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Proposed Data Centre (SSD-69223466)

Air Quality Impact Assessment

Addressee(s): Goodman Property Services (Aust.) Pty Ltd

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Final Authority

This report must be regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below. A draft report is a working document, is issued without prejudice and is subject to change.



Martin Doyle

23 July 2025

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EXECUTIVE SUMMARY

This Air Quality Impact Assessment has been prepared by Northstar Air Quality Pty Ltd to accompany a State Significant Development Application for the construction and ongoing operation of a data centre facility at 132 McCredie Road, Guildford West NSW 2161, in the Cumberland Council Local Government Area. The site is legally described as Lot 1 in DP596315.

This report has been prepared to address the Secretary's Environmental Assessment Requirements issued for the Project Pluto Data Centre (SSD-69223466) dated 4 April 2024.

This report concludes that the proposed data centre is suitable and warrants approval subject to the implementation of the following mitigation measures.

- **Construction Phase:** implementation of a range of industry-standard mitigation measures to manage construction-phase air quality risks, which may be implemented through a Construction Environmental Management Plan.
- **Operational Phase:** during an unplanned power outage event, the operation of the emergency power diesel-fuelled generators would result in air quality impacts. However, the assessment quantifies the probability of this occurrence as very low, based upon the modelled likelihood of impacts, prevailing meteorological conditions and historical probability of power outage events. During operation of the diesel-fuelled generators during routine and planned maintenance testing, the assessment does not predict any exceedances of the relevant impact assessment criteria, and as such no further mitigation is considered to be warranted.

Following the implementation of the above mitigation measures, the remaining impacts are appropriate.

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1. INTRODUCTION

Goodman Property Services (Aust.) Pty Ltd (the Proponent) has commissioned Northstar Air Quality Pty Ltd (Northstar) to perform an air quality impact assessment (AQIA) to accompany a State Significant Development Application (SSDA) for a proposed data centre (the Proposal) at 132 McCredie Road, Guildford West NSW 2161 (the Proposal site).

The AQIA is to be submitted to Cumberland Council and NSW Department of Planning, Housing, and Infrastructure (NSW DPHI) and 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).

The AQIA identifies and examines potential air quality impacts associated with the construction and operation of the Proposal, aligning with the industry specific NSW Planning Secretary's Environmental Assessment Requirements (SEARs) for data storage centres, and outlines mitigation and monitoring requirements commensurate with those anticipated impacts to ensure that air quality criteria are achieved at surrounding sensitive receptor locations.

1.1. Summary of the Proposal

An SSDA has been prepared in support of a proposed data centre at the Proposal site. The site is zoned E4 General Industrial pursuant to the Cumberland Local Environmental Plan 2021 (CLEP2021) and has a road frontage to McCredie Road. The developable site area is 71 710 square metres (m²).

The proposed development comprises:

- Site preparation works including bulk excavation and removal of existing hard standing and structures on the site, tree and vegetation clearing, and bulk earthworks;
- Construction, fit out and operation of a data centre with an approximate building height of 25.77 metres (m) and total gross floor area of approximately 29 444 m² comprising:
 - At-grade parking for 53 car parking spaces and 2 accessible car parking spaces
 - Two (2) loading dock spaces.
 - Two (2) levels of technical data hall floor space with incorporating a total of nine (9) data halls.
 - Ancillary office space.
- Provision of required utilities, including:
 - Fuel storage
 - Two (2) Switch-rooms
 - Four (4) industrial water storage tanks

- Vehicle entry and egress driveways located along McCredie Road
- Internal access road
- Associated landscaping and site servicing
- Installation of services and drainage infrastructure.

Layouts of the Proposal site are presented in Appendix B.

The Proposal would operate 24-hours, seven days per week. Standby power would be provided by a total of 68 no. containerised diesel-powered back-up generators at the Proposal site. It is anticipated that the Proposal would install the following (or similar) generators:

- 67 no. 2 500 kW diesel -fuelled generators (model MTU 20V 4000 DS3100); and
- 1 no. 600 kW diesel -fuelled generators (model MTU 16V 2000 DS1100).

It is noted that the back-up generators would only be operated during a power outage event or as required during periodic maintenance testing.

1.2. Purpose of the Report

The purpose of this AQIA is to examine and identify whether the construction and operation of the Proposal may adversely impact on air quality in the surrounding area.

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*;
- *Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2024)*; and
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*

Appendix A presents a list of abbreviations, nomenclature and specified units referenced in this AQIA.

1.3. Assessment Requirements

This report has been prepared to address the specific requirements outlined in the NSW Planning Secretary's Environmental Assessment Requirements (SEARs) for data storage centres¹, which have been provided for the Project Pluto Data Centre project (SSD-69223466).

Table 1 details the SEARs coverage and indicates where each requirement has been addressed in this AQIA.

¹ <https://www.planning.nsw.gov.au/sites/default/files/2023-03/sears-data-storage-centres.pdf>

Table 1 Coverage of SEARs relevant to SSD-69223466

Item	Description of Requirements	Section Reference
Air Quality	Provide an assessment of air quality impacts, prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines.	Section 3 Section 5.2 Section 7
	The assessment must address construction works ...	Section 5.1 Section 6 Appendix C
	... and include modelling of emissions and air pollutants from predicted operations (including testing of the back-up power system) ...	Section 5.2 Section 7.2
	... and a peak emission and air pollutant scenario ...	Section 5.2 Section 7.1
	... and outline the proposed mitigation, management and monitoring measures that would be implemented.	Section 8.2.4 Appendix C

In addition to the requirements outlined in Table 1, an accompanying cover letter issued on 4 April 2024 for the Project Pluto Data Centre by NSW DPHI provided additional assessment requirements relating to air quality, which state that:

“The EIS must include an air quality impact assessment, which:

- *Includes consideration of potential impacts to nearby commercial and industrial receptors (refer Section 4.2)*
- *Is prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA, 2022) (this report) ”*

Section 9 of the Approved Methods outlines the NSW EPA's requirements for the information included in an AQIA. Table 2 summarises each requirement relevant to this type of development proposal and outlines where this information can be located in the AQIA.

Table 2 NSW EPA Approved Methods – impact assessment reporting requirements

Assessment component	Addressed
9.1 Site Plan	
Layout of the site clearly showing all unit operations	Appendix B
All emissions sources clearly identified	Figure 5, Figure 6 Section 5.2.3 Figure B4
Plant boundary	Figure 1
Sensitive receptors (e.g. nearest residences)	Section 4.2

Assessment component	Addressed
Topography	Section 4.5 Section 5.2.1.3
9.2 Description of the activities carried out on the site	
A detailed discussion of all unit operations carried out on the site, including all possible operational variability	Section 2.2 Section 2.3.2
A detailed list of all process inputs and outputs	Section 2.2 Section 2.3.2
Plans, process flow diagrams and descriptions that clearly identify and explain all pollution control equipment and techniques for all processes on the premises	Section 8.2.4 Section 8.2.5 Appendix G
A description of all aspects of the air emission control system, with particular regard to any fugitive emission capture systems (e.g. hooding, ducting), treatment systems (e.g. scrubbers, bag filters) and discharge systems (e.g. stacks)	Section 8.2.4 Section 8.2.5 Appendix G
The operational parameters of all emission sources, including all operational variability, i.e. location, release type (stack, volume or area) and release parameters (e.g. stack height, stack diameter, exhaust velocity, temperature, emission concentration and rate)	Section 5.2.3
9.3 Emissions Inventory	
A detailed discussion of the methodology used to calculate the expected pollutant emission rates for each source	Section 5.2
Detailed calculation of pollutant emission rates for each source	Section 5.2.3
Tables showing all release parameters of stack and fugitive sources (e.g. temperature, exit velocity, stack dimensions, and emission concentrations and rates)...	Section 5.2.3
...and all pollutant emission concentrations with a comparison of the emission concentrations against the relevant requirements of the Regulation	Section 7
9.4 Meteorological data	
A detailed discussion of the prevailing dispersion meteorology at the proposed site. The report should typically include wind rose diagrams, an analysis of wind speed, wind direction, stability class, ambient temperature and mixing height; and joint frequency distributions of wind speed and wind direction as a function of stability class	Section 4.3, Appendix D
Demonstration that the site-representative data adequately describes the expected meteorological patterns at the site under investigation (e.g. wind speed, wind direction, ambient temperature, atmospheric stability class, inversion conditions and katabatic drift)	Appendix D
A description of the techniques used to prepare the meteorological data into a format for use in the dispersion modelling	Section 5.2.1.2 Appendix D
A quality assurance and quality control analysis of the meteorological data used in the dispersion modelling. Provide and discuss any relevant results of this analysis	Appendix D
9.5 Background air quality data	
A detailed discussion of the methodology used to calculate the background concentrations for each pollutant	Section 4.4 Appendix E
Tables summarising the ambient monitoring data	Section 4.4

Assessment component	Addressed
	Appendix E
9.6 Dispersion modelling	
A detailed discussion and justification of all parameters used in the dispersion modelling and the manner in which topography, building wake effects and other site-specific peculiarities that may affect plume dispersion have been treated	Section 5.2.1
A detailed discussion of the methodology used to account for any atmospheric pollutant formation and chemistry	Section 5.2.1
A detailed discussion of air quality impacts for all relevant pollutants, based on predicted ground-level concentrations at the plant boundary and beyond, and at all sensitive receptors	Section 7
Ground-level concentrations, hazard index and risk isopleths (contours) and tables summarising the predicted concentrations of all relevant pollutants at sensitive receptors	Section 7

1.4. Qualification

This AQIA has been prepared by Northstar Air Quality Pty Ltd (Northstar) (ABN 52 609 741 728) which is an independent and specialised air quality consultancy. The principal author and contributors to this AQIA are provided in Table 3.

Table 3 Report authorship and contributions

Project Role	Name	Qualification	Role
Principal author	Martin Doyle	BSc(hons), PhD, CAQP	Director
Technical inputs, data collation and processing, GIS	Declan Alder	BSc(hons), CEnv, CAQP	Principal Air Quality Scientist
	Marie-Laure Nguyen-Van	BSc, MSc, CAQP	Senior Air Quality Scientist, Technical Lead Modelling Services
	Nick Phillips-Glyde	BComm, BMarBiol	Air Quality Scientist
	Sophie Saunders	BSc	Air Quality Scientist
QA/QC	Gary Graham	BSc(hons), MSc, CSci, CEnv, CAQP	Director

1.5. Test Of Adequacy

As part of the SSDA process, a Test of Adequacy (ToA) was carried out by NSW DPHI to ensure the draft Environmental Impact Statement (EIS) addressed the SEARs (refer Table 1).

On 1 April 2025, NSW DPHI provided comments on the AQIA for SSD-69223466, which reflected report reference 24.1098.FR1V4, dated 24 February 2025.

Table 4 outlines the ToA comments and associated clarifications associated with that report. In response, the AQIA was updated where appropriate, with clarifications provided where no changes were made. That report was provided the reference 24.1098.FR1V5 and was dated 10 April 2025.

Note that the clarifications/responses in Table 4 reflected the AQIA at that time (24.1098.FR1V4), specifically the operation of eight (8) generators during the routine testing scenario. This current AQIA has been modified in response to NSW DPHI comments on report 24.1098.FR1V5, and presents a modified generator maintenance scenario (refer Section 1.6).

Table 4 Test of adequacy comments – SSD-69223466

NSW DPHI ToA comments	Clarification / response
The air quality impact assessment (AQIA) in Appendix T should be updated to include consideration of potential impacts to nearby public recreational areas including Smithfield Park and Tom Uren Park, commercial buildings including Crown on McCredie Hotel and schools including Guildford West Public School and Children’s Centre	The dispersion model has been updated to include those additional receptors identified, such as a school, childcare centre, parks, and a hotel. The spatial locations of all discrete receptor locations considered for this AQIA are provided on Figure 3 and described in Table 9. The corresponding results are reported in Section 7 of this AQIA.
The generator stacks modelled under the standard operating/testing scenarios appear to be located towards the north of the development with no stacks at the southern end of the building modelled. The AQIA should clarify the standard generator testing scenario is reflective of the most conservative model at all receiver locations.	The modelling reflects a representative standard testing scenario in which up to eight generators are operated simultaneously within the same zone or level of the development. While the current configuration focuses on the northern portion of the site, the scenario was selected to represent a conservative case in terms of predicted off-site impacts, including at the most sensitive receptor locations. As outlined in the AQIA, a sensitivity test was conducted to identify generator locations likely to result in the highest off-site impacts. Generators located to the north-west of the Proposal site were subsequently selected for detailed modelling under Scenario 2. It is also clarified that the dispersion modelling for the maintenance testing scenario has assumed 8 no generators operating at 100 % load, to provide confidence that if this quantity of generators can be tested simultaneously, then the proposed 2 no at 100 % load and 6 no at 0 % load, would be easily able to meet the criteria. <i>[NOTE: The comment above was associated with report 24.1098.FR1V4, and was addressed in report 24.1098.FR1V5. The response has now been superceded, and the updated generator testing regime (four tested at one time, two at 100 % load and two at 0% load) has been assessed in this current report, in response to comments from DPHI on report 21.1098.FR1V5. Further details are provided in Table 5, Section 2.3.2, and Section 7.2].</i>

NSW DPHI ToA comments	Clarification / response
The AQIA should be updated to clearly label and identify all emissions source point locations of the development on the pollutant concentration contour diagrams in Section 7 of the AQIA.	Figure 5 and Figure 6 provide a 3D representation of the building configurations and emission stack locations for both assessed scenarios, which have been updated for clearer site location indication. Additionally, Appendix B provides an overview of the stack locations pertinent to the Proposal, which can be cross-referenced with the architectural plans submitted as part of the SSDA. The AQIA focuses on the maximum predicted incremental impacts from the Proposal site boundary. Including detailed generator labels in the contour diagrams would not add significant value, as the isopleth plots are designed to reflect broader air quality impacts. Emission source points have been added to the contour isopleths to indicate generator locations, but labels have been omitted, as they do not enhance the interpretation.
Appendix T: Appendices are not labelled in contents table	Appendix headers are included in the contents table for completeness.
The predicted incremental pollutant concentration contours do not appear to suitably reflect the corresponding prediction tables in Section 7 of the AQIA. The contour diagrams should be updated accordingly to suitably demonstrate predicted pollutant concentrations or provide clarification/justification.	The contours are based on the same dispersion model outputs used to prepare the tabulated results; however, it is acknowledged that there may be discrepancies in the visual representation due to the chosen contour intervals. The associated contour plots contained in Section 7 have been updated to align with the corresponding results tables.
Section 8.2.2. notes that no exceedances of cumulative concentrations are predicted however cumulative exceedances of PM is identified as a result of elevated background levels. The AQIA should be updated to clarify the exceedance and provide justification accordingly.	Under Scenario 2, no additional exceedances of the cumulative impact assessment criteria are predicted as a result of the proposal. Exceedances of the 24-hour PM_{2.5} criterion identified in Table 29 are attributable to elevated background concentrations, not project-related emissions. The commentary in Section 8.2.2 has been amended for completeness.

1.6. Additional Matters for Submissions Report

On 18 June 2025, NSW DPHI provided additional matters to be addressed in a submissions report, which included advice from Council and relevant government agencies. In relation to air quality, comments were provided by NSW DPHI and NSW EPA.

The NSW DPHI comments are presented and addressed in Table 5, with the NSW EPA comments/observations presented and addressed in Table 6.

