N	296	162.1	309	697.7	
HC1-Emissions (based on 5% O2)	mg/m3N	75.7	107.8	154.1	295.4	
PM-Emissions (based on 5% O2)	mg/m3N	20.2	37.8	73.4	194.3	

Engine

Manufacturer	MTU
Model	16V4000G84F
Type	4-cycle
Arrangement	16V
Displacement: l	76.3
Bore: mm	170
Stroke: mm	210
Compression ratio	16.4
Rated speed: rpm	1500
Engine governor	ECU 9
Max power: kWm	2185
Air cleaner	dry

Fuel system

Maximum fuel lift: m	5
Total fuel flow: l/min	20

Fuel consumption [a]	l/hr	g/kwh
At 100% of power rating:	513.3	195
At 75% of power rating:	381.1	193
At 50% of power rating:	260.6	198

Liquid capacity (lubrication)

Total oil system capacity: l	300
Engine jacket water capacity: l	175
Intercooler coolant capacity: l	50

Combustion air requirements

Combustion air volume: m^3/s	2.6
Max. air intake restriction: mbar	50

Cooling/radiator system

Coolant flow rate (HT circuit): m3/hr	68.5
Coolant flow rate (LT circuit): m3/hr	30
Heat rejection to coolant: kW	800
Heat radiated to charge air cooling: kW	410
Heat radiated to ambient: kW	90
Fan power for electr. radiator (40°C): kW	44

Exhaust system

Exhaust gas temp. (after turbocharger): °C	490
Exhaust gas volume: m^3/s	6.6
Maximum allowable back pressure: mbar	85
Minimum allowable back pressure: mbar	30

Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94LF				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN³ values base on residual oxygen value of [%]	5				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	3307	2480	1653	827	331
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1500	1499	1499	1500	1499
Engine speed relative	[-]	1	1	1	1	1
NOX-Emissions specific	g/kWh	8.58	7.72	6.23	6.61	
CO-Emissions specific	g/kWh	0.55	0.67	1.94	2.89	
HC1-Emissions specific	g/kWh	0.09	0.11	0.16	0.33	
NMHC-Emissions specific	g/kWh	0.09	0.11	0.16	0.32	
NOX+HC1-Emissions specific	g/kWh	8.67	7.84	6.39	6.94	
NOX+NMHC-Emissions specific	g/kWh	8.67	7.83	6.39	6.93	
PM-Emissions specific (Meas.)	g/kWh	0.03	0.046	0.147	0.266	
NOX-Emissions (based on 5% O2)	mg/m3N	3071	2824	2130	2063	
NOX+HC1-Emissions (based on 5% O2)	mg/m3N	3103	2863	2185	2164	
NOX+NMHC-Emissions (based on 5% O2)	mg/m3N	3102	2862	2184	2162	

CO-Emissions (based on 5% O2)	mg/m3N	189.4	235.5	644.5	889.1	
HC1-Emissions (based on 5% O2)	mg/m3N	31.5	39.2	54.7	100.8	
PM-Emissions (based on 5% O2)	mg/m3N	10.4	16.4	49	81.9	

Application data [1)]

Engine

Manufacturer	MTU
Model	20V4000G94LF
Type	4-cycle
Arrangement	20V
Displacement: l	95.4
Bore: mm	170
Stroke: mm	210
Compression ratio	16.4
Rated speed: rpm	1500
Engine governor	ADEC (ECU 9)
Max power: kWm	3308
Air cleaner	dry

Fuel system

Maximum fuel lift: m	5
Total fuel flow: l/min	27

Fuel consumption [2)]	l/hr	g/kwh
At 100% of power rating:	806	202
At 75% of power rating:	565	189
At 50% of power rating:	403	202

Liquid capacity (lubrication)

Total oil system capacity: l	390
Engine jacket water capacity: l	260
Intercooler coolant capacity: l	50

Combustion air requirements

Combustion air volume: m³/s	4.5
Max. air intake restriction: mbar	30

Cooling/radiator system

Coolant flow rate (HT circuit): m³/hr	80
Coolant flow rate (LT circuit): m³/hr	44
Heat rejection to coolant: kW	1220
Heat radiated to charge air cooling: kW	840
Heat radiated to ambient: kW	105
Fan power for electr. radiator (40°C): kW	105

Exhaust system

Exhaust gas temp. (after engine): °C	481
Exhaust gas temp. (before turbocharger): °C	693
Exhaust gas volume: m³/s	11.5
Maximum allowable back pressure: mbar	50
Minimum allowable back pressure: mbar	-

APPENDIX F

Additional Mitigation Measures

As outlined in Section 8.2.4, a number of additional mitigation measures considered to be Best Available Technology (BAT) have been reviewed and discussed below. For clarity, the Proposal is predicted to not result in any exceedances of the relevant air quality criteria under the proposed maintenance testing schedule and correspondingly, the following additional controls have been outlined to solely provide context for how air quality impacts may be further reduced.

To prevent or minimise emissions during operation, BAT ensures through proper design, operation, and maintenance, that emission control techniques are utilised at their optimal capacity and availability.