Table 5 NSW DPHI issues raised on the AQIA

NSW DPHI Comment	Clarification / response
The Department notes it is unclear whether the back-up generator/s modelled as part of the standard generator testing scenario is reflective of worst-case standard operations. Accordingly, please confirm the location of the generators modelled as part of this scenario, along with detailed justification for why the chosen location/s can be considered to reflect a realistic ‘worst-case’ assessment of day-to-day operations at all nearby sensitive receptors.	The NSW DPHI comments are related and have been considered together. The actual generator maintenance regime proposed at the time of the original submission (i.e. May 2025) comprised the testing of two (2) generators at 100 % load, and six (6) at no load (electrical test only) between 7:00 am and 6:00 pm (8:00 am to 6:00 pm on Sundays and Public Holidays) (refer Section 2.3.2).
Further to the above, the Department seeks clarification on the number of generators tested during the realistic operations scenario (Scenario 2). Figure 6 of the Air Quality Impact Assessment (AQIA) in appendix T of the EIS appears to illustrate 5 discharge points under Scenario 2 and Table 15 identifies 8 generators active during Scenario 2. However, the proposed generator maintenance testing regime identifies 2 generators tested a 100% load and 6 generators with no load per test. Please clarify and update the AQIA to accurately reflect a realistic ‘worst-case’ assessment of standard operations.	However, the previous versions of the AQIA assumed eight (8) generators being tested at one time at full load (100 %) for 24-hours per day, seven days per week (24/7). The AQIA provided results which confirmed that that maintenance scenario would not result in any exceedances of the air quality criteria at any surrounding receptor locations. The maintenance scenario provided within this updated AQIA presents potential impacts associated with the testing of four (4) generators, with two (2) at 100 % load, and two (2) at no load (0 % load), 24/7. It presents a less conservative approach than previously presented, which aligns with the actual proposed testing regime (number of generators tested), whilst providing some operational flexibility to reflect different users and their operational requirements if potentially required in future (hours of generator testing). As outlined in Section 5.2.2, a sensitivity test was conducted to identify generator locations likely to result in the highest off-site impacts. Generators located to the north-west of the Proposal site were subsequently selected for detailed modelling under Scenario 2.

NSW DPHI Comment	Clarification / response
	It is noted that the modelling considers the effects of building downwash on the dispersion patterns, so the most impactful generators are assessed with consideration of other dispersion factors than proximity.

Table 6 NSW EPA issues raised on the AQIA

NSW EPA Comment	Clarification / response
The Air Quality Impact Assessment (AQIA) predicts several exceedances of the 1-hour NO₂ concentrations during emergency conditions (Scenario 1) and indicates that at worst-case scenario (Scenario 1), the project is predicted to exceed the 24-hour average PM₁₀ and PM_{2.5} assessment criteria at several receptor points. The AQIA addresses the low likelihood of the emergency scenario occurring and proposes mitigation measures to address potential impacts.	Noted. Section 7.1 provides the predicted impacts during emergency operations, with Section 8.2.1 providing an assessment of the low likelihood of those impacts occurring at the same time as a power outage.
It is noted that Scenario 2 represents normal operating conditions. In accordance with Approved Methods for Modelling and Assessment of Air Pollutants in NSW (2022), there should be no additional exceedances as a result of the application during normal operations.	Noted. As outlined in Table 5, the routine maintenance scenario (Scenario 2) has been updated in response to NSW DPHI comments. For clarity, the predicted impacts are now lower than previously reported, due to the reduction in generators assumed (modelled) to be tested at one time (was eight, now two). Results for this scenario are presented in Section 7.2 and show compliance with the adopted air quality criteria.
The EPA would recommend DPHI consider consent conditions relating to air quality be applied. Also, the EPA is willing to be consulted further as part of preparing any draft conditions for the project.	Noted.

2. THE PROPOSAL

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

2.1. The Proposal Site

The Proposal site is located on Gandangara Land and is in the Smithfield Industrial Area within the Cumberland Local Government Area (LGA). It is bounded by McCredie Road to the north.

The front part of the Proposal site adjoins the Guildford Transmission Substation, which is located immediately to the east and fronts onto McCredie Road. Other industrial uses are located further east, with residential properties beyond.

The Guildford West Sports Ground, which comprises several playing fields, is located to the south of the Guildford Transmission Substation. The playing fields bound the southern part of the Proposal site to the east. The playing fields / public recreation area also abuts the southern boundary of the Proposal site.

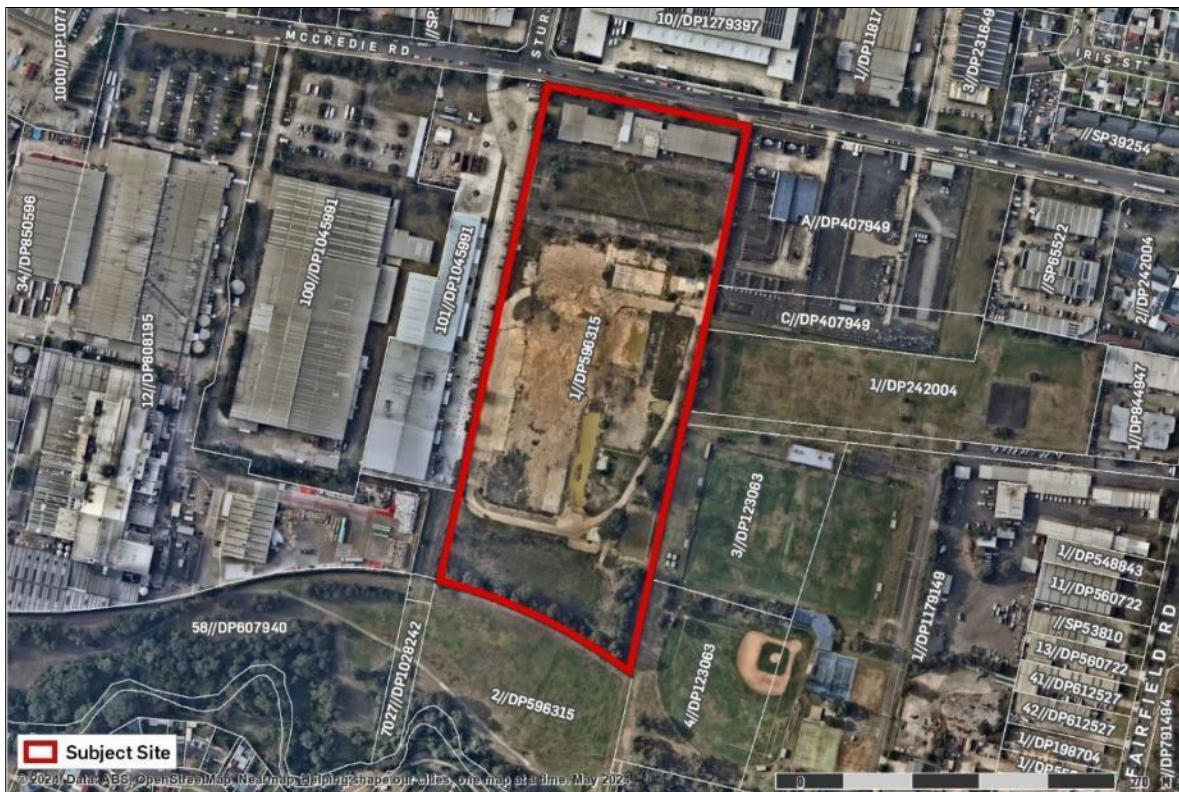
Prospect Creek is located to the south of the public recreation area and is zoned C2 Environmental Protection. The area to the south of Prospect Creek is predominately characterised by low density single storey residential housing.

The Proposal site is located in the south eastern corner of the Smithfield Industrial Estate and is within close proximity of the Cumberland Highway (A28) and M4 and M7 motorways, which provide access to Sydney CBD, western Sydney and the south. A range of large format industrial uses are located to the west and north west of the site. The Smithfield Industrial Estate extends across the A28 to Gipps Road (approximately 3km west of the site). It forms part of the broader Smithfield Wetherill Park industrial area, which is one of the largest of its kind in the Southern Hemisphere and makes a significant contribution to the New South Wales and Australian economies.

The Proposal site has a net developable area of 71 710 m² and is currently vacant. It previously operated as a Castrol Lubricants facility. However, the majority of the Proposal site has now been cleared and subject to category 1 remediation works. A single storey office building is located on the northern portion of the Proposal site fronting McCredie Road. The building is vacant.

A map showing an aerial photograph of the Proposal site is provided in Figure 1 and the local context is illustrated in Figure 2. A full description of the sensitivity and uses of the surrounding land, and the identification of discrete receptor locations used in the AQIA, is provided in Section 4.2.

Figure 1 Proposal site aerial



Source: Urbis

Figure 2 Local context



Source: Urbis

2.2. Proposal Staging

The proposal seeks consent for development to be constructed and operated in two phases to reflect the staged availability power supply. The proposed stages involve the following:

- **Stage 1:** Construction of the main data centre building as well as the car park, perimeter access road, site access/exit driveways and landscaping. Stage one will involve the fit-out and operation of five of the 9 proposed data halls at levels 1 and 2 as well as the associated electrical rooms, generators, storage and office rooms.
- **Stage 2:** Completion of the ultimate development scheme involving the extension of the building to the south with an additional four data halls, associated electrical rooms and generators, and associated landscaping and external works. The electrical substations will also be constructed in the north of the site during this phase.

The works are to be completed in four (4) construction stages, as per below:

- Stage 1:
 - CC1 – Site Preparation works (including but not limited to vegetation removal, earthworks & piling, installation of footings, retaining walls)
 - CC2 – Inground services installation, structural works
 - CC3 – Façade construction, installation of services, fit out
 - CC4 – Landscaping and external works
- Stage 2:
 - CC1 – Site Preparation works (earthworks & piling, installation of footings)
 - CC2 – Inground services installation, structural works
 - CC3 – Façade construction, installation of services, fit out
 - CC4 – Landscaping and external works

Give the staged approach outlined above, this AQIA has been performed to address the construction and operation of the development as a whole. In this regard, the following comments are provided to address and queries relating to the coverage of the AQIA in relation to the staging:

- Scenario 1 – Stage 1 construction
 - Potential impacts during construction of the whole development (Stage 1 and Stage 2) have been assessed (refer Section 5.1), with mitigation measures identified to achieve 'negligible' impacts on surrounding receptors. Impacts during Stage 1 construction alone are anticipated to also be negligible, with the implementation of appropriate controls.

- Scenario 2 – Stage 1 operation
 - Quantitative modelling has been performed associated with Stage 1 and Stage 2, operating together. Any impacts associated with Stage 1 operations alone would be expected to be lower than those predicted for Stage 1 and Stage 2 operating together.
- Scenario 3 – Stage 1 operation during Stage 2 construction
 - Given that the construction phase is anticipated to result in negligible impacts at surrounding receptor locations, the operations during Stage 1 alone, with construction of Stage 2 is anticipated to have been appropriately considered through modelling for both Stage 1 and Stage 2 operations.
- Scenario 4 – Stage 1 & 2 operation
 - This has been subject to quantitative modelling for both maintenance activities and emergency (power outage) conditions. It provides the potential 'worst-case' impacts of the development as a whole, operating at maximum capacity.

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.

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

- Excavators and front-end loaders (FEL);
- Graders;
- Light -and heavy-duty vehicles;
- Drills and pneumatic hand or power tools; and
- Cranes and elevated working platforms;

The assessment of the potential impacts upon local air quality, resulting from construction activities, is presented in Section 6, while the full risk assessment is provided in Appendix C.

2.3.2. Operation Phase

Operational emissions from the Proposal 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 diesel-fuelled generators anticipated to be installed at the Proposal site are outlined in Section 2.2.

Emissions data for each generator has been calculated based on technical specification documents as provided by the project team for use in this assessment, presented in Appendix F. Dispersion modelling was performed to predict impacts from the operation of the Proposal site on the surrounding area.

During periods when the back-up generators may be required to maintain electrical supply or used for maintenance testing, short-term emissions of combustion related pollutants may be generated. Emissions from diesel-fuelled emergency generators are envisaged to include various air pollutants, as listed in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (NPI EETM) for combustion engines (NPI, 2008). The pollutants of concern from the operation of the backup generators includes (in no order):

- Particulate matter (PM);
- Oxides of nitrogen (NO_x);
- Carbon monoxide (CO);
- Sulphur dioxide (SO₂);
- Polycyclic aromatic hydrocarbons (PAHs);
- Volatile organic compounds (VOCs), as benzene (C₆H₆), toluene (C₇H₈) and xylene (C₈H₁₀); and
- Formaldehyde (CH₂O).

The anticipated maintenance testing schedule has been provided by the Proponent and is outlined in Table 7 overleaf). This assumes that each generator would be tested for a period of 65 minutes (quarterly) and 90 minutes (annually), with four generators tested concurrently (two at 100% load, and two at no load). Additional information provided by the Proponent indicates that testing would be performed during daylight hours i.e. between 7:00 am and 6:00 pm (8:00 am to 6:00 pm on Sundays and Public Holidays), although assessment has been performed to assess whether the maintenance testing schedule could be extended to cover a full 24-hour period, with four generators tested (two at 100% load, and two at no load) concurrently. It is important to note that generator testing over a full 24-hour period for four generators (two at 100% load, and two at no load) may not be required or may be limited by other environmental factors. The purpose of air quality modelling over the full 24-hour period with four generators tested (two at 100% load, and two at no load) concurrently is to provide assurance that should that extent of testing be required, constraints would not be posed by air quality issues to allow that flexibility.

The Proposal includes on-site fuel storage, which may contribute to air emissions through fugitive VOCs during filling and dispensing, as well as from potential spillages and leaks that may occur. The tank design is

expected to incorporate adequate containment (e.g. double walled / secondary containment) and automated leak detection measures in compliance with applicable Australian Standards (AS) such as AS 1940:2017 ("Storage and Handling of Flammable and Combustible Liquids") and AS 1692:2006 ("Steel Tanks for Flammable and Combustible Liquids") with low sulphur content diesel fuel utilised for the standby generators. In addition to containment of tanks, spill containment will be provided around tank fill connections, pumps, and filters, where required.

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 odour emissions, with the exception of the periodic operation of the diesel-fuelled generators for testing and back-up power generation purposes only, as outlined above.

Air emissions of VOCs have been assessed as benzene (C_6H_6) as a principal toxic air pollutant, with anticipated emissions of toluene (C_7H_8) and xylene (C_8H_{10}) assessed and compared against the relevant odour impact assessment criteria.

Table 7 Back-up generator maintenance testing schedule

Test	Type	Duration (minute)		Load (%)	Number of Generators	Gens run per test	Number of Tests	Total Number of Tests	Total Mins
		Run	Cooldown						
1	Quarterly	65	5	100	68	2	34	34	2 380
2	Quarterly	65	5	100	68	2	34	34	2 380
3	Quarterly	65	5	100	68	2	34	34	2 380
4	MV / transformer maintenance and testing	1 195	5	100	8	2	1	1	1 200
5	Annual	90	5	100	68	2	34	34	3 230
Total Minutes per Year									11 570
Total Hours per Year									192.83

Note: Two generators to be tested concurrently at no load (0 %) with the two at 100 % load.

2.4. Alternative Options for Power Generation

Currently, alternatives to diesel generators are not feasible for large-scale data centres, which depend on diesel for reliability, quick startup, and robust power delivery. While emerging technologies² like HVO100 renewable diesel, hydrogen fuel cells, microgrids, and battery storage show promise, they are not yet technologically or financially viable for widespread use.

Due to the high load density and steady load profile, solar panels covering the entire roof would only meet a small portion of the site's power needs, and mechanical equipment further limits available space for solar installations.

While batteries could provide short-term backup, the fuel needed for 24-hour autonomy to maintain critical services during extended outages is significant. Using batteries for the same duration would be prohibitively expensive and space-intensive, also posing similar risks to diesel, such as chemical spills and fire hazards

As a consequence, diesel generators will continue to be essential for the data centre industry until feasible alternatives are commercially available.

² <https://www.datacenterdynamics.com/en/opinions/is-it-time-to-replace-diesel-backup-generators/>

3. LEGISLATION, REGULATION AND GUIDANCE

The following outlines the legislation and air quality criteria which are applicable to the activities being performed at the Proposal site.

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.*

and

9 *Chemical storage*

(1) *This clause applies to the following activities--*

"general chemicals storage", meaning the storage or packaging in containers, bulk storage facilities or stockpiles of any chemical substance classified as a dangerous good in the Transport of Dangerous Goods Code, other than the following--

...

"petroleum products storage", meaning the storage or packaging of petroleum or petroleum products in containers, bulk storage facilities or stockpiles.

(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.

Table

<i>Column 1</i>	<i>Column 2</i>
<i>Activity</i>	<i>Criteria</i>
...	
<i>petroleum products storage</i>	<i>capacity to store more than 200 tonnes (liquefied gases) or 2,000 tonnes (chemicals in any other form)</i>

During times of stable external supply of electricity, the back-up generators will only operate during scheduled maintenance events (refer Table 7). On this basis, the Proposal would not exceed the 200-hour limit, for the generation of electricity by means of electricity plant that is emergency stand-by plant.

Further, the Proposal may be deemed to be a scheduled activity due to the quantity of diesel fuel stored at the Proposal site. Should the Proposal have the capacity to store more than 2 000 tonnes (t) of diesel fuel (equivalent to 2 350 kilolitres (kL) assuming a fuel density of $850.8 \text{ kg}\cdot\text{m}^{-3}$), then the Proposal may be deemed to be a scheduled activity under Schedule 1, Part 1 Clause 9 of the POEO Act.

The diesel consumption rates of the proposed generator models (refer Section 5.2.3) indicate that if the Proposal were to store enough diesel to operate the back-up generators continuously for 24 hours, the stored capacity of diesel fuel would not exceed 2 000 t.

Given the discussion provided above, the Proposal is not considered to be a scheduled activity and correspondingly, an Environmental Protection License (EPL) would not be required.

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) establishes requirements and concentration standards for air emissions from industrial activities in NSW. It regulates air quality issues related to various sources, including burning activities, motor vehicle fuels, fuel usage and transfer, air impurities from activities and plants, and the storage of volatile organic liquids.

Part 5 of the POEO CAR specifically addresses air impurities from activities and plant, referring to Schedule 2 to set concentration standards for both scheduled and non-scheduled premises. The standards are in-stack emission limits and are the maximum emissions permissible.

As previously discussed in Section 3.1, if the Proposal is deemed to be a scheduled activity under the POEO Act, the general standards of concentration for scheduled activities as outlined in the POEO CAR would apply. In any event, the generators would be required to achieve the Schedule 2, Part 3 standard of concentration for non-scheduled activities. 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.*

As outlined in Table 7, the generators would be operated for less than 200 hours per year, and the exemption above would therefore apply to the Proposal.

The standards of concentration, and whether they are applicable to the Proposal, are summarised in Table 8.

Table 8 POEO CAR standards of concentrations for applicable air impurities

Air impurity	Activity or plant	Concentration	Applicable
Schedule 2, Part 2, Division 2 – Electricity generation (Group 6)			
Solid particles (Total)	An activity or plant using a liquid or solid standard fuel or a non-standard fuel	50 mg·Nm ⁻³ ^(A)	No. Not a scheduled activity
Nitrogen dioxide (NO ₂) or nitric oxide (NO) or both, as NO ₂ equivalent	A turbine operating on a fuel other than gas, being a turbine used in connection with an electricity generating system with a capacity of 30 MW or more	90 mg·Nm ⁻³ ^(A)	No. Not a scheduled activity and also operates for <200 hrs·year ⁻¹ .
Schedule 2, Part 2, Division 3 - Scheduled premises (Group 6)			
Solid particles (Total)	An activity or plant	50 mg·Nm ⁻³ ^(A)	No. Not a scheduled activity
Nitrogen dioxide (NO ₂) or nitric oxide (NO) or both, as NO ₂ equivalent	Stationary reciprocating internal combustion engines	450 mg·Nm ⁻³ ^(A)	No. Not a scheduled activity
Volatile organic compounds (VOCs), as n-propane	A stationary reciprocating internal combustion engine using a liquid fuel	1 140 mg·Nm ⁻³ ^(A) VOCs or 5 880 mg·Nm ⁻³ ^(A) CO	No. Not a scheduled activity
Smoke	An activity or plant in connection with which liquid or gaseous fuel is burnt	20 % opacity	No. Not a scheduled activity
Schedule 2, Part 3 - Non-scheduled premises (Group C)			
Solid particles (Total)	An activity or plant	100 mg·Nm ⁻³ ^(B)	Yes
Smoke	An activity or plant in connection with which liquid or gaseous fuel is burnt	20 % opacity	Yes

Notes (A) POEO CAR Sch2, Pt 3, Div 1: dry, 273 K, 101.3 kPa, 7 % O₂

(B) POEO CAR Sch 2, Pt 2, Div 2: dry, 273 K, 101.3 kPa, 7% O₂

Part 4 Clause 20 of the POEO CAR requires that motor vehicles do not emit excessive air impurities which may be visible for a continuous period of more than 10-seconds when determined in accordance with the relevant standard.

All vehicles, plant and equipment to be used either at the Proposal site or to transport materials to and from the Proposal site will be maintained regularly and in accordance with manufacturers' requirements, where these vehicles are under the operational control of the Proponent.

3.3. NSW EPA Approved Methods

State air quality guidelines are prescribed by NSW EPA in the Approved Methods which has been consulted during the preparation of this AQIA (see Section 1.3, Table 2).

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 on the basis that they are carcinogenic, mutagenic, highly persistent, or highly toxic in the environment.

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

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW for relevant individual air pollutants are presented in Table 9.

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 $0.029 \text{ mg}\cdot\text{m}^{-3}$ ($29 \text{ }\mu\text{g}\cdot\text{m}^{-3}$) as outlined in table 12 of the Approved Methods has been adopted.

Benzene (C_6H_6) is one of the primary components of TVOC emissions resulting from diesel combustion engines and correspondingly, compliance with the benzene (C_6H_6) criterion (refer Table 9) 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 (C_7H_8) of $0.36 \text{ mg}\cdot\text{m}^{-3}$ ($360 \text{ }\mu\text{g}\cdot\text{m}^{-3}$) and xylene (C_8H_{10}) of $0.19 \text{ mg}\cdot\text{m}^{-3}$ ($190 \text{ }\mu\text{g}\cdot\text{m}^{-3}$) to address odour.

Table 10 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 the Approved Methods.

Table 9 NSW EPA impact assessment criteria

Pollutant	Averaging period	Criterion		Notes
		$\mu\text{g}\cdot\text{m}^{-3}$ ^(a)		
Sulphur dioxide (SO ₂)	1 hour	215		Numerically equivalent to the AAQ NEPM ^(b) standards and goals
	24 hours	57		
	1 year	4		
Nitrogen dioxide (NO ₂)	1 hour	164		
	Annual	31		
Particulates (as PM ₁₀)	24 hours	50		
	1 year	25		
Particulates (as PM _{2.5})	24 hours	25		
	1 year	8		
Particulates (as TSP)	1 year	90		
Pollutant	Averaging period	Criterion		Notes
		ppm ^(c)	$\text{mg}\cdot\text{m}^{-3}$, ^(d)	
Carbon monoxide (CO)	15 minutes	87	100	Numerically equivalent to the AAQ NEPM ^(b) standards and goals
	1 hour	25	30	
	8 hours	9	10	

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 10 NSW EPA impact assessment criteria for principal and individual toxic pollutants

Pollutant	Averaging period	Criterion		Notes
		ppm ^(a)	$\text{mg}\cdot\text{m}^{-3}$ ^(b)	
Polycyclic Aromatic Hydrocarbon (PAH) as benzo(a)pyrene	1 hour	n/a	0.0004	
Benzene (C_6H_6)	1 hour	0.009	0.029	
Ethylbenzene (C_8H_{10})	1 hour	1.8	8.0	
Toluene (C_7H_8)	1 hour	0.06	0.36	Odour
Xylene (C_8H_{10})	1 hour	0.04	0.19	Odour
Formaldehyde (CH_2O)	1 hour	0.018	0.02	

Notes: (a): parts per million (10^6)
 (b): milligrams per cubic metre of air

3.4. Cumberland Local Environmental Plan 2021

The Cumberland Local Environmental Plan 2021 (CLEP2021) came into effect on 5 November 2021 and provides the legislative framework for developments and land use within the Cumberland LGA. Specifically, the aims of the CLEP2021 are as follows:

- (aa) to protect and promote the use and development of land for arts and cultural activity, including music and other performance arts,*
- (a) to provide a comprehensive planning framework for the sustainable development of land in Cumberland,*
- (b) to provide for a range of land uses and development in appropriate locations to meet community needs,*
- (c) to facilitate economic growth and employment opportunities within Cumberland,*
- (d) to conserve and maintain the natural, built and cultural heritage of Cumberland,*
- (e) to provide for community facilities and services in Cumberland to meet the needs of residents, workers and visitors,*
- (f) to promote development that is environmentally sustainable.*

It is noted that the CLEP2021 does not outline any specific requirements for the development of data centres with regard to air quality and correspondingly, potential air quality impacts would be managed under the requirements of the POEO Act, POEO CAR and the Approved Methods.

3.5. Cumberland Development Control Plan

The Cumberland Development Control Plan (DCP) 2021 provides guidance regarding the operation and design of developments within the Cumberland LGA to achieve the aims and objectives of the CLEP2021.

The objectives of the Cumberland DCP 2021 with reference to air quality include:

- "O1. Any machinery or processes used should not result in air pollution emissions that have a detrimental impact on the environment.*
- O2. Potential adverse environmental, public health and amenity impacts from industrial developments must be adequately controlled...*
- ...O9. Reduce the amount of greenhouse gas emissions...*

...O11. Ensure that satisfactory measures are incorporated to alleviate negative environmental impacts associated with industrial zones."

3.6. NSW Government Air Quality Planning

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

- **Legislation:** formed principally through the implementation of the POEO Act and the POEO CAR. The overall objective of the legislative instruments is to achieve the requirements of the National Environment Protection (Ambient Air Quality) Measure;
- **Clean Air for NSW:** The 10-year plan for the improvement in air quality;
- **Inter-agency Taskforce on Air Quality in NSW:** a vehicle to co-ordinate cross-government incentives and action on air quality;
- **Managing Particles and Improving Air Quality in NSW;** and
- **Diesel and Marine Emission Management Strategy.**

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

4. EXISTING CONDITIONS

The following information provides context around the location of sensitive receptor locations surrounding the Proposal site, the prevailing meteorology and air quality of the surrounding area and identifies other sources of air pollutants which have the potential to impact cumulatively with the Proposal.

4.1. Surrounding Land Use Sensitivity

The Proposal site is zoned as E4 General Industrial, pursuant to the Cumberland Local Environmental Plan 2021 (CLEP2021). The proposed use as a data centre is permissible with consent in the E4 General Industrial zone under CLEP2021.

The surrounding land use is comprised of additional E4 General Industrial zoning while other surrounding land zones include RE1 Public Recreation to the east and south and C2 Environmental Conservation further to the south of the Proposal site.

The closest residential dwelling is located on Hemingway Crescent, Fairfield, approximately 160 m to the south of the Proposal site.

4.2. Sensitive 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.

The Approved Methods defines a sensitive receptor location to be:

'A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area'.

It is noted that the assessment criteria applied to particulates and sulphur dioxide (SO₂) (refer Table 9) are for a 24-hour averaging period, and as such the predicted impacts need to be interpreted at commercial and industrial receptor locations with care. It is considered to be atypical for a person to be at those locations for a complete 24-hour period and as such, the exposure risks associated with those pollutants 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.

In addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations 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, several receptors have been identified and the receptors adopted for use within this AQIA are presented in Table 11 and illustrated in Figure 3.

Table 11 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.

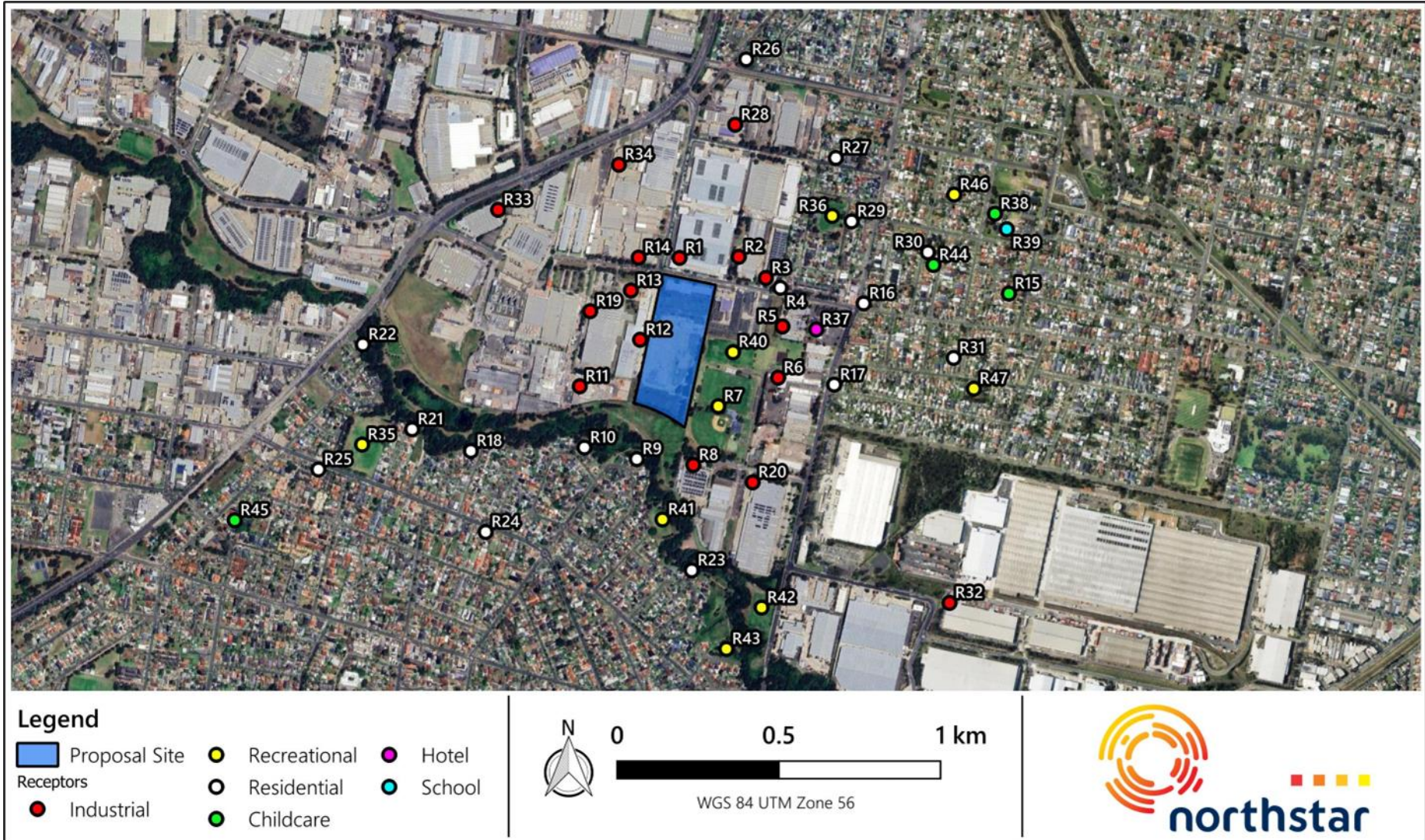
Table 11 Discrete sensitive receptor locations

Receptor ID	Location	Land use	Coordinates (UTM)	
			mE	mS
R1	McCredie Road, Smithfield	Industrial	310 823	6 252 712
R2	McCredie Road, Smithfield	Industrial	311 007	6 252 715
R3	McCredie Road, Smithfield	Industrial	311 090	6 252 650
R4	McCredie Road, Guildford West	Residential	311 135	6 252 619
R5	McCredie Road, Guildford West	Industrial	311 142	6 252 500
R6	Fairfield Road, Guildford West	Industrial	311 129	6 252 342
R7	Guildford West Sportsground, Guildford West	Recreational	310 943	6 252 254
R8	Foray Street, Yennora	Industrial	310 866	6 252 072
R9	Hemingway Crescent, Fairfield	Residential	310 691	6 252 091
R10	Solo Crescent, Fairfield	Residential	310 529	6 252 126
R11	McCredie Road, Smithfield	Industrial	310 515	6 252 315
R12	McCredie Road, Smithfield	Industrial	310 701	6 252 459
R13	McCredie Road, Smithfield	Industrial	310 673	6 252 611
R14	McCredie Road, Smithfield	Industrial	310 697	6 252 713
R15	Palmer Street, Guildford Street	Childcare	311 842	6 252 602
R16	McCredie Road, Guildford West	Residential	311 393	6 252 571
R17	Fairfield Road, Guildford West	Residential	311 302	6 252 320
R18	Chisholm Street, Smithfield	Residential	310 178	6 252 116
R19	McCredie Road, Smithfield	Industrial	310 547	6 252 547
R20	Fairfield Road, Yennora	Industrial	311 050	6 252 019
R21	Vineyard Avenue, Smithfield	Residential	309 996	6 252 182
R22	Low Street, Smithfield	Residential	309 844	6 252 444
R23	Crosby Crescent, Fairfield	Residential	310 861	6 251 747
R24	The Horsley Drive, Smithfield	Residential	310 224	6 251 865
R25	The Horsley Drive, Smithfield	Residential	309 706	6 252 058
R26	Warren Road, Woodpark	Residential	311 030	6 253 325
R27	Pavesi Street, Guildford West	Residential	311 307	6 253 021
R28	Sturt Street, Smithfield	Industrial	310 996	6 253 123
R29	Karani Avenue, Guildford West	Residential	311 356	6 252 825
R30	Queen Street, Guildford West	Residential	311 592	6 252 729
R31	Phillip Street, Guildford West	Residential	311 671	6 252 403
R32	Dennistoun Avenue, Yennora	Industrial	311 659	6 251 646
R33	Herbert Place, Smithfield	Industrial	310 262	6 252 861
R34	Warren Road, Smithfield	Industrial	310 636	6 253 000
R35	Smithfield Park, Smithfield	Recreational	309 841	6 252 135
R36	Tom Uren Park, Guildford West	Recreational	311 296	6 252 842
R37	Crown On McCredie, Guildford West	Hotel	311 246	6 252 491
R38	Guildford West Children's Centre, Guildford West	Childcare	311 799	6 252 848
R39	Guildford West Public School, Guildford West	School	311 836	6 252 801

Receptor ID	Location	Land use	Coordinates (UTM)	
			mE	mS
R40	Guildford West Sportsground, Guildford West	Recreational	310 989	6 252 421
R41	Bernadette Park, Fairfield	Recreational	310 771	6 251 904
R42	Fairfield Road Park, Yennora	Recreational	311 077	6 251 632
R43	Cawarra Park, Fairfield	Recreational	310 968	6 251 504
R44	Little Lucy's Family Day Care, Guildford West	Childcare	311 609	6 252 690
R45	Smithfield Montessori Academy CCC, Smithfield	Childcare	309 447	6 251 901
R46	Helena St Reserve, Guildford West	Recreational	311 673	6 252 908
R47	Os Young Park, Guildford West	Recreational	311 734	6 252 308

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

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

Three stations have been identified located proximate to the Proposal site. A summary of the identified AWS is provided in Table 12 below (listed by proximity).