Source – Pathway – Receptor Model

The source-pathway-receptor (SPR) model is useful for understanding the hypothetical relationships between contributing factors to create exposure linkages and also how controls may be applied to manage the risk of exposure from those linkages. Each component of the SPR model is defined below, as relates to the context of this study:

- **Source** – the origin of air emissions, which in this case is the discharge points from the back-up generators.
- **Pathway** – the route through which pollutants disperse from source to receptor. In this case the pathway assessed in through atmospheric dispersion which can be influenced by various parameters such as meteorological conditions, terrain, and characteristics of the emission source(s).
- **Receptor** – The presence of receptors that could be adversely affected by a contaminant. In this case receptors are assessed as the receptor locations identified in Section 4.2.

For air emissions to have an impact on the receiving environment, there needs to be a connection through the SPR model. This means that the source of pollution, the way it travels (pathway), and the affected area (receptor) must all be linked for there to be a potential risk.

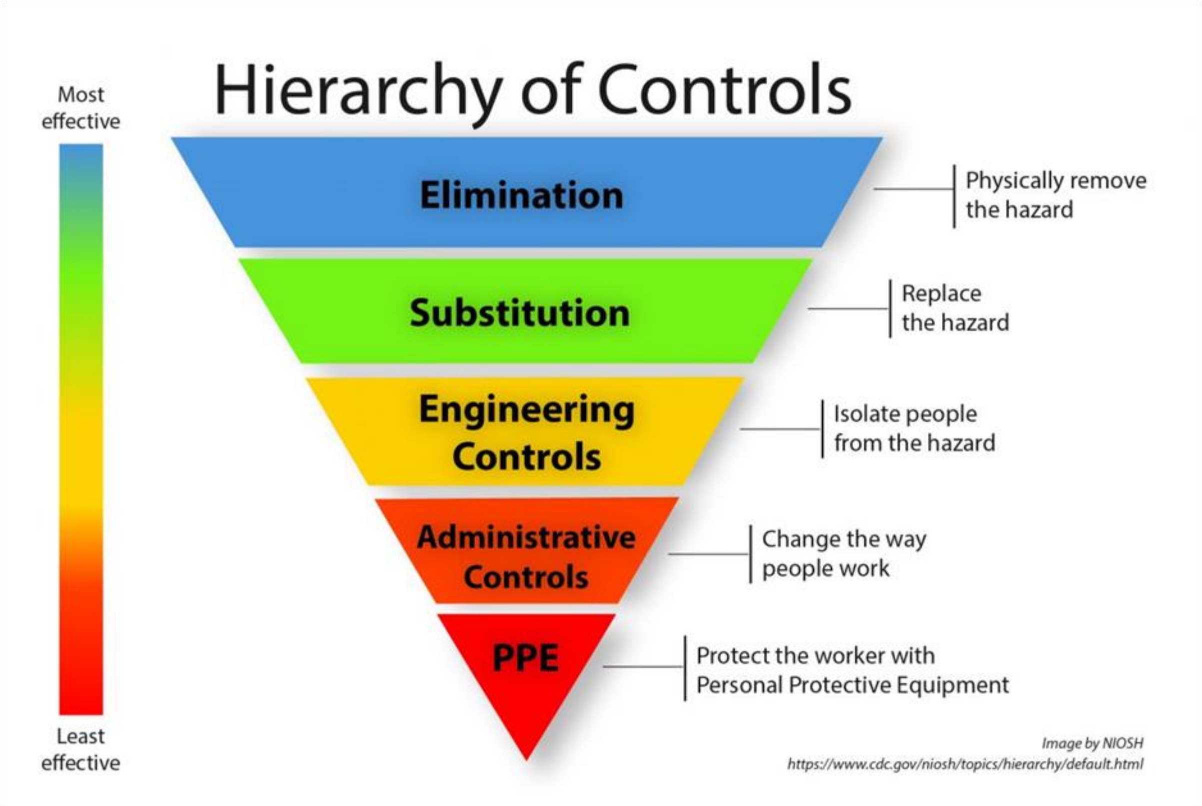
Identification of the SPR model allows for targeted management interventions to manage the environmental risks and prevent pollution from reaching sensitive areas.

Hierarchy of Controls

The hierarchy of controls are a well-documented and utilised tool for evaluating the efficacy and reliability for the control of hazards. An example of the hierarchy is presented in Figure F1.

The hierarchy of controls shows 'elimination' of the hazard as the most desirable control, through 'substitution', 'engineering' and 'administrative controls' to 'PPE' (i.e. protection from the hazard at the point of exposure) being the least effective.

Figure F1 Hierarchy of controls



Source: Centres for Disease Control and Prevention (CDC) / National Institute for Occupational Safety & Health (NIOSH)

For each identified potential control that is subsequently evaluated below, each control has been given a unique identifier that is **[S*x*]**, **[P*x*]** or **[R*x*]** relating to how they fit into the SPR model and ***x*** being a sequential number (e.g. **[S1]**, **[S2]**, **[S3]**… for identified controls at source).

It is noted that these references may occur in multiple places in the following sections.

Controls at Source

Air pollution controls at the source may involve the installation of emission control devices and adoption of efficient power generation techniques to minimise pollutant releases from the Proposal site.

Selection of Generators

The capacity, number and configuration of the back-up generators at the Proposal site will have been dependant on the requirements sought by the Proponent during the detailed design phase of the development.

Key factors which may have influenced the selection of generators at the Proposal site include (in no order) fuel efficiency, reliability, capabilities to retrofit air pollution control (APC) techniques, start-up times and compliance with appropriate emissions limit values as specified in legislative and regulatory requirements.

The UK Environment Agency's working draft guide on the approach to the permitting and regulatory aspects for Data Centres (UK Environment Agency, 2018) notes that:

> *"It is generally accepted that the BAT for data centre back-up generation is presently a set of diesel generators – this allows for an on-site store of fuel for reliability and a scalable provision of MWelec."*

Other technologies identified for standby power generation purposes include the Diesel Rotary Uninterruptible Power Supply engine (DRUPS) and natural gas-fuelled back-up generators utilising either combined-cycle or open-cycle gas turbine technologies or employing spark ignition.

In terms of generator selection for the Proposal site:

- Diesel engines can offer a faster response speed relative to the demanded load; making them a crucial component for data centre operations which require fast response times. Rapid start-up of back-up generators is essential where a near instantaneous supply of electricity is imperative in the event of a power outage.
- Diesel engines typically have lower maintenance cost compared to gas-fired generators; and,
- Ensuring a reliable fuel supply, particularly diesel, is essential for maintaining dependability. Use of a natural gas generator for example would necessitate reliance on an off-site supply network.

In terms of pollutants, NO_X is a predominant byproduct obtained from the combustion process. The adoption of low NO_X engine technology would aide in reducing emissions at source. It is acknowledged that gas engines are known to emit lower amounts of NO_X, SOX, and particulate matter (PM) in comparison to diesel fired engines.

As each generator has a unique specification for operating conditions (such as fuel consumption rate, operating temperature, and resultant emission specifications), the selection of generators to account for the different emission specification is a consideration for control **[S1]**.

In Chapter 3 of the BAT Reference Document (BREF) for Large Combustion Plants (LCP BREF) (Lecomte, et al., 2017) low NO_x burners are described as employing a combination of air staging, fuel staging and internal flue-gas recirculation techniques to achieve low NO_X emission from combustion. The control efficiency can vary depending on the specific design of the burner, the combustion technology applied and fuel type, with low NO_x burners generally achieving between 20 % and 70 % of a reduction of NO_x emissions (Lecomte, et al., 2017) **[S2]**.

Emissions Standards

In NSW, standby generators are not required to comply with emissions standards, as long as their operation does not exceed a specific annual hour limit or if maintenance and testing activities are conducted for less than a designated number of hours per year (refer Section 3.2).

Schedule 2, Part 3 of the POEO CAR sets out emission limits relevant to standby electricity generators as a non-scheduled activity. Table F1 outlines the standards of concentration for non-scheduled premises. It is important to note that no reference to other pollutants such as NO_X is within Schedule 2.

Table F1 POEO CAR – Schedule 2, Part 3 – general standards of concentrations for non-scheduled premises

Air impurity	Activity or plant	Group	Concentration
Solid particles	Any activity or plant (except as listed below)	Group A	400 $mg \cdot m^{-3}$
		Group B	250 $mg \cdot m^{-3}$
		Group C	100 $mg \cdot m^{-3}$
Smoke	Any activity or plant in connection with which liquid or gaseous fuel is burnt	Group A, B, C	Ringelmann 1 or 20 % opacity

Standby generators in Australia commonly adhere to either United States (US) emissions standards (Tier 1 to Tier 4) or European Union (EU) emissions standards (Stage I to Stage V) due to the prevalent manufacturing of diesel engines in these regions.

The US non-road emissions standards are categorized by engine horsepower and model year, regulated by the US EPA. Tier 1 standards were phased in from 1996 to 2000, followed by more stringent Tier 2 from 2001 to 2006, and Tier 3 from 2006 to 2008 (applicable to engines from 37 kW to 560 kW).

Current Tier 4 standards, implemented from 2008 to 2015, require around a 90 % reduction in NO_x and PM emissions, achieved through exhaust gas aftertreatment technologies like SCR catalysts. The California Air Resources Board (CARB) is developing Tier 5 standards to be in place between 2028 and 2030, aiming to further reduce NO_x and PM emissions by between 50 %-90 %, which currently under consideration by the US EPA for adoption into their respective non-road engine regulations.

An air information report published by NSW EPA on the reduction of emissions from non-road diesel engines (NSW EPA, 2014) notes that:

> *Tier 4 emission standards make provision for the following reductions compared to Tier 1 emission standards:*
>
> - *95 % reduction in NOx for engines less than 560 kW and 60% reduction for larger engines*
> - *85 % reduction in HC for engines less than 560 kW and 70% reduction for larger engines, and*
> - *50–60% reduction in PM during first phase (2008), and 80–95% reduction in second phase (2013–2015).*

Table F2 provides details of the corresponding US EPA Tier 1 to Tier 3 emissions standards for engines rated above 560 kW and Table F3 outlines the respective requirements under US EPA Tier 4 emissions standards.