Table 12 Details of meteorological monitoring surrounding the Proposal site

Site name	Source	Station #	Approximate location		Approximate distance (km)
			mE	mS	
Bankstown Airport AWS	BoM	066137	313 855	6 245 099	7.7
Horsley Park Equestrian Centre AWS	BoM	067119	301 708	6 252 298	9.0
Sydney Olympic Park AWS	BoM	066195	320 948	6 252 558	10.0

The Bankstown Airport AWS is noted to be the most proximate BoM operated AWS to the Proposal site, located approximately 7.7 km to the southeast of the Proposal site. As such, it is considered that data collected at Bankstown AWS is most likely to represent the conditions at the Proposal site, based upon its proximity.

Correspondingly, data acquired from Bankstown Airport AWS for the period between 2019 and 2023 (the most recent five years of complete data) have been analysed for use in this AQIA. The wind roses presented in Appendix D indicate that from 2019 to 2023, winds at Bankstown AWS show similar wind distribution patterns across the years assessed, with no predominant wind direction.

The majority of wind speeds experienced at Bankstown Airport AWS between 2019 and 2023 are generally in the range 0.5 meters per second ($\text{m}\cdot\text{s}^{-1}$) to $8 \text{ m}\cdot\text{s}^{-1}$ with the highest wind speeds (greater than $8 \text{ m}\cdot\text{s}^{-1}$) occurring generally from south-easterly directions. Winds of this speed are rare and occur during 1.6 % of the observed hours during the years. Calm winds (less than $0.5 \text{ m}\cdot\text{s}^{-1}$) are more common and occur during 20.8 % of hours on average across the years between 2019 and 2023.

An analysis of the correlation coefficients between each year for wind speed, wind direction and particulate matter data distribution was performed to select a representative year for the meteorological modelling (refer Appendix D). Following this analysis, the year 2021 was chosen as the most suitable for further assessment.

To provide a characterisation of the meteorology which would be expected at the Proposal site, a meteorological modelling exercise has also been performed. A summary of the inputs and outputs of the meteorological modelling assessment, including validation of those outputs is presented in Appendix D.

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.

The Proposal site is located proximate to two air quality monitoring stations (AQMS) operated by NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW). These locations (listed by proximity) are summarised in Table 13.

Table 13 Proximate NSW DCCEEW AQMS relative to the Proposal site

AQMS location	Dates of operation	Distance to Proposal site (km)	Measurements						
			PM ₁₀	PM _{2.5}	TSP	NO ₂	CO	SO ₂	O ₃
Parramatta North	2017-present	6.8	✓	✓	✗	✓	✓	✓	✓
Prospect	2007-present	7.2	✓	✓	✗	✓	✓	✓	✓
Chullora	2002-present	9.5	✓	✓	✗	✓	✓	✓	✓
Liverpool	1988-present	9.9	✓	✓	✗	✓	✓	✗	✓

The closest active AQMS is noted to be located at Parramatta North and is generally considered to be the monitoring location most reflective of the conditions at the Proposal site. Correspondingly, given its proximate distance to the Proposal site and availability of data, air quality monitoring data collected at Parramatta North AQMS for the year 2021 (corresponding with the selected meteorological data [refer Section 4.3]) have been adopted for use in this AQIA.

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

Given the wind distributions and PM concentrations across the years examined, data for the year 2021 has been selected as being appropriate for further assessment, as it best represents the general trend across the five-year period studied. Reference should be made to Appendix D for further details.

It is noted that none of the AQMS identified in Table 13 monitor total suspended particulate (TSP) which 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 E.

It is noted that a number of pollutants assessed as part of this AQIA are not routinely monitored at AQMS locations in NSW as follows:

- PAH;
- Benzene (C_6H_6);
- Formaldehyde (CH_2O);
- Toluene (C_7H_8); and
- Xylene (C_8H_{10}).

For the purposes of this assessment, it has been assumed that background concentrations of the abovementioned pollutants are negligible. In any case, section 7 of the Approved Methods only requires the assessment of the 99.9th percentile incremental impacts for the pollutants outlined above.

It is noted that although impacts of ozone (O_3) have not been considered in this assessment, O_3 data observed at Parramatta North AQMS have been adopted to assist in calculating the conversion of the results of the dispersion modelling assessment (NO_x to NO_2) (refer Section 5.2.6).

It is additionally noted that Parramatta North AQMS recorded $PM_{2.5}$ concentrations above the NEPM AAQ standard on three days in 2021 driven by extensive hazard reduction burning performed north of Sydney (NSW DPE, 2023).

The AQIA has been performed to assess the contribution of the Proposal to the air quality of the surrounding area. A full discussion of how the Proposal impacts upon local air quality is presented in Section 7 and Section 8.

A summary of the air quality monitoring data and assumptions used to produce this AQIA are presented in Table 14 (overleaf).

Table 14 Summary of background air quality used in the AQIA

Pollutant	Averaging period	Units	Measured value	Notes
Particles (as TSP) (derived from PM ₁₀)	Annual	µg·m ⁻³	35.1	Estimated on a TSP:PM ₁₀ ratio of 2.0551 : 1
Particles (as PM ₁₀)	24-hour	µg·m ⁻³	Daily Varying	The maximum 24-hour PM ₁₀ concentration in 2021 was 42.5 µg·m ⁻³
	Annual	µg·m ⁻³	17.1	Annual average in 2021
Particles (as PM _{2.5})	24-hour	µg·m ⁻³	Daily Varying	The maximum 24-hour PM _{2.5} concentration in 2021 was 27.4 µg·m ⁻³
	Annual	µg·m ⁻³	6.6	Annual average in 2021
Nitrogen dioxide (NO ₂)	1-hour	µg·m ⁻³	Hourly varying	The maximum 1-hour NO ₂ concentration in 2021 was 96.4 µg·m ⁻³
	Annual	µg·m ⁻³	15.2	Annual average in 2021
Carbon monoxide (CO)	15-minute	mg·m ⁻³	1.8	Calculated from 1-hr data
	1-hour	mg·m ⁻³	1.4	Maximum 1-hr average in 2021
	8-hour	mg·m ⁻³	1.1	Maximum 8-hr average in 2021
Sulphur dioxide (SO ₂)	1 hour	µg·m ⁻³	42.9	Maximum 1-hr average in 2021
	24-hour	µg·m ⁻³	8.6	Maximum 24-hr average in 2021

Note: Reference should be made to Appendix E

These data indicate that whilst air quality in the area generally achieved the relevant criteria, exceedances of the short-term PM_{2.5} criterion were measured in the assessment year of 2021.

4.5. Topography

The elevation at the Proposal site is approximately 20 m Australian Height Datum (AHD) (refer Figure 1).

The topography between the Proposal site and identified sensitive receptor locations is uncomplicated (from an AQIA perspective) and is relatively consistent with elevation variances of less than 15 m within the immediate locality. Nonetheless, the influence of topography has been included in the dispersion modelling assessment as described in Section 5.2.1.3.

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 cumulative (additive) impacts of those separate emissions should be assessed in aggregate against the criteria provided in the Approved Methods.

A number of developments have been identified proximate to the Proposal site that may result in cumulative impacts with the Proposal at surrounding land uses as presented in Table 15. It is noted that none of the identified developments are currently operating as they have either only been recently approved or are presently under assessment. Table 15 includes approved facilities as well as developments currently under assessment.

It is noted that given none of the developments identified in Table 15 were operational in the selected assessment year of 2021, potential emissions resulting from those developments are not captured in the background air quality monitoring data (refer Section 4.4). Correspondingly, a review of the documents associated with the application references provided on the NSW Major Projects website³ has been performed to better understand the potential air quality impacts resulting from the identified developments. The review found that air quality assessments have been performed for the following developments:

- Smithfield Recycling Centre (Northstar, 2022);
- Woolworths Distribution Centre (Northstar, 2021); and
- Cobra Waste Solutions (Benbow, 2022).

Given that publicly available air quality assessments could not be found associated with Smithfield Battery Energy Storage or the Waste Transfer Station, a quantitative assessment of potential cumulative impacts with the Proposal at surrounding land uses cannot be performed as part of this AQIA. However, potential cumulative impacts would be anticipated to be minimal, given the likely air emission profile, and magnitude of emissions associated with those developments.

With reference to Woolworths Distribution Centre, it is noted that the development is located approximately 3.5 km to the west of the Proposal site. Based on Northstar's experience in assessing air quality impacts generated from data centres, it is considered highly unlikely that cumulative impacts from the Woolworths Distribution Centre and the Proposal would occur at proximate receptors and as such, an assessment of cumulative impacts has not been performed within this AQIA.

Additionally, it is noted that the air quality assessments performed for Smithfield Recycling Centre (Northstar, 2022) and Cobra Waste Solutions (Benbow, 2022) only assessed emissions of PM at nearby receptor locations. Northstar's experience indicates that the primary pollutant of concern associated with the operation of backup diesel generators is generally NO_x, while air quality impacts relating to PM are typically minor. Correspondingly, it is considered that an assessment of cumulative PM impacts with Smithfield Recycling Centre and Cobra Waste Solutions is not necessary and has not been considered further as part of this AQIA.

Additionally, with regard to the operation of the Proposal, the potential for cumulative impacts would only occur in the event of periodic generator testing and / or power outage. At all other times the air emissions from the operation of the Proposal would be negligible.

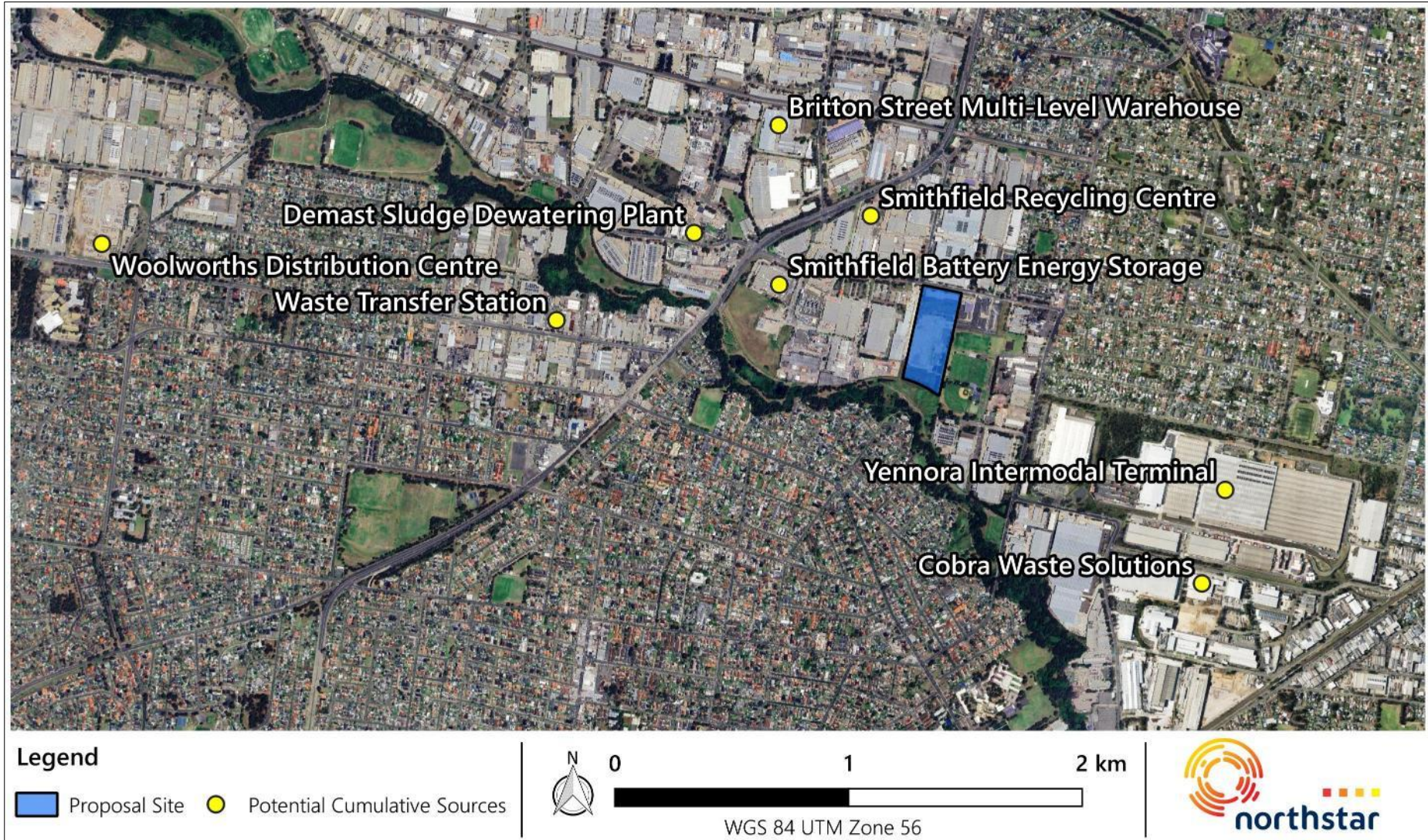
³ <https://www.planningportal.nsw.gov.au/major-projects>

Table 15 Identified potential cumulative sources

Site	Development application reference	Development description	Decision	Decision date	Distance to Proposal site (km)
Smithfield Recycling Centre – 132 - 144 Warren Road, Smithfield	SSD-19425495	Use of an existing warehouse (operating 24 hours 7 days a week) to receive up to 150,000 tonnes per annum of domestic and commercial recyclable materials and sort these materials into categories for transportation to dedicated reprocessing facilities	Approved	20/12/24	0.4
Smithfield Battery Energy Storage System – 6 Herbert Place, Smithfield	DA94/165-Mod-3	Removal of disused combined cycle gas turbine infrastructure including the steam turbine generator and four cell cooling towers. Installation and operation of new replacement of cooling system.	Approved	09/04/2024	0.6
250 Victoria Street, Wetherill Park (Woolworths WDC Wetherill Park	SSD-15221509	Construction and operation of a warehouse and distribution facility in Wetherill Park for handling chilled and fresh products	Awaiting determination (response to submissions stage)	NA	3.5
Cobra Waste Solutions Resource Recovery Facility	SSD-9320662	Operation of a Resource Recovery Facility to process up to 150,000 tonnes per annum of general solid waste (non-putrescible) consisting of construction and demolition waste and commercial and Industrial waste.	Approved	17/11/2023	1.4
68 Victoria Street, Smithfield	PPSSWC-390	Waste or resource transfer station	Under Assessment	NA	1.5
81 Byron Road, Yennora	SSD-59076719	The project seeks approval to facilitate the future transformation of the current facility into a modern multistorey warehouse and distribution facility. It is currently at the EIS preparation stage. Through this application, the applicant seeks to amend the existing consent under DA 264-09-01.	Preparation of EIS.	NA	0.8

Site	Development application reference	Development description	Decision	Decision date	Distance to Proposal site (km)
15-21 Britton Street & Amp; 28-54 Percival Road, Smithfield	SSD-67368956	Demolition of on-site structures, construction and 24/7 operation of a multi-level warehouse and distribution centre, comprised of 3 buildings connected by hardstand, 2-3 storeys in height, gross floor area of 108,896 m2, and ancillary offices.	Awaiting Determination (response to submissions stage)	NA	0.7
7 Long Street, Smithfield	SSD-72775222	Upgrade to an existing Sludge Dewatering Plant to increase the processing capacity from 46,720 tpa of drill mud to 300,000 tpa of sludge, groundwater, GSW soils, virgin excavated natural material (VENM) and excavated natural material (ENM).	Preparation of EIS	NA	1.0

Figure 4 Identified potential cumulative sources



Source: Northstar

5. METHODOLOGY

This report provides a qualitative assessment of dust impacts (soiling and human health) during the construction phase, adapted from (IAQM, 2024), and a quantitative assessment aligned with the Approved Methods for evaluating operational phase air quality impacts.

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 assessment, Northstar has adapted the *Guidance on the Assessment of Dust from Demolition and Construction* published by the Institute of Air Quality Management (IAQM, 2024) in the United Kingdom. The IAQM construction phase assessment approach is commonly used for evaluating fugitive dust and particulate matter emissions from construction activities in development projects across NSW and Australia. Reference should be made to Appendix C for the methodology.

Briefly, the adapted method uses a six-step process for assessing dust impact risks from construction activities, and to identify key activities for control as outlined in Appendix C.

5.2. Operation Phase

5.2.1. Dispersion Modelling Approach

The air emissions assessment for the operational phase of the Proposal has utilised quantitative dispersion modelling techniques. This section outlines the approach taken in the AQIA for the operational phase of the Proposal.

5.2.1.1. Dispersion Model

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF Atmospheric Dispersion Model. CALPUFF is a Lagrangian Gaussian (steady-state) plume dispersion model, recognised in the Approved Methods as a widely accepted model for regulatory applications in NSW. It is used to predict pollutant concentrations from various sources typically found at industrial facilities.

The CALPUFF model uses hourly meteorological data to define conditions for plume rise, transport, diffusion, and deposition. It estimates concentrations or deposition values for each source-receptor combination on an hourly basis and calculates user-selected short-term averages. CALPUFF also accounts for local terrain, making it well-suited for modelling complex terrains, including slope flows, valley flows, terrain blocking, and kinematic effects.

Since most air quality standards are based on averages or percentiles, CALPUFF enables further analysis of results for comparison. The CALPUFF-percent post-processing utility calculates the maximum concentration of a pollutant at a specific percentile over a given period, across all receptors. This percentile approach helps omit unusual short-term meteorological events that may cause elevated concentrations, providing a more accurate representation of likely average pollutant concentrations over the averaging period.

Table 16 provides the model input configuration to assess the impact of generator emissions from the Proposal, in consideration of the Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia' (Barclay & Scire, 2011).

Table 16 General model parameters for CALPUFF dispersion modelling

Model parameter	Input
Model mode	CALPUFF Refined Mode CALMET No-Observations (No-Obs) Mode
Meteorological data	Prognostic Data (TAPM)
Terrain topography	SRTM3
Model / Grid domain size	10 km × 10 km × 4 km
Grid resolution / spacing	0.1 km

(Barclay & Scire, 2011) recommend using CALMET No-Obs mode for regulatory screening when good-quality gridded prognostic meteorological data are available, which has been applied in the dispersion modelling process.

Given the variable topography, the terrain radius of influence was set at 1.55 km, with a minimum of 0.1 km. Terrain data with a 3 arc-second resolution (approximately 90 m) were used, in consideration of (Barclay & Scire, 2011). The dispersion model was run over a large grid (10 km × 10 km) at ground level, encompassing the nearest sensitive receptors (see Section 4.2), covering all potentially impacted nearby land uses.

5.2.1.2. Meteorological Modelling

Section 4 of the Approved Methods requires one-year of site-specific meteorological data or site-representative meteorological data, in the absence of site-specific data, to be used for dispersion modelling.

The 3-D meteorological dataset was derived using gridded prognostic data generated from The Air Pollution Model (TAPM, v 4.0.5) as developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), in conjunction with CALMET (refer Appendix D). Section 4.5 of the Approved Methods further identifies TAPM as a commonly used prognostic meteorological model in NSW.

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.

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

Further discussion on the meteorological model configuration and input parameters is provided in Appendix D.

5.2.1.3. Terrain Effects

The CALPUFF model incorporates terrain information with heights being applied to all receptors and sources. In order to account for the potential influence on pollution dispersion and varying receptor elevations across the modelling domain, a gap filled and filtered (vegetation and obstacles removed) topography file with 3 second resolution (approximately 90 m) derived from the Shuttle Radar Topography Mission (SRTM) data was obtained from Geoscience Australia and was processed for use in CALPUFF.

5.2.1.4. Building Downwash

For dispersion modelling assessments, the influence of surrounding buildings on emission transport is a material consideration. Nearby buildings can create turbulence and a building wake that affect pollutant

dispersion, particularly through a phenomenon known as building downwash. The ratio of stack height to building height also impacts this effect; if the stack is significantly taller than the building, downwash is minimal.

Section 5.3 of the Approved Methods outlines the following requirements for determining which buildings to consider within a dispersion modelling assessment:

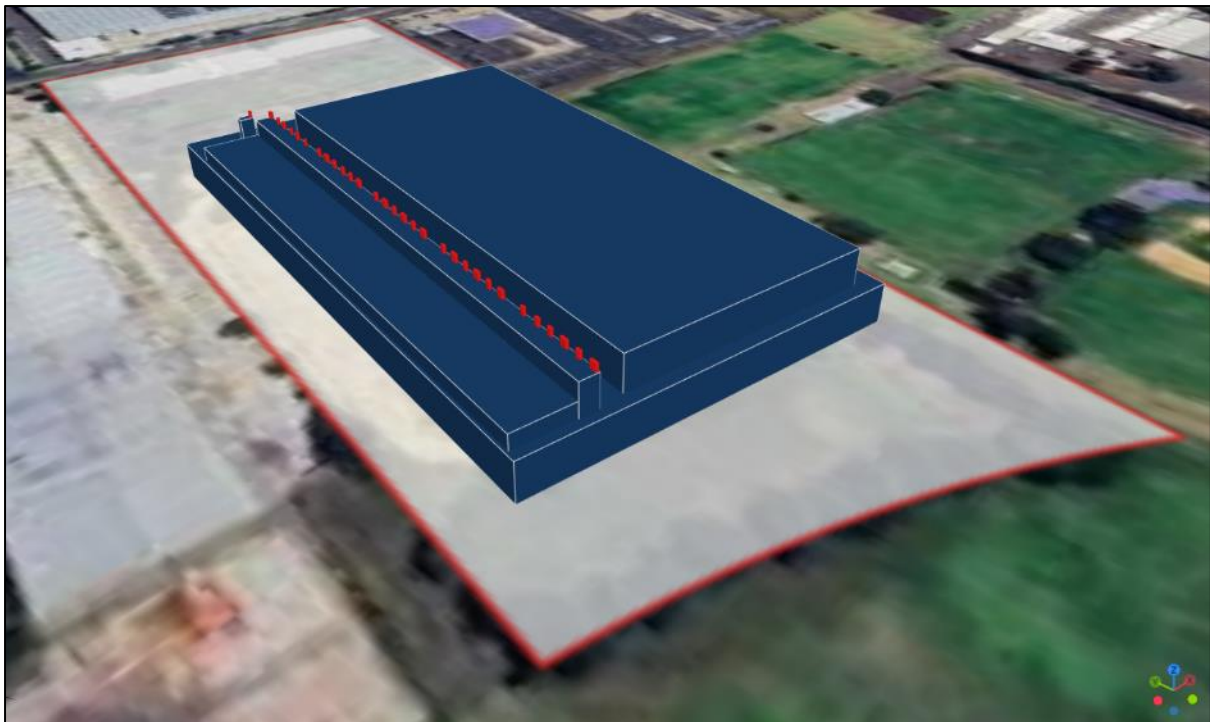
“The location and dimensions of buildings located within a distance of $5L$ (where L is the lesser of the height or width of the building) from each release point for buildings with a height greater than 0.4 times the stack height...”

The Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) uses building heights and corner locations near the stack to simulate effective dimensions. The BPIP-PRIME downwash algorithm computes these dimensions in ten-degree intervals, allowing CALPUFF to assess the impact on plume dispersion and ground-level concentrations. While simplified, this building geometry offers a reasonable estimate of how structures disrupt wind flow nearby.

Therefore, to analyse downwash effects from point sources mimicking air emissions, the buildings surrounding the Proposal site were incorporated into the CALPUFF model.

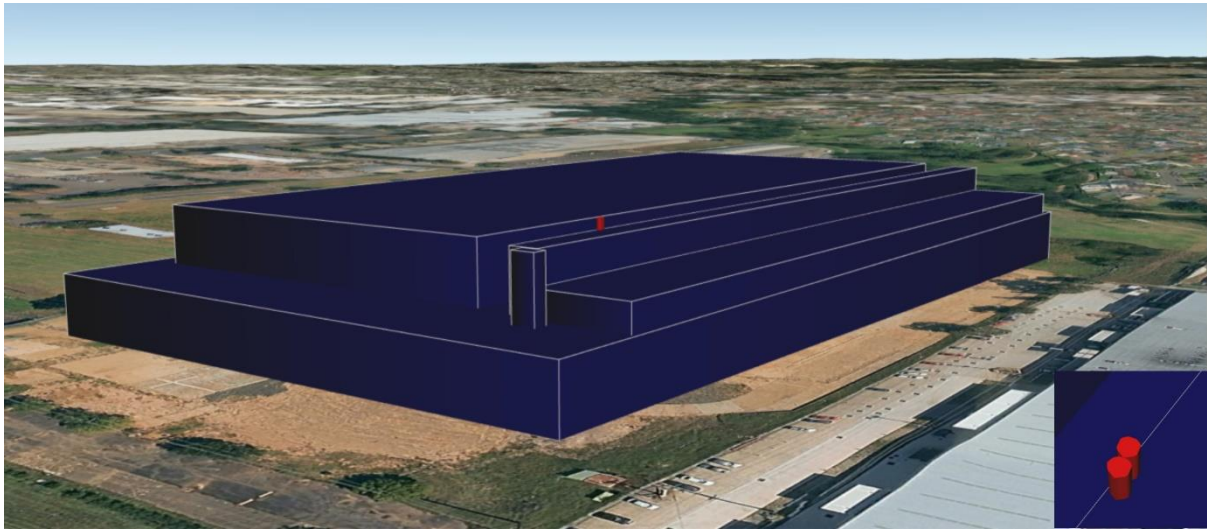
With reference to the requirements outlined in the Approved Methods, Figure 5 illustrates the locations of the buildings included in the BPIP-PRIME model for downwash calculations, which are subsequently incorporated into the CALPUFF dispersion modelling process. Also shown are the emission discharge points for each scenario modelled (refer Section 5.2.2).

Figure 5 Buildings and discharge points considered in dispersion modelling (Scenario 1)



Source: Northstar

Figure 6 Buildings and discharge points considered in dispersion modelling (Scenario 2)



Source: Northstar

5.2.2. Modelling Scenarios

The following modelling scenarios have been completed to determine the potential impact under the anticipated operational conditions of the emergency standby generators.

- **Scenario 1 – justified worst case scenario** – Operating all 68 no. generators at 100 % load at the Proposal site.

 - This is an unlikely scenario which would result from catastrophic failure in the electricity supply system. However, given that the Proposal includes up to 68 no. generators, this AQIA has assessed the potential impact of those generators operating concurrently.
 - Each generator has 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 highly conservative assessment of the potential impacts.
 - 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 AQIA provides context around how likely any exceedances of air quality criteria would be, given the likelihood of such catastrophic failure.
- **Scenario 2 - realistic operations (maintenance testing)** – The anticipated testing schedule is 4 no. generators operating (two at 100 % load and two at no load [0 %]) for each operating hour as representative of the generator testing regime to be performed at the Proposal site. To provide flexibility in the operation of the Proposal, modelling has been performed assessing the potential

impact of testing two generators at 100 % load and two at 0 % load, concurrently over a 24/7 period.

- This is a scenario which would regularly occur, as detailed in Table 7 whereby 4 no. 2.5 MW generators at the Proposal site may be tested at any one time, (two at 100% load, and two at 0 % load). For the purposes of providing flexibility in the Proposal operation, two generators have been modelled to be tested at any one time at 100 % load, between the hours of midnight and midnight (24-hours). As previously noted, the testing program is likely to be performed between the hours of 7:00 am and 6:00 pm (8:00 am to 6:00 pm Sundays and public holidays), although dispersion modelling results are presented for the full 24-hour period, to provide assurances that air quality impacts are not a constraint to the duration of the testing program.
- The generators assumed to be tested at one time (for the purposes of this AQIA) are shown in Figure 6. A sensitivity test was previously undertaken to identify the general location of generators that would result in the highest impacts at surrounding receptors. Generators located to the north-west of the Proposal site were subsequently selected for detailed assessment based on the outcome of this test. The impacts associated with these generators are considered to provide an appropriate approximation of potential maximum impacts on surrounding sensitive receptors.
- While the generator layout has since been revised, no further sensitivity testing has been undertaken. The selected scenario remains reasonable and suitably conservative, noting that generator testing is expected to occur within a confined area of the development (e.g. within the same level or zone), rather than being distributed across the full site.

5.2.3. Generator Emission Rates and Source Characteristics

A summary of the standby generator stack design components used to model each scenario is provided in Table 17. Details of the technical specifications for the standby generators are provided in Appendix F.

Air pollutant emission concentrations for both MTU 20V 4000 DS3100 and MTU 16V 2000 DS1100 generators are provided in Appendix F and summarised in Table 17.

The locations of the modelled emissions sources at the Proposal site under Scenario 1 and Scenario 2 are illustrated in Figure 5 and Figure 6 (refer Section 5.2.1.4).