Table F2 US EPA Tier 1 to Tier 3 emissions standards – engines above 560 kW

Rated power	Tier	Model year	Emissions standards					
			Units	CO	HC	NMHC + NO_x	NO_x	PM
≥ 560 kW (≥ 750 hp)	Tier 1	2000	g·kWh	11.4	1.3	-	9.2	0.54
			g·bhp-hr^{-1}	8.5	1.0	-	6.9	0.4
	Tier 2	2006	g·kWh	3.5	-	6.4	-	0.2
			g·bhp-hr^{-1}	2.6	-	4.8	-	0.15

Note: NMHC – non-methane hydrocarbon

Table F3 US EPA Tier 4 emissions standards – engines above 560 kW

Model year	Category	Emissions standards				
		Units	CO	NMHC	NO_x	PM
2011 - 2014	Generator sets > 900 kW	g·kWh	3.5	0.40	0.67	0.10
		g·bhp-hr^{-1}	2.6	0.30	0.50	0.075
	All engines except gensets > 900 kw	g·kWh	3.5	0.40	3.5	0.10
		g·bhp-hr^{-1}	2.6	0.30	2.6	0.075
2015	Generator sets	g·kWh	3.5	0.19	0.67	0.03
		g·bhp-hr^{-1}	2.6	0.14	0.5	0.022
	All engines except gensets	g·kWh	3.5	0.19	3.5	0.04
		g·bhp-hr^{-1}	2.6	0.14	2.6	0.03

Note: NMHC – non-methane hydrocarbon

European emissions standards follow a tiered approach, akin to the US, driven by EU parliamentary directives. EU Directive 2015/2193 on Medium Combustion Plant (MCPD) establishes requirements for stationary combustion plants with a thermal rating of equal to or more than 1 MW and less than 50 MW with limits for SO_2, NO_X, and PM.

According to MCPD Article 6, emergency plants operating less than 500 hours per year, as a five-year rolling average, are exempt from emission limit values. Each generator with its own discharge stack, under MCPD provisions, can operate for testing or emergencies for up to 500 hours per calendar year without emission limit values under the MCPD. If generators share a common discharge stack, the set can be tested and maintained without emissions limit values for up to 500 hours per year.

Other non-road engine emissions in Europe adhere to EU Directive 2016/1628, known as the NRMM Regulation. This regulation sets emission limits for various power ranges and applications, outlining procedures for engine manufacturers to obtain type-approval. European Stage V standards, derived from Directive 2016/1628, mandates stringent limits on PM emissions, necessitating diesel particulate filters (DPFs) for non-road engines rated between 19 kW and 560 kW. Stage V emissions limits are also established for engines above 560 kW.

Table F4 provides the EU Stage V emissions limits for generators set engines rated above 560 kW.

Table F4 EU Stage V emissions limits by engine category

Engine category	Ignition type	Net power (kW)	Date	Emission limit (g·kWh)			
				CO	HC	NO_x	PM
NRG-v-1 NRG-c-1	All	P > 560	2019	3.5	0.19	0.67	0.035

While the standby generators for the Proposal have already been determined, ensuring that the selected generators are compliant with the abovementioned emissions standards has been considered in this review **[S1]**.

Selection of Fuel

The Proposal site utilises diesel for the purposes of standby power generation. Diesel is typically the fuel used for emergency generators, and reciprocating engines fuelled by low-sulfur diesel are the most common choice for other developments of this nature.

Diesel fuel in Australia is subject to specified parameters governing environmental factors like sulfur and hydrocarbons (HC), as well as operational considerations such as carbon residue and sediments, which can impact engine performance.

Part 9 of the POEO CAR specifies limits on sulfur content within liquid fuel, whereby clause 159(2) states:

> *"A person must not operate fuel burning equipment powered by a reciprocating internal combustion engine using diesel, if the fuel has a sulfur content of more than the sulfur content specified for diesel—*
>
> *(a) in a fuel standard determined under the Fuel Quality Standards Act 2000 of the Commonwealth, section 21, or*
>
> *(b) in an approval granted under the Fuel Quality Standards Act 2000 of the Commonwealth, section 13."*

The Fuel Standard (Automotive Diesel) Determination 2001, as authorised by the Fuel Quality Standard Act 2000 denotes that diesel fuels must not contain more than 10 $mg \cdot kg^{-1}$ (ppm) from 1 January 2009.

In the US, non-road engine emission regulations allowed higher sulfur content (up to 0.5 %) at Tier 1 to Tier 3 stages. However, to accommodate sulfur-sensitive control technologies in Tier 4 engines, like catalytic particulate filters, the US EPA mandated a reduction in sulfur content to 15 ppm for non-road diesel fuels.

Alternative fuel types identified through the desktop review include natural gas, propane, gasoline, liquefied natural gas (LNG). These fuels may provide gas engines with higher thermal efficiencies when compared to use over diesel generators. However, it is important to note that gas engines may come with relatively higher levels of investment, operating and maintenance costs. Additionally, whilst the use of gas engines may have the potential for lower NO_x emissions compared to diesel engines, there would be a reliance on the national gas grid for an uninterruptable supply, which may not provide the Proponent with fuel security **[S3]**.