Table 17 Back-up generator emissions and stack parameters

Parameter	Units	Scenario 1 (Justified worst case)		Scenario 2 (Realistic case)
		Emergency operations		Maintenance testing
Hour start	Hr	00:00		00:00
Hour end	Hr	00:00		00:00
% load	%	100		100
Emergency generator model		MTU 20V4000DS3100	MTU 16V2000DS1100	MTU 20V4000DS3100
Number of generators active	no.	67	1	2
Diesel consumption rate (per gen)	L·hr ⁻¹	618	237	618
Power	kW	2 670	979	2 670
Stack height	m AGL	25.7	25.7	25.7
Stack diameter	mm	600	600	600
Stack CSA	m ²	0.283	0.283	0.283
Actual discharge rate	Am ³ ·s ⁻¹	8.0	3.35	8.0
Exit temperature	°C	570	530	570
Exit velocity	m·s ⁻¹	28.3	11.8	28.3
Generator emission specification				
NO _x	g·kWh ⁻¹	13.46	7.23	13.46
CO	g·kWh ⁻¹	1.06	0.55	1.06
TVOC	g·kWh ⁻¹	0.21	0.14	0.21
PM	g·kWh ⁻¹	0.045	0.046	0.045
Pollutant emission rates				
NO _x ^(a)	g·s ⁻¹	9.98E+00	1.97E+00	9.98E+00
CO ^(a)	g·s ⁻¹	7.90E-01	1.50E-01	7.90E-01
TVOC ^(a)	g·s ⁻¹	1.56E-01	3.81E-02	1.56E-01
PM (PM ₁₀ and PM _{2.5}) ^{(a)(d)}	g·s ⁻¹	3.34E-02	1.25E-02	3.34E-02
SO ₂ ^(c)	g·s ⁻¹	7.96E-07	2.80E-07	7.96E-07
Benzene ^(b)	g·s ⁻¹	1.51E-03	3.69E-04	1.51E-03
Toluene ^(b)	g·s ⁻¹	5.45E-04	1.33E-04	5.45E-04
Xylene ^(b)	g·s ⁻¹	3.80E-04	9.29E-05	3.80E-04
PAH emission ^(b)	g·s ⁻¹	2.24E-08	5.48E-09	2.24E-08
Formaldehyde emission ^(b)	g·s ⁻¹	1.53E-04	3.75E-05	1.53E-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). Refer Section 5.2.4.
 - (c): Based on sulphur content of fuel.
 - (d): 100 % of PM is emitted as PM_{2.5}, and PM_{2.5} = PM₁₀.
 - (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 F.

5.2.4. Speciated VOCs

The technical specification documents presented in Appendix F 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 (more than 450 kW) diesel engines and fuel consumption rates of between 513.3 L·hr⁻¹ and 256.0 L·hr⁻¹ respectively.

The emission factors for TVOC and the respective speciated VOCs have been factored to calculate the mass fractions of those species within TVOC. Table 18 presents the speciated VOC fraction assumptions that are used for this assessment. The impacts of odorants (toluene (C₇H₈) and xylene(C₈H₁₀)) 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 18 Speciated VOC fractions

Substance	EF % (of TVOC) (NPI, 2008)	EF g·s ⁻¹	
		MTU 20V4000G74F	MTU 16V2000DS1100
TVOC	100 %	1.56E-01	3.81E-02
Benzene	0.97 %	1.51E-03	3.69E-04
Toluene (odour)	0.35 %	5.45E-04	1.33E-04
Xylene (odour)	0.24 %	3.80E-04	9.29E-05

5.2.5. Particle Size Fractions

In regard to particulates from diesel, virtually 100 % of diesel particles are less than 1 µm in diameter (i.e. PM₁) and consequently particulates from diesel combustion are assessed as PM_{2.5}. In this AQIA, the emission rate of PM_{2.5} will be the same as PM₁₀, as all of the PM₁₀ particles are assessed as being ≤ 2.5 µm in diameter (PM_{2.5}).

5.2.6. NO_x to NO₂ 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 NO₂ and nitric oxide (NO), conversion of NO_x predictions to NO₂ concentrations may be performed.

NO_x from a combustion process will be emitted as NO and NO₂. Over time and after the point of discharge, NO in ambient air will be transformed by secondary atmospheric reactions with atmospheric ozone (O₃) to form NO₂, 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.

AQIAs need to account for the conversion of NO to NO₂ to enable a comparison against the air quality criteria for NO₂. The Approved Methods outlines various methods of assessment, which range from the simple to the more detailed. The three methods outlined in the Approved Methods are briefly outlined below:

- **Method 1 - 100 % conversion:** the most conservative assumption is to assume that 100 % of the total NO_x emitted is discharged as NO₂, and that further reactions do not occur.
- **Method 2 - Ozone limiting method (OLM):** this method uses contemporaneous ozone data to estimate that rate at which NO is oxidised to NO₂ hour-on-hour using an established relationship.
- **Method 3 – NO to NO₂ conversion using empirical relationship:** an empirical relationship between NO and NO₂ may be used to derive 'steady state' relationships. A relationship has been developed by (Janssen, Van Wakeren, Van Duuren, & Elshout, 1988) associated with power plant plumes.

Section 8.1 of the Approved Methods outlines the approach to NO₂ assessment, which clearly indicates that each stage should be performed sequentially. That is, Method 1, Level 1 should be performed first and *'if the impact assessment criteria are exceeded, a more refined assessment should be undertaken and/or additional management practices or emission controls applied'*

If exceedances are predicted, then Method 1, Level 2 should be performed, with the same assessment of the potential for exceedance of the 1-hour NO₂ criterion applied. The process then continues through Method 2 (Level 1 and Level 2), and Method 3 (Level 1 and Level 2).

This AQIA has used Method 3 to approximate the conversion of NO_x to NO₂, in accordance with the empirical equation described in the Approved Methods:

$$NO_2 / NO_x = A(1 - \exp(-\alpha x))$$

Where:

x = distance (km) from the source

A and α are classified according to O₃ concentration, wind speed and season, with (Janssen, Van Wakeren, Van Duuren, & Elshout, 1988) providing values for A and α .

At each receptor, the hourly varying NO₂ / NO_x relationship has been calculated, based on the season, hourly varying O₃ concentration, and wind speed. Results are presented in Section 7.1.2 and 7.2.2 for the maximum predicted incremental NO_x / NO₂ concentration and the maximum predicted cumulative NO₂ concentration using the relevant NO_x/NO₂ conversion method(s)..

5.2.7. Short Term Pollutant Concentrations

With reference to criteria air pollutants with sub-hourly criteria (CO, refer Section 3.3), hourly dispersion model outputs have been adjusted using the following Power Law adjustment⁴:

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

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)

⁴ <http://www.epa.vic.gov.au/~media/Publications/1551.pdf>

6. CONSTRUCTION AIR QUALITY RISK ASSESSMENT

The methodology adapted by Northstar from the IAQM demolition and construction dust guidance (IAQM, 2024) has been used to assess construction phase risk. This approach utilises a six-step process to assess the risks associated with dust impact from construction activities (refer Appendix C). It considers receptor sensitivity and potential impact magnitude to identify key control measures, as detailed in Section 5.1.

6.1. Risk (Pre-Mitigation)

Given the sensitivity of the identified receptors is classified as low for dust soiling, and medium for health effects (as described in Appendix C), and the dust emission magnitudes for the various construction phase activities as presented in Appendix C, the resulting risk of air quality impacts (without mitigation) is as presented in Table 19.

Table 19 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 impacts										
Med.	N/A	Med.	Large	Large	Large	N/A	Med.	Med.	Med.	Med.
Human health impacts										
Low	N/A	Med.	Large	Large	Large	N/A	Low	Low	Low	Low

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

Table 19 summarises the risks, indicating that dust soiling impacts are associated with medium risks for all construction phase activities while human health impacts are associated with low risks for all construction phase activities if no mitigation measures were to be applied to control emissions.

6.2. Risk (Post Mitigation)

The adapted methodology emphasises the aim of preventing significant effects on receptors during construction activities through the implementation of effective mitigation measures. Experience demonstrates that achieving this goal is feasible. Considering the size of the Proposal site, the distance to sensitive receptors, and the nature of activities involved, residual impacts related to fugitive dust emissions from the Proposal are expected to be 'negligible' if the mitigation measures outlined in Appendix C are implemented appropriately.

7. OPERATIONAL 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 operation of the Proposal.
- **Cumulative impact** – relates to the incremental concentrations predicted as a result of the operation of the Proposal PLUS the background (Bkg) air quality (refer 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
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7.1. Scenario 1 – Justified Worst-Case

The following presents the results of the modelling assessment under the assumptions of Scenario 1 (refer Section 4.2.2), with up to 68 no. emergency standby generators operating at 100 % load and consideration of the background pollutant concentrations (refer Section 4.4), where appropriate.

Results are presented in this section for short term criteria only (i.e. ≤ 24 hours).

Note: care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of back-up generators for an entire 24-hour period).

Note: The assessment against annual average criteria is essentially meaningless, given that the generators would only be operational for a small number of hours, during the justified worst-case scenario. Operation of those generators over an entire year would not occur.

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

7.1.1. 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 9. The emissions adopted for Scenario 1 reflect the operational profile of the Proposal over that averaging period (refer Section 5.2.2).

7.1.1.1. Maximum 24-Hour PM₁₀ and PM_{2.5} Concentrations

Table 20 presents the maximum 24-hour average PM₁₀ and PM_{2.5} concentrations predicted to occur at the nearest receptors, as a result of the assumptions under Scenario 1. No background concentrations are included within this table.

Table 20 Predicted maximum incremental 24-hour PM₁₀ and PM_{2.5} concentrations – Scenario 1

Receptor	Maximum 24-hour average concentration (µg·m ⁻³)	
	PM ₁₀	PM _{2.5}
Criterion	50	25
Max. % of criterion	103.5	206.9
R1	16.2	16.2
R2	18.2	18.2
R3	16.7	16.7
R4	19.8	19.8
R5	21.8	21.8
R6	17.2	17.2
R7	44.7	44.7
R8	24.2	24.2
R9	16.2	16.2
R10	12.5	12.5
R11	7.7	7.7
R12	25.2	25.2
R13	15.3	15.3
R14	13.0	13.0
R15	10.1	10.1
R16	14.6	14.6
R17	13.0	13.0
R18	7.7	7.7
R19	12.4	12.4
R20	12.9	12.9
R21	5.7	5.7
R22	5.9	5.9
R23	13.3	13.3
R24	7.8	7.8
R25	4.0	4.0
R26	5.8	5.8
R27	9.3	9.3
R28	7.9	7.9

Receptor	Maximum 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM ₁₀	PM _{2.5}
Criterion	50	25
Max. % of criterion	103.5	206.9
R29	10.9	10.9
R30	12.2	12.2
R31	8.0	8.0
R32	5.2	5.2
R33	11.8	11.8
R34	8.7	8.7
R35	4.7	4.7
R36	11.6	11.6
R37	19.2	19.2
R38	11.0	11.0
R39	10.5	10.5
R40	51.7	51.7
R41	17.2	17.2
R42	11.7	11.7
R43	10.3	10.3
R44	12.3	12.3
R45	3.4	3.4
R46	10.8	10.8
R47	7.1	7.1

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 PM₁₀ (PM_{2.5} is a subset of PM₁₀) and therefore the results will be consistent between PM₁₀ and PM_{2.5} for these two emissions sources.

Note: care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of all back-up generators for an entire 24-hour period).

Table 20 indicates that the highest 24-hour average PM₁₀ and PM_{2.5} incremental concentrations related to the Proposal are predicted at receptor R40 (Guildford West Sportsground).

A contemporaneous analysis of the 24-hour PM₁₀ and PM_{2.5} data has been performed where each predicted incremental concentration is added to the corresponding monitored background concentration, in accordance with Section 11.2.3(b) of the Approved Methods.

Table 21 and Table 22 present the predicted maximum 24-hour average PM₁₀ and PM_{2.5} concentrations resulting from the operation of the Proposal through Scenario 1, with the corresponding background included for each day.

Results are presented in Table 21 and Table 22 for those receptors at which the greatest impacts have been predicted (see Table 20).

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.

Note: care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of all back-up generators for an entire 24-hour period).

For PM₁₀, both the maximum cumulative impact (left-hand side of Table 21) and the maximum incremental impact (right-hand side of Table 21) are predicted at receptor R40. For PM_{2.5}, the maximum cumulative impact (left-hand side of Table 22) is predicted at receptor R7, while the maximum incremental impact (right-hand side of Table 22) is predicted at receptor R40.

A contour plot of the predicted incremental 24-hour PM₁₀ concentrations associated with the Proposal is presented in Figure 7 to allow examination of the distribution of particulate matter in the area surrounding the Proposal. Note that this figure also shows the incremental PM_{2.5} impacts, as the results are identical for the reasons discussed in Section 5.2.5.

The number of additional exceedances of the 24-hour PM₁₀ and PM_{2.5} criteria predicted at various receptors resulting from emergency generator operation is presented in Section 7.1.4. These values are discussed further in Section 8.2.

Table 21 Summary of contemporaneous 24-hour PM₁₀ concentrations – Scenario 1

Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R40			Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R40		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
24/04/2021	42.0	31.4	73.4	27/05/2021	51.7	12.0	63.7
15/04/2021	46.8	25.8	72.6	6/08/2021	50.5	12.8	63.3
26/04/2021	37.7	33.6	71.3	4/06/2021	50.2	15.6	65.8
23/04/2021	40.5	29.4	69.9	5/07/2021	48.2	10.8	59.0
15/01/2021	30.6	35.3	65.9	5/08/2021	47.4	12.0	59.4
4/06/2021	50.2	15.6	65.8	15/04/2021	46.8	25.8	72.6
27/05/2021	51.7	12.0	63.7	14/05/2021	44.7	14.1	58.8
6/08/2021	50.5	12.8	63.3	10/04/2021	43.5	14.3	57.8
21/04/2021	26.8	34.7	61.5	13/05/2021	42.2	13.8	56.0
5/08/2021	47.4	12.0	59.4	24/04/2021	42.0	31.4	73.4
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.			

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 22 Summary of contemporaneous 24-hour PM_{2.5} concentrations – Scenario 1

Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R7			Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R40		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
21/08/2021	37.5	27.4	64.9	27/05/2021	51.7	3.1	54.8
20/04/2021	44.7	11.9	56.6	6/08/2021	50.5	7.3	57.8
9/09/2021	44.0	5.6	49.6	4/06/2021	50.2	10.5	60.7
22/08/2021	23.1	21.2	44.3	5/07/2021	48.2	6.9	55.1
20/08/2021	28.3	14.3	42.6	5/08/2021	47.4	4.4	51.8
26/07/2021	37.8	2.6	40.4	15/04/2021	46.8	7.9	54.7
15/08/2021	22.6	16.9	39.5	14/05/2021	44.7	4.5	49.2
12/06/2021	32.5	6.8	39.3	10/04/2021	43.5	5.5	49.0
24/03/2021	37.3	1.2	38.5	13/05/2021	42.2	5.7	47.9
14/04/2021	33.2	4.6	37.8	24/04/2021	42.0	15.0	57.0
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.			

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Figure 7 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ impacts – Scenario 1



Source: Northstar

7.1.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO₂) under the assumptions of Scenario 1 (refer Section 5.2.2). The averaging period associated with the criterion for NO₂ is 1-hour as specified in Table 9. Note that impacts have not been compared with the annual average criterion for NO₂ as the generators would not be operating for an entire year, and the results would be meaningless.

Emissions of NO_x have been calculated with subsequent ground-level concentrations predicted using dispersion modelling techniques. Given that NO_x is a mixture of NO₂ and nitric oxide (NO), conversion of NO_x predictions to NO₂ concentrations may be performed. Within this assessment, the Janssen method (Method 3) has been adopted as outlined in Section 5.2.6.

The predicted maximum 1-hour average NO₂ concentrations resulting from the Proposal operations under Scenario 1 are presented in Table 23.