Discharge Design

According to (UK Environment Agency, 2018), data centres can have short, below roof level emissions stacks, which can impact on the efficiency of dispersion of emissions. With reference to BAT, the following techniques are noted for the adequate dispersion of exhaust emissions:

1. Increased stack height
2. Vertical ports
3. Increased distances from buildings to be above roof line
4. 'Common windshield' combining several individual flues.

Stack Height

By raising the stack height, this can facilitate a higher level of dispersion of exhaust gases as they mix with the surrounding air beyond the stack plume. Although this does not decrease the pollutant concentration at source, this does aide in reducing pollutant concentrations at ground level. Elevating the stack height serves to mitigate the impact of building wake and the entrainment of emissions in the locality of the emission source.

When wind interacts with buildings or structures, turbulent eddies form on the downwind side, potentially forcing a stack plume down to the ground if it's located within approximately five times the height of the nearby structure. This turbulence, known as building downwash, can lead to increased ground-level pollutant concentrations downstream of the building or structure.

Elevating the stack height above the highest point of the building in which it is located (or nearby buildings) will help mitigate building downwash effects and reduce air quality impacts beyond the Proposal site, where feasible **[S4]**.

Discharge Velocity

Decreases in ground-level pollutant concentrations can be accomplished through improved mixing with the surrounding air once the exhaust gas plume terminates from the stack. A higher emission velocity generates increased momentum, increasing the height of the plume in the atmosphere beyond the stack exit point. This increased vertical mixing contributes to lower pollutant concentrations at surrounding receptors.

Any increase in discharge velocity should be considered alongside any improvements to the stack height to optimise plume dispersion conditions.

Increasing discharge velocities associated with the standby generators may be achieved by:

- increasing the air extraction rate from the discharge point; and / or
- decreasing the physical dimensions of the discharge point; and / or
- the addition of dilution air into the exhaust stream prior to discharge.

Exhaust stack restriction devices can regulate the corresponding exhaust flow through adjustment of the cross-sectional area of the stack at point of discharge **[S5]**

Enhanced discharge velocity may also be gained through the use of dilution fans (for example[4]). They operate by drawing in additional air below the point of discharge to increase volumetric flow and increasing discharge velocity. The effect of this is to significantly increase vertical momentum, which can increase the effective discharge height to conditions that are less affected by turbulent air flows over buildings and enhance dispersion.

They can be configured by multiple inlet manifold and variable speed drive fans to serve multiple discharge points, and as such may offer a practical solution for data centres that are designed with nested discharge points and have highly variable discharge flows.

Such devices have been used on other developments in the Greater Sydney region to good effect **[S6]**.

Discharge Temperature

High stack exhaust temperatures can increase both buoyancy and plume rise dispersion conditions. Plumes tend to rise more rapidly when the associated gases are warmer compared to the atmospheric temperature, which in turn contributes to a higher plume rise which can affect the dispersion pattern.

Combustion modification such as changes to the flame temperature and O_2 content of the air-fuel (stoichiometric) mixture aim to reduce NO_x pollution by ensuring that the fuel is burned completely, or reducing the amount of nitrogen from the air that is burnt in the combustion process. Such approaches include lean burn, water injection, exhaust gas recirculation or low-NO_x boiler designs that reduce the flame temperature.

Secondary abatement technologies such as SCR operated within a narrow temperature range. Operating at lighter loads typically results in emissions at lower temperature, resulting in poorer performance of SCR aftertreatment **[S7]**.

[4] https://www.criticalairflow.com/site/assets/files/1080/critical_airflow_tristactech.pdf

Multi-Stack Configuration

By physically bringing together the exhaust streams for multiple engines, it is possible to improve the mixing of flue gases with the surrounding air. This plume aggregation does not decrease the absolute quantities of pollutants being emitted however it can lead to enhanced plume dispersion which results in lower concentration at ground level.

A multi-flue stack configuration pertains to a chimney or exhaust system that contains several flues, where each generator can discharge independently through its own flue but is constrained within that stack. Multi-flue stacks are common in facilities with multiple combustion processes. Each flue may lead to a specific emission control system or stack gas treatment unit.

A combined flue stack configuration involves the use of a single exhaust stack system for the collective discharge of combustion byproducts from various power generation sources. This serves as the termination point with each flue feeding into the shared exhaust system **[S8]**.

Air Pollution Control

Air pollution control (APC) encompasses a range of technologies and strategies aimed at eliminating or minimising the release of pollutants into the atmosphere. With regard to standby power generation from diesel combustion, the application of exhaust aftertreatment technologies is common.

Known air pollution control technologies that are available to reduce diesel combustion pollutant emissions include:

- **Diesel Oxidisation Catalyst (DOC) –** use of a catalyst to promote the oxidation of CO and hydrocarbons (HC) contained in the diesel exhaust gas to produce CO_2 and water as byproducts.
- **Diesel Particulate Filters (DPF) –** filters particulate matter (PM) from the exhaust gas and is 'burned off' through either active of passive filter regeneration.
- **Selective Catalytic Reduction (SCR) –** emissions control method that reduces NO_x emissions within exhaust gases by injecting a reducing agent which initiates a chemical reaction that converts NO_x into N_2, water, and small amounts of CO_2.
- **Non-selective Catalytic Reduction (NSCR) –** use of a catalyst reaction to simultaneously reduce NOx, CO, and hydrocarbon (HC) to water, CO_2, and N_2.

A diesel oxidisation catalyst (DOC) is an aftertreatment component that is designed specifically for modern diesel engines to convert CO and HC and are commonly used alongside other emission control devices such as DPF and SCR systems. DOCs can achieve a higher level of performance with the use of low sulfur diesel. General information provided by the US Environmental Protection Agency[5] (US EPA) indicates that DOCs are

[5] https://www.epa.gov/sites/default/files/2016-03/documents/420f10031.pdf

typically effective at reducing emissions of particulate matter (PM) between 20 % to 40 %, HC emissions can be reduced between 40 % and 75 % and CO emissions between 10 % and 60 % **[S9]**.

A Diesel Particulate Filter (DPF) serves as an APC device aimed at minimising particulate matter (PM) emissions linked to diesel engine exhaust. Positioned downstream of the engine, the DPF employs a filtration medium, typically a porous ceramic filter, to capture PM. Subsequently, the accumulated PM undergoes combustion at elevated temperatures to ensure effective removal. This technology can be combined with other emissions controls including SCR and DOC as DPF has a limited effect on other pollutants such as NO_X.

Passive regeneration takes place when the exhaust gas temperatures reach a level that initiates the combustion of collected PM within the DPF without the need for additional fuel, heat, or driver intervention. Conversely, Active regeneration may necessitate external sources of fuel or heat to elevate the DPF temperature to a point where the accumulated PM can be effectively combusted.

The associated control efficiencies for DPF technology, as verified by US EPA[6] ranges between 85 % and 90 % for PM emissions **[S10]**.

Selective catalytic reduction (SCR) control devices are considered to be one of the most effective abatement techniques for NO_X releases. SCRs induce a chemical reduction via a reducing agent and catalyst to convert NO_X to molecular nitrogen (N_2) and water in the presence of a catalyst. In mobile source applications, an aqueous urea solution is typically preferred as the reductant. The LCP BREF (Lecomte, et al., 2017) notes that, *"A higher NO_X reduction is achieved with the use of several layers of catalyst. The technique design can be modular; a special catalyst and / or preheating can be used to cope with low loads or with a wide flue-gas temperature window."*

Conversion of NO_X occurs on the catalyst surface with an ideal temperature range of between 300 °C and 450 °C, and less effectively over a wider temperature range of 170 °C and 510 °C depending on the catalyst type and/or configuration employed.

SCR can typically reduce NO_X emissions between 75 % and 90 %, HC emissions by up to 80 %, and PM emissions between 20 % and 30 %[7]. SCR requires the engine and exhaust system to reach operating temperature to be effective, requiring special pre-heaters for NO_X reduction in standby generators, which may reflect a higher cost for implementation **[S11]**.

Selective Non-Catalytic Reduction (SNCR) involves reducing NO_x to N_2 through the reaction with ammonia (NH_3) or urea (CH_4N_2O) at a temperature between 800 °C and 1 100 °C for optimal reaction. The LCP BREF (Lecomte, et al., 2017) provides a technical description for SNCR, whereby, "*Using ammonia as a reagent, the following chemical reactions take place more or less at the same time. At the lower temperature, both*

6 https://www.epa.gov/sites/default/files/2016-03/documents/420f10029.pdf

7 https://archive.epa.gov/international/air/web/pdf/default-file_dieselfact_0106.pdf

reactions are too slow; at the higher temperature, the unwanted by-reaction dominates with an increase in NO_X emissions."

In contrast to SCR technology, a catalyst is not required, which lowers investment and maintenance costs, and less space is required to house the SNCR technology at the generator location. The LCP BREF (Lecomte, et al., 2017) notes that SNCR cannot be applied to gas engines or turbines due to the residence time and temperature window required for operation. SNCR processes can typically achieve a NO_X reduction level of between 30 % and 50 % (Lecomte, et al., 2017).

In NSCR technology, the engine exhaust flows through a catalyst bed where NO_x is converted to N_2. Simultaneously, VOCs and CO undergo oxidation, resulting in the formation of water and CO_2 under optimal conditions.

A technical progress report on reciprocating engine emissions control (Chapman, 2004) notes that, *"For an NSCR system to operate optimally (i.e., to minimize NO_x emissions), the inlet exhaust stream must have very low oxygen content, as well as proper concentrations of NO_x, hydrocarbons, and carbon monoxide. This requires initial engine adjustments, followed by careful monitoring of oxygen content in the exhaust."*

The catalyst demands exhaust with less than 0.5 % O_2 content. Although employing a fuel-rich mixture increases engine fuel consumption due to back pressure, it enables effective NO_X control, typically achieving levels between 90 % and 98 %[8] **[S12]**.

Various standby generator manufacturers have developed retrofit emission control device (RECD) systems[9] based on electrostatic precipitation (ESP) fundamentals for use with diesel generator sets. The RECD is installed after the standby generator exhaust and no modifications to the exhaust are required. However, the RECD would have additional spacing requirements which may be constrained at the Proposal site **[S13]**.