Table 23 Predicted 1-hour NO₂ concentrations – Scenario 1

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)		
	1-hour average		
	Incr.	Bkg.	Cumul.
Criterion	164		
Max % of criterion	512.6	23.8	528.8
R1	165.4	26.7	192.0
R2	256.4	10.3	266.6
R3	283.2	10.3	293.5
R4	290.9	6.2	297.1
R5	325.0	26.7	351.6
R6	335.0	18.5	353.4
R7	446.5	10.3	456.8
R8	252.3	10.3	262.5
R9	185.6	16.4	202.0
R10	191.6	4.1	195.7
R11	174.5	6.2	180.6
R12	82.4	22.6	105.0
R13	94.6	< 0.1	94.6
R14	151.2	28.7	179.9
R15	840.7	26.7	867.3
R16	424.6	26.7	451.2
R17	406.1	18.5	424.6
R18	249.1	6.2	255.3
R19	137.3	18.5	155.8
R20	346.6	2.1	348.7
R21	264.2	8.2	272.4

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)		
	1-hour average		
	Incr.	Bkg.	Cumul.
R22	364.1	4.1	368.2
R23	305.1	16.4	321.5
R24	431.2	10.3	441.4
R25	336.0	6.2	342.2
R26	330.3	26.7	357.0
R27	447.5	2.1	449.6
R28	298.0	4.1	302.1
R29	415.7	10.3	426.0
R30	503.8	22.6	526.3
R31	767.2	26.7	793.8
R32	617.0	24.6	641.6
R33	227.0	14.4	241.4
R34	281.1	28.7	309.8
R35	299.1	8.2	307.3
R36	430.2	10.3	440.4
R37	424.5	26.7	451.1
R38	621.1	22.6	643.7
R39	666.8	22.6	689.3
R40	435.2	6.2	441.3
R41	306.9	2.1	308.9
R42	457.6	10.3	467.9
R43	421.4	39.0	460.3
R44	537.6	22.6	560.2
R45	453.2	6.2	459.3
R46	575.6	34.9	610.5
R47	659.0	26.7	685.7

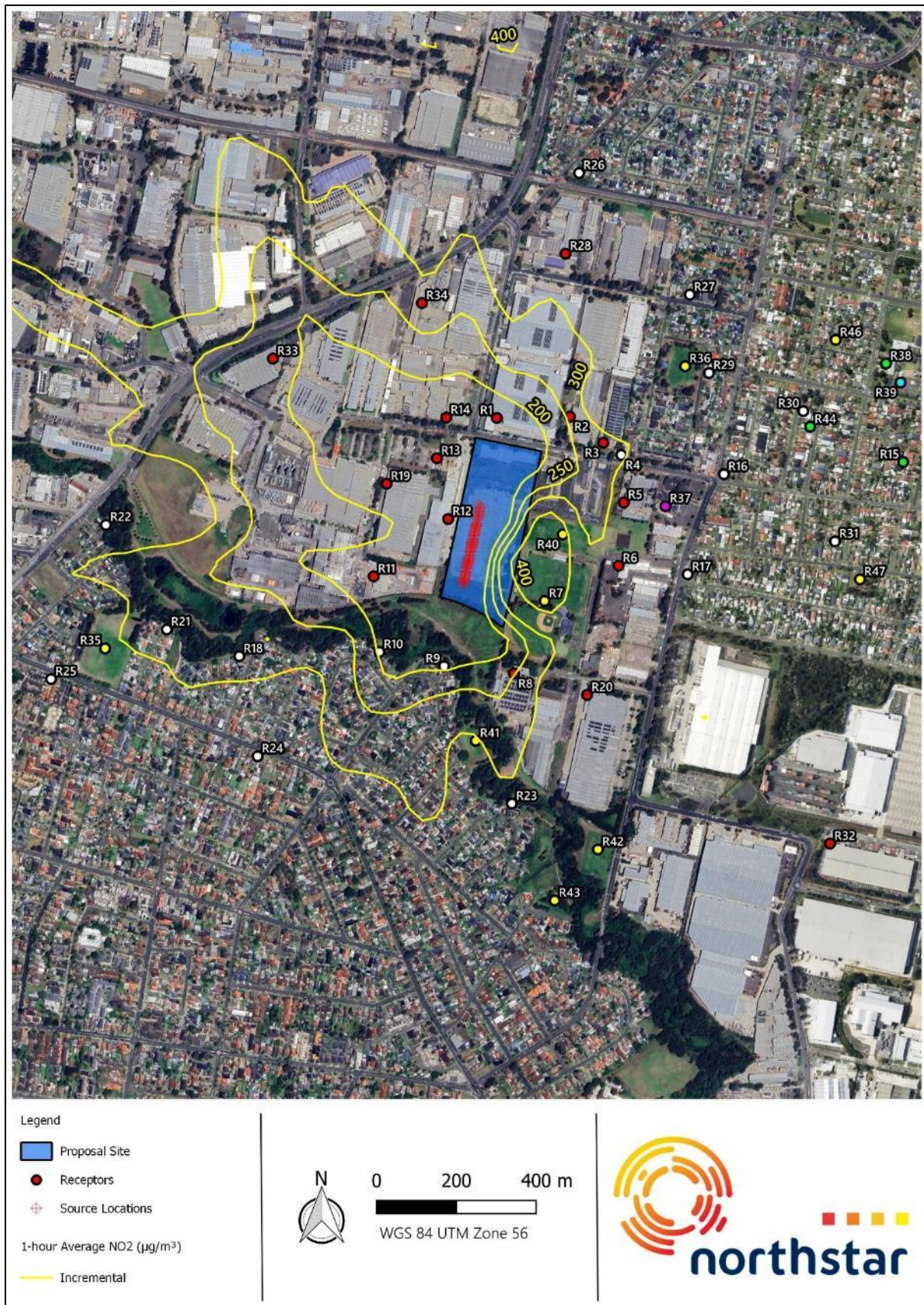
Notes: Incr. – Incremental, Bkg. – Background, Cumul. – Cumulative.

The results indicate that predicted incremental concentrations of NO₂ under Scenario 1 are above the criteria at all surrounding receptor locations with the exception of receptors R9, R10, R12, R13, R14, and R19.

A contour plot of the predicted maximum 1-hour incremental NO₂ impact is presented in Figure 8.

The number of additional exceedances of the 1-hour NO₂ criterion predicted at each receptor resulting from emergency generator operation is presented in Section 7.1.4. These values are discussed further in Section 8.2.

Figure 8 Predicted maximum incremental 1-hour NO₂ impacts – Scenario 1



Source: Northstar

7.1.3. All Other Pollutants

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

Presented in Table 24 to Table 26 are the predicted concentrations of CO, SO₂, PAHs, VOCs and CH₂O at varying averaging periods (≤24 hours) at the surrounding receptors.

Note: care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of all back-up generators for an entire 24-hour period).

The predicted cumulative concentrations for CO are below the relevant criteria for all averaging periods at all receptors as shown in Table 24.

The results presented in Table 21 indicate that predicted incremental impacts of SO₂ 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 26 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 R7 (15.7 % of the relevant criterion).

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

Table 24 Predicted 15-minutes, 1-hour, and 8-hour average CO concentrations – Scenario 1

Receptor	Carbon monoxide (CO) concentration (mg·m ⁻³)								
	15-minute			1-hour			8-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	3.1	1.8	4.9	7.9	4.7	12.6	19.3	11.0	30.3
R1	1.2	1.8	3.0	0.9	1.4	2.3	0.5	1.1	1.6
R2	1.3	1.8	3.1	1.0	1.4	2.4	0.7	1.1	1.8
R3	1.3	1.8	3.1	1.0	1.4	2.4	0.7	1.1	1.8
R4	1.3	1.8	3.1	0.9	1.4	2.3	0.7	1.1	1.8
R5	1.5	1.8	3.3	1.1	1.4	2.5	0.7	1.1	1.8
R6	1.4	1.8	3.2	1.1	1.4	2.5	0.8	1.1	1.9
R7	3.1	1.8	4.9	2.4	1.4	3.8	1.9	1.1	3.0
R8	1.4	1.8	3.2	1.1	1.4	2.5	0.7	1.1	1.8
R9	0.9	1.8	2.7	0.7	1.4	2.1	0.5	1.1	1.6
R10	0.7	1.8	2.5	0.5	1.4	1.9	0.4	1.1	1.5
R11	0.7	1.8	2.5	0.5	1.4	1.9	0.3	1.1	1.4
R12	1.4	1.8	3.2	1.0	1.4	2.4	0.7	1.1	1.8
R13	0.7	1.8	2.5	0.5	1.4	1.9	0.5	1.1	1.6
R14	1.1	1.8	2.9	0.8	1.4	2.2	0.5	1.1	1.6
R15	1.4	1.8	3.2	1.0	1.4	2.4	0.4	1.1	1.5
R16	1.2	1.8	3.0	0.9	1.4	2.3	0.6	1.1	1.7
R17	1.2	1.8	3.0	0.9	1.4	2.3	0.7	1.1	1.8
R18	0.4	1.8	2.2	0.3	1.4	1.7	0.3	1.1	1.4
R19	0.6	1.8	2.4	0.5	1.4	1.9	0.3	1.1	1.4
R20	1.2	1.8	3.0	0.9	1.4	2.3	0.6	1.1	1.7
R21	0.3	1.8	2.1	0.3	1.4	1.7	0.2	1.1	1.3
R22	0.5	1.8	2.3	0.4	1.4	1.8	0.2	1.1	1.3
R23	0.9	1.8	2.7	0.7	1.4	2.1	0.5	1.1	1.6
R24	0.6	1.8	2.4	0.5	1.4	1.9	0.3	1.1	1.4
R25	0.3	1.8	2.1	0.2	1.4	1.6	0.2	1.1	1.3
R26	0.7	1.8	2.5	0.6	1.4	2.0	0.3	1.1	1.4
R27	0.9	1.8	2.7	0.7	1.4	2.1	0.4	1.1	1.5
R28	0.8	1.8	2.6	0.6	1.4	2.0	0.4	1.1	1.5
R29	1.1	1.8	2.9	0.8	1.4	2.2	0.5	1.1	1.6
R30	1.0	1.8	2.8	0.8	1.4	2.2	0.4	1.1	1.5
R31	1.5	1.8	3.3	1.1	1.4	2.5	0.4	1.1	1.5
R32	0.9	1.8	2.7	0.7	1.4	2.1	0.3	1.1	1.4
R33	0.6	1.8	2.4	0.4	1.4	1.8	0.3	1.1	1.4
R34	1.1	1.8	2.9	0.8	1.4	2.2	0.4	1.1	1.5
R35	0.3	1.8	2.1	0.2	1.4	1.6	0.2	1.1	1.3
R36	1.2	1.8	3.0	0.9	1.4	2.3	0.5	1.1	1.6

Receptor	Carbon monoxide (CO) concentration (mg-m ⁻³)								
	15-minute			1-hour			8-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R37	1.5	1.8	3.3	1.2	1.4	2.6	0.6	1.1	1.7
R38	1.0	1.8	2.8	0.8	1.4	2.2	0.4	1.1	1.5
R39	1.0	1.8	2.8	0.8	1.4	2.2	0.4	1.1	1.5
R40	3.2	1.8	5.0	2.4	1.4	3.8	1.8	1.1	2.9
R41	1.0	1.8	2.8	0.8	1.4	2.2	0.6	1.1	1.7
R42	0.9	1.8	2.7	0.7	1.4	2.1	0.4	1.1	1.5
R43	0.9	1.8	2.7	0.7	1.4	2.1	0.4	1.1	1.5
R44	1.1	1.8	2.9	0.8	1.4	2.2	0.5	1.1	1.6
R45	0.3	1.8	2.1	0.2	1.4	1.6	0.2	1.1	1.3
R46	1.0	1.8	2.8	0.8	1.4	2.2	0.4	1.1	1.5
R47	1.2	1.8	3.0	0.9	1.4	2.3	0.4	1.1	1.5

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 25 Predicted 1-hour and 24-hour SO₂ concentrations – Scenario 1

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	215			57		
Max. % of criterion	< 0.1	20.0	20.0	< 0.1	15.1	15.2
R1	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R2	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R3	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R4	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R5	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R6	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R7	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R8	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R9	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R10	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R11	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R12	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R13	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R14	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R15	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R16	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R17	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R18	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R19	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R20	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R21	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R22	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R23	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R24	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R25	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R26	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R27	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R28	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R29	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R30	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R31	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R32	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R33	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R34	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R35	< 0.1	42.9	43.0	< 0.1	8.6	8.7

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R36	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R37	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R38	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R39	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R40	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R41	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R42	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R43	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R44	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R45	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R46	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R47	< 0.1	42.9	43.0	< 0.1	8.6	8.7

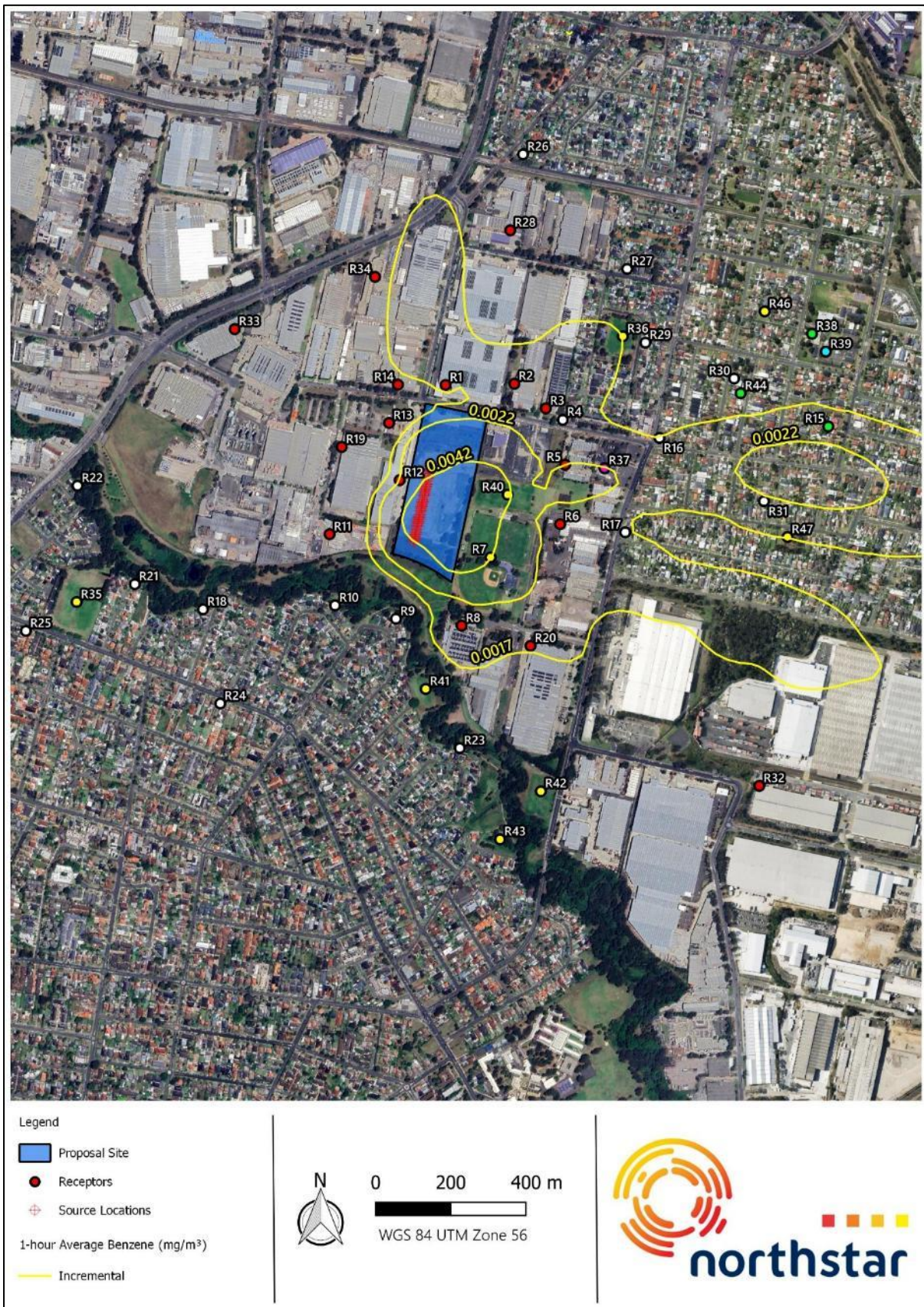
Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 26 Predicted maximum incremental 1-hour PAH, benzene, and formaldehyde concentrations – Scenario 1 (Proposal only)