Each air pollution control device identified in this section requires retrofitting to each standby generator (or each discharge point in the event of co-vented discharges), incurring associated costs. Retrofitting involves integrating or adding these devices to existing plant to enhance their emission control capabilities. The costs associated with this process include expenses for purchasing the control devices, installation, and potentially ongoing maintenance **[S10-13]**.

Controls in the Pathway

Enhancing the dilution and dispersion of a pollutant plume during its journey from the source to the receptor will lower the concentration at the receptor, subsequently minimising exposure. For instance, extending the

8 https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf

9 http://www.jnmachineries.com/cummins_retrofit_emission_control_device.php

pathway, such as by emitting emissions from a tall stack, will generally, under constant conditions, increase both dilution and dispersion conditions.

Green Infrastructure

The integration of Green Infrastructure (GI) in the environment has the potential to reduce the effectiveness of the pathway from the emission source to the receptor. Introducing natural elements, like vegetation or green spaces, as contiguous barriers can disrupt the usual flow of pollutants, creating obstacles that impede the direct transmission of emissions. This interference promotes dispersion, dilution, and absorption of pollutants by greenery, which can aide in lowering the concentration of pollutants reaching the receptor.

Strategically placed Vegetative Environment Buffers (VEB) along the perimeter of industrial areas, abutting sensitive areas such as residential, child-care and educational facilities can aide in mitigation human exposure to air pollution.

According to recent research (Barwise & Kumar, 2020), the optimal configuration and plant composition of GI are unclear. Furthermore, the effectiveness of GI depends on factors such as the condition of the built environment, as well as the type, location, and configuration of GI (Kumar, et al., 2019) **[P1]**.

Structural Barriers

Structural barriers such as sound walls or shelterbelts can influence the exposure pathway by obstructing the pollutant plume. These barriers can induce turbulence in the airflow, leading to enhanced dispersion and are used in industrial settings to reduce direct exposure to emissions at receptors. These methods may be more feasible in comparison to GI which would also require additional considerations with regard to establishment and maintenance activities.

The Proposal site is located within a predominately industrial zone (refer Section 4.1) with residential land use, areas located adjacent to the east.

While the discharges are released at a height, the implementation of structural barriers may be limited to the immediate vicinity of the Proposal site due to the distance to sensitive land uses and the magnitude of the discharge and structural constraints due to the increased loads of such structures **[P2]**.

Stack Height Optimisation

Increasing the stack height can influence the dispersion pattern of pollutants emitted from a stack. A taller stack emits the discharge at greater height and into atmospheric conditions which can enhance more effective dispersion.

Stack heights may be increased through retrofitting, noting that the increased height may have an effect of duct pressure which may affect performance of APC devices.

Often, planning restrictions may also impose limitations on stack heights to limit other environmental effects such as visual impact and design aesthetics **[S4, P3]**.

Controls at Receptors

Air Filtration Systems

Air filtration systems reduce indoor pollutant levels in buildings by extracting contaminants from airflow and commonly feature filters like activated carbon and HEPA filters, which capture airborne pollutants, particularly particulates, effectively.

Research conducted by the Public Health Research & Practice[10] assessed the effectiveness of air filtration, particularly those utilising HEPA filtration, in residential settings, focusing on their potential to increase infiltration rates. The research focused on the quantification of HEPA filters in residential settings during smoke events and notes that:

> *"The percentage reduction of $PM_{2.5}$ attributable to using the HEPA cleaner, which ranged between 30 % and 75 %. Other international studies suggest that HEPA cleaners can provide approximately 52 % – 67% reductions in PM….*
>
> *The effectiveness of HEPA cleaners depends on several factors, including outdoor smoke concentrations, room size, housing characteristics and building ventilation"*

Commercial and industrial buildings in the surrounding environment likely incorporate air handling units (AHU) within their respective building design whilst residential dwellings may also have some uses.

This control is by definition, only of value inside engineered airtight buildings and of limited value in non-airtight buildings (such as residential properties), and of no value in outdoor locations **[R1]**.

Alerts and Alarms

Implementation of air quality monitoring networks and early warning systems can assist in safeguarding sensitive receptors in proximity to the Proposal site. These systems can detect pollutant levels in real-time and can issue timely alerts, which can alert the local community to any potential pollution episodes. Alarm and alert systems that could be potentially implemented include:

- Real-time air quality monitoring stations that detect elevated levels of pollutants.
- Automated warning systems that send alerts via SMS, email, or mobile apps to the local community when pollution levels exceed any impact assessment criterion or predetermined thresholds.

[10] https://www.phrp.com.au/issues/online-early/residential-indoor-air-quality-and-hepa-cleaner-use/

- Integration with weather forecasting data to anticipate changes in air quality due to meteorological conditions.
- Online platforms or dashboards providing up-to-date information on air quality advisories for the community.

Increased community engagement, through mediums such as public forums, community advisory boards and meetings can help educate the local community to understand the Proposal site's procedures for standby power generation and the potential implications on air quality. The associated costs of implementing real time air quality monitoring and automated warning systems may not be viable given the likelihood of the Proposal site suffering a catastrophic power outage.

If implemented, each standby generator will feature operational alarms to alert in case of faults and will adhere to maintenance schedules and compliance monitoring programs to ensure emission control equipment functions correctly and complies with regulations. Regular testing and monitoring of the standby generators would incur costs **[R2]**.

Summary

The feasibility of implementing the identified control options in the SPR model have been evaluated by considering the following factors:

- Implementations cost;
- Regulatory requirements;
- Environmental impacts;
- Safety implications; and
- Compatibility with current processes.

This summary assesses the measures that may constrain the implementation of the control measures outlined above. Each measure is provided a risk rating (**low**, **medium**, or **high**) which identifies the constraints which may result in the implementation of the measure not being practical at the Proposal site. Where any of the measures of practicability are rated as high, these measures are not considered further.

It is noted that for the assessment of implementation costs, this review has adopted a relative and qualitative approach as follows:

- Low = $
- Medium = $$
- High = $$$

Table F5 provides a summary of the additional controls that could be employed at the Proposal site to minimise and reduce air pollution impacts from the standby generator operations.

Table F5 Practicality of implementing control measures at the Proposal site

Control measure	Potential Constraints					Conclusion of evaluation
	Implementation costs	Regulatory requirements	Environmental impacts	Safety implications	System compatibility	
Source						
S1 generator specification	$$$	Low	Low	Low	High	• Selecting alternative generator sets would be a high-cost option, and would be very difficult to implement once the facility is operating.
S2 low NO_x burners	$$$	Low	Low	Medium	Low	• Change in designed operational conditions (combustion stability, heat exchange) represents some safety issues that would require due consideration. • May offer additional air pollution control however would require extensive retrofitting to each standby generator.
S3 alternative fuels	$$	Low	Low	High	High	• Compatibility, storage and handling capabilities and combustion characteristics. Standby generators utilise diesel fuel and would require significant modification, and/or re-specification.
S4 stack height	$	Low	Low	Medium	Low	• Compatibility with clearance requirements to negate building downwash effects, stability, and structural integrity considerations. • May be considered a feasible for implementation.
S5 increased stack velocities	$	Low	Low	Medium	Low	• Change in designed operational conditions which may then require structural integrity considerations to stack configuration. • May be feasible for implementation.
S6 dilution fans	$$	Low	Low	Low	Medium	• Higher capital cost but reduced operating cost due to inlet manifolds serving multiple discharges and variable drives. • Retrofitting may require load considerations. • May be considered a feasible for implementation.

Control measure	Potential Constraints					Conclusion of evaluation
	Implementation costs	Regulatory requirements	Environmental impacts	Safety implications	System compatibility	
S7 stack temperature	$$	Low	Low	Low	Low	• May be considered a feasible for implementation.
S8 multi-stack configuration	$$	Low	Low	Medium	Medium	• Structural and maintenance considerations required from design perspective. • Additional works required to combine flues into a multi-stack configuration. • Separating exhaust into multiple stacks may aide in optimizes airflow, reducing backpressure, and enhancing generator performance.
S9 diesel oxidisation catalyst	$$	Low	Low	Medium	Low	• Require additional design considerations. • May offer additional air pollution control, requires retrofitting to each standby generator.
S10 diesel particulate filters	$$	Low	Low	Medium	Low	• Require additional design considerations. • May offer additional air pollution control, requires retrofitting to each standby generator.
S11 selective catalytic reduction	$$	Low	Low	Medium	Medium	• Require additional design considerations. • May offer additional air pollution control, requires retrofitting to each standby generator.
S12 non-selective catalytic reduction	$$	Low	Low	Medium	Medium	• Require additional design considerations. • May offer additional air pollution control, would require retrofitting to each standby generator.
S13 electrostatic precipitation	$$	Low	Low	Medium	Medium	• Require additional design considerations. • May offer additional air pollution control, would require retrofitting to each standby generator.

Control measure	Potential Constraints					Conclusion of evaluation
	Implementation costs	Regulatory requirements	Environmental impacts	Safety implications	System compatibility	
Pathway						
P1 green infrastructure	$	Low	Low	Low	Low	• May be feasible for implementation
P2 structural barriers	$$	Medium	Low	Medium	Low	• Require compliance with building codes, planning policies. • Choice, design, and stability capabilities for type of barrier used. • Strategic use of barriers may provide airflow restriction from source to receptor.
P3 optimised stack height	$$	Low	Low	Medium	Low	• Compatibility with clearance requirements to negate building downwash effects, stability, and structural integrity considerations.
Receptor						
R1 air filtration systems	$$	Low	Low	Low	Low	• May be feasible for implementation
R2 alerts and alarms	$	Low	Low	Low	Low	• May be feasible for implementation

air quality | environment | sustainability

air quality	Northstar specialises in all aspects of air quality, dust, and odour management, covering monitoring, modelling and assessment, due diligence and process specification, licencing and regulatory advice, peer review and expert witness.
environment	Our team has extensive experience in environmental management, covering environmental policy and management plans, licencing, compliance reporting, auditing, data, and spatial analysis.
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