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	15.7	0.5	0.6	2.3
R1	2.67E-08	1.80E-03	6.49E-04	4.53E-04	1.83E-04
R2	2.90E-08	1.95E-03	7.05E-04	4.92E-04	1.98E-04
R3	2.91E-08	1.96E-03	7.08E-04	4.94E-04	1.99E-04
R4	2.71E-08	1.83E-03	6.59E-04	4.59E-04	1.85E-04
R5	3.25E-08	2.19E-03	7.91E-04	5.51E-04	2.23E-04
R6	3.09E-08	2.08E-03	7.52E-04	5.24E-04	2.12E-04
R7	6.76E-08	4.55E-03	1.64E-03	1.15E-03	4.62E-04
R8	3.01E-08	2.03E-03	7.31E-04	5.10E-04	2.06E-04
R9	1.86E-08	1.25E-03	4.51E-04	3.15E-04	1.27E-04
R10	1.55E-08	1.05E-03	3.78E-04	2.63E-04	1.06E-04
R11	1.46E-08	9.82E-04	3.54E-04	2.47E-04	9.97E-05
R12	2.97E-08	2.00E-03	7.22E-04	5.03E-04	2.03E-04
R13	1.50E-08	1.01E-03	3.65E-04	2.54E-04	1.03E-04
R14	2.34E-08	1.58E-03	5.70E-04	3.97E-04	1.60E-04
R15	2.94E-08	1.98E-03	7.15E-04	4.99E-04	2.01E-04
R16	2.51E-08	1.69E-03	6.11E-04	4.26E-04	1.72E-04
R17	2.57E-08	1.73E-03	6.26E-04	4.36E-04	1.76E-04
R18	8.98E-09	6.05E-04	2.18E-04	1.52E-04	6.14E-05
R19	1.40E-08	9.42E-04	3.40E-04	2.37E-04	9.57E-05
R20	2.58E-08	1.74E-03	6.26E-04	4.37E-04	1.76E-04
R21	7.43E-09	5.01E-04	1.81E-04	1.26E-04	5.09E-05
R22	1.11E-08	7.47E-04	2.70E-04	1.88E-04	7.59E-05
R23	1.97E-08	1.33E-03	4.79E-04	3.34E-04	1.35E-04
R24	1.32E-08	8.88E-04	3.21E-04	2.23E-04	9.02E-05
R25	6.91E-09	4.65E-04	1.68E-04	1.17E-04	4.73E-05
R26	1.62E-08	1.09E-03	3.94E-04	2.75E-04	1.11E-04
R27	1.89E-08	1.27E-03	4.60E-04	3.20E-04	1.29E-04
R28	1.74E-08	1.17E-03	4.24E-04	2.95E-04	1.19E-04
R29	2.29E-08	1.54E-03	5.57E-04	3.88E-04	1.57E-04
R30	2.20E-08	1.48E-03	5.35E-04	3.73E-04	1.51E-04
R31	3.18E-08	2.14E-03	7.72E-04	5.38E-04	2.17E-04
R32	2.05E-08	1.38E-03	4.98E-04	3.47E-04	1.40E-04
R33	1.28E-08	8.62E-04	3.11E-04	2.17E-04	8.76E-05
R34	2.35E-08	1.58E-03	5.72E-04	3.98E-04	1.61E-04
R35	7.03E-09	4.74E-04	1.71E-04	1.19E-04	4.81E-05

Receptor	Maximum 1-hour average concentration (mg·m ⁻³)				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
R36	2.52E-08	1.70E-03	6.13E-04	4.27E-04	1.72E-04
R37	3.31E-08	2.23E-03	8.05E-04	5.61E-04	2.26E-04
R38	2.21E-08	1.49E-03	5.37E-04	3.74E-04	1.51E-04
R39	2.27E-08	1.53E-03	5.51E-04	3.84E-04	1.55E-04
R40	6.83E-08	4.60E-03	1.66E-03	1.16E-03	4.67E-04
R41	2.16E-08	1.45E-03	5.25E-04	3.66E-04	1.48E-04
R42	1.93E-08	1.30E-03	4.70E-04	3.28E-04	1.32E-04
R43	1.88E-08	1.27E-03	4.58E-04	3.19E-04	1.29E-04
R44	2.33E-08	1.57E-03	5.67E-04	3.95E-04	1.60E-04
R45	6.63E-09	4.47E-04	1.61E-04	1.12E-04	4.54E-05
R46	2.17E-08	1.46E-03	5.28E-04	3.68E-04	1.49E-04
R47	2.53E-08	1.70E-03	6.14E-04	4.28E-04	1.73E-04

Figure 9 Predicted maximum incremental 1-hour benzene impacts – Scenario 1



Source: Northstar

7.1.4. Assessment of Criteria Exceedances

Presented in Table 27 is a summary of the number of additional exceedances of the short-term PM₁₀, PM_{2.5} and NO₂ criteria, and those values presented as a probability ($p=0$ being impossible, $p=1$ being certain). These values are discussed further in Section 8.2.

Table 27 Assessment of the number of additional exceedances – Scenario 1

Receptor	Number of additional exceedances of the criterion			Probability (p) 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	0	1	1	-	0.0027	0.0001
R2	0	1	95	-	0.0027	0.0108
R3	0	7	361	-	0.0192	0.0412
R4	0	8	444	-	0.0219	0.0507
R5	0	17	337	-	0.0466	0.0385
R6	0	4	270	-	0.0110	0.0308
R7	7	38	302	0.0192	0.1041	0.0345
R8	0	4	60	-	0.0110	0.0068
R9	1	1	2	0.0027	0.0027	0.0002
R10	0	1	11	-	0.0027	0.0013
R11	0	0	2	-	-	0.0002
R12	1	4	0	0.0027	0.0110	-
R13	0	0	0	-	-	-
R14	0	0	1	-	-	0.0001
R15	0	1	271	-	0.0027	0.0309
R16	0	1	348	-	0.0027	0.0397
R17	0	2	267	-	0.0055	0.0305
R18	0	0	23	-	-	0.0026
R19	0	0	0	-	-	-
R20	0	2	122	-	0.0055	0.0139
R21	0	0	36	-	-	0.0041
R22	0	0	34	-	-	0.0039
R23	0	1	139	-	0.0027	0.0159
R24	0	1	79	-	0.0027	0.0090
R25	0	0	69	-	-	0.0079
R26	0	0	142	-	-	0.0162
R27	0	1	294	-	0.0027	0.0336
R28	0	0	132	-	-	0.0151
R29	0	2	463	-	0.0055	0.0529
R30	0	1	384	-	0.0027	0.0438
R31	0	1	261	-	0.0027	0.0298

Receptor	Number of additional exceedances of the criterion			Probability (p) 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
R32	0	1	146	-	0.0027	0.0167
R33	0	0	27	-	-	0.0031
R34	0	0	43	-	-	0.0049
R35	0	0	52	-	-	0.0059
R36	0	2	421	-	0.0055	0.0481
R37	0	7	357	-	0.0192	0.0408
R38	0	1	394	-	0.0027	0.0450
R39	0	1	363	0.0000	0.0027	0.0414
R40	30	87	805	0.0822	0.2384	0.0919
R41	0	2	72	-	0.0055	0.0082
R42	0	0	141	-	-	0.0161
R43	0	0	155	-	-	0.0177
R44	0	1	346	-	0.0027	0.0395
R45	0	0	88	-	-	0.0100
R46	0	1	449	-	0.0027	0.0513
R47	0	1	241	-	0.0027	0.0275

Note: care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of all back-up generators for an entire 24-hour period).

7.2. Scenario 2 – Realistic Operations

Presented below are the results of the modelling assessment under the assumptions of Scenario 2 (refer Section 5.2.2) with 4 no generators operating (two at 100 % load and two at 0% load) for each specified testing hour (24-hours). It is noted that the likely maintenance scenario would include those generators operating concurrently between the hours of 7:00 am and 6:00 pm, Monday to Saturday, and 8:00 am and 6:00 pm, Sundays and public holidays.

7.2.1. Particulate Matter

7.2.1.1. Annual Average TSP, PM₁₀ and PM_{2.5} Concentrations

The predicted annual average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}) resulting from Scenario 2 operations are presented in Table 28. Predicted incremental concentrations of TSP, PM₁₀ and PM_{2.5} at all receptor locations are low.

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

Table 28 Predicted annual average TSP, PM₁₀ and PM_{2.5} concentrations – Scenario 2

Receptor	Annual average concentration (µg·m ⁻³)								
	TSP			PM ₁₀			PM _{2.5}		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	90			25			8		
Max. % of criterion	0.2	39.0	39.3	0.8	68.4	69.2	2.4	82.5	84.9
R1	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R2	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R3	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R4	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R5	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R6	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R7	0.2	35.1	35.3	0.2	17.1	17.3	0.2	6.6	6.8
R8	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R9	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R10	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R11	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R12	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R13	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R14	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R15	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R16	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R17	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R18	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R19	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R20	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R21	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R22	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R23	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R24	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R25	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R26	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R27	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R28	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R29	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R30	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R31	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R32	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R33	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R34	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R35	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R36	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7

Receptor	Annual average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)								
	TSP			PM ₁₀			PM _{2.5}		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R37	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R38	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R39	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R40	0.1	35.1	35.3	0.1	17.1	17.2	0.1	6.6	6.7
R41	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R42	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R43	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R44	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R45	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R46	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7
R47	<0.1	35.1	35.2	<0.1	17.1	17.2	<0.1	6.6	6.7

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

7.2.1.2. Maximum 24-Hour PM₁₀ and PM_{2.5} Concentrations

Table 29 presents the maximum 24-hour average PM₁₀ and PM_{2.5} concentrations predicted to occur at the nearest receptors, as a result of the Proposal operations under Scenario 2. No background concentrations are included within this table.

The predicted incremental concentrations of PM₁₀ and PM_{2.5} are demonstrated to be minor at all receptor locations with the Proposal in operation, under the testing regime.

An assessment of the 24-hour PM₁₀ and PM_{2.5} concentrations with background included is not presented, as the concentrations are predominantly driven by background conditions. The addition of the predicted increments presented in Table 29 for the Proposal do not result in any additional exceedances of the criteria at any receptor location.

As discussed in Section 5.2.5, the emission rate of PM_{2.5} is the same as PM₁₀, as all of the PM₁₀ particles are assessed as being $\leq 2.5 \mu\text{m}$ in diameter (PM_{2.5}). A contour plot of the predicted incremental 24-hour PM₁₀ concentrations associated with the Proposal under Scenario 2 is presented in Figure 10 to allow examination of the distribution of particulate matter (both PM₁₀ and PM_{2.5}) in the area surrounding the Proposal site.

Table 29 Predicted maximum incremental 24-hour PM₁₀ and PM_{2.5} concentrations – Scenario 2

Receptor	Maximum 24-hour average concentration (µg·m ⁻³)	
	PM ₁₀	PM _{2.5}
Criterion	50	25
Max. % of criterion	3.9	7.9
R1	0.2	0.2
R2	0.4	0.4
R3	0.6	0.6
R4	0.6	0.6
R5	0.6	0.6
R6	0.5	0.5
R7	2.0	2.0
R8	0.9	0.9
R9	0.6	0.6
R10	0.5	0.5
R11	0.5	0.5
R12	0.3	0.3
R13	0.3	0.3
R14	0.2	0.2
R15	0.3	0.3
R16	0.5	0.5
R17	0.4	0.4
R18	0.3	0.3
R19	0.2	0.2
R20	0.5	0.5
R21	0.2	0.2
R22	0.2	0.2
R23	0.5	0.5
R24	0.3	0.3
R25	0.1	0.1
R26	0.1	0.1
R27	0.3	0.3
R28	0.2	0.2
R29	0.4	0.4
R30	0.4	0.4
R31	0.2	0.2
R32	0.2	0.2
R33	0.2	0.2
R34	0.2	0.2
R35	0.2	0.2
R36	0.3	0.3
R37	0.5	0.5
R38	0.3	0.3

Receptor	Maximum 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM ₁₀	PM _{2.5}
R39	0.3	0.3
R40	1.0	1.0
R41	0.6	0.6
R42	0.4	0.4
R43	0.4	0.4
R44	0.3	0.3
R45	0.1	0.1
R46	0.4	0.4
R47	0.2	0.2

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 PM₁₀ (PM_{2.5} is a subset of PM₁₀) and therefore the results will be consistent between PM₁₀ and PM_{2.5} for these emissions sources.

A contemporaneous analysis of the 24-hour PM₁₀ and PM_{2.5} data has been performed where each predicted incremental concentration is added to the corresponding monitored background concentration, in accordance with Section 11.2.3(b) of the Approved Methods.

Table 30 and Table 31 present the predicted maximum 24-hour average PM₁₀ and PM_{2.5} concentrations resulting from the operation of the Proposal through Scenario 2, with the corresponding background included for each day. Results are presented in Table 30 and Table 31 for those receptors at which the greatest impacts have been predicted (see Table 29).

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.

For PM₁₀ and PM_{2.5}, the maximum cumulative impacts (the left-hand side of Table 30 and Table 31) and the maximum incremental impact (the right-hand side of Table 30 and Table 31)) are predicted at receptor R7.

A contour plot of the predicted incremental 24-hour PM₁₀ concentrations associated with the Proposal are presented in Figure 7 to allow examination of the distribution of particulate matter in the area surrounding the Proposal.

Table 30 Summary of contemporaneous 24-hour PM₁₀ concentrations – Scenario 2

Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R7			Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor R7		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
04/05/2021	0.6	42.5	43.1	20/04/2021	2.0	23.8	25.8
19/01/2021	<0.1	40.6	40.7	09/09/2021	1.9	13.7	15.6
09/10/2021	0.2	39.9	40.1	21/08/2021	1.7	32.0	33.7
27/04/2021	<0.1	38.3	38.4	24/03/2021	1.7	8.5	10.2
16/04/2021	<0.1	38.1	38.2	25/06/2021	1.6	8.9	10.5
02/03/2021	<0.1	37.5	37.6	13/07/2021	1.5	10.9	12.4
02/06/2021	0.3	37.1	37.4	24/07/2021	1.5	7.7	9.2
29/10/2021	0.3	37.0	37.3	28/07/2021	1.4	10.4	11.8
23/01/2021	0.5	36.6	37.1	26/07/2021	1.4	8.2	9.6
30/04/2021	<0.1	35.9	36.0	24/09/2021	1.4	13.7	15.1
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.			

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 31 Summary of contemporaneous 24-hour PM_{2.5} concentrations – Scenario 2

Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R7			Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor R7		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
21/08/2021	1.7	27.4	29.1	20/04/2021	2.0	11.9	13.9
04/05/2021	0.6	26.8	27.4	09/09/2021	1.9	5.6	7.5
09/10/2021	0.2	25.8	26.0	21/08/2021	1.7	27.4	29.1
08/07/2021	<0.1	23.0	23.1	24/03/2021	1.7	1.2	2.9
09/07/2021	<0.1	22.9	23.0	25/06/2021	1.6	5.7	7.3
22/08/2021	1.0	21.2	22.2	13/07/2021	1.5	6.9	8.4
14/08/2021	<0.1	19.8	19.9	24/07/2021	1.5	7.1	8.6
27/04/2021	<0.1	18.2	18.3	28/07/2021	1.4	2.8	4.2
29/08/2021	0.5	17.4	17.9	26/07/2021	1.4	2.6	4.0
10/10/2021	0.2	17.3	17.5	24/09/2021	1.4	5.4	6.8
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.			

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Figure 10 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ impacts – Scenario 2



Source: Northstar

7.2.2. Nitrogen Dioxide

Results are presented in this section for the predictions of nitrogen dioxide (NO₂) under Scenario 2. The averaging periods associated with the criteria for these pollutants is 1-hour and an annual average, as specified in Table 9.

The predicted maximum 1-hour and annual average NO₂ concentrations resulting from the assumptions under Scenario 2, are presented in Table 32.

The results indicate that predicted incremental and cumulative hourly NO₂ concentrations are below the criteria at all surrounding receptor locations.

The performance of the Proposal under Scenario 2 does not result in any exceedances of the criteria for NO₂.

A contour plot of the predicted maximum 1-hour incremental NO₂ impact is presented in Figure 11.

Table 32 Predicted 1-hour and annual average NO₂ concentrations – Scenario 2

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)					
	1-hour average			Annual average		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	164			31		
Max. % of criterion	22.9	21.3	35.2	2.8	49.0	51.8
R1	5.4	4.1	9.5	0.2	15.2	15.4
R2	8.2	10.3	18.5	0.4	15.2	15.6
R3	10.0	34.9	44.8	0.6	15.2	15.8
R4	10.9	22.6	33.4	0.6	15.2	15.8
R5	13.9	26.7	40.6	0.5	15.2	15.7
R6	11.3	18.5	29.7	0.4	15.2	15.6
R7	37.5	2.1	39.5	0.9	15.2	16.1
R8	13.6	<0.1	13.6	0.5	15.2	15.7
R9	13.0	16.4	29.4	0.6	15.2	15.8
R10	13.1	<0.1	13.2	0.5	15.2	15.7
R11	14.5	28.7	43.2	0.4	15.2	15.6
R12	6.0	8.2	14.2	<0.1	15.2	<15.3
R13	4.9	8.2	13.1	0.1	15.2	15.3
R14	4.6	4.1	8.7	0.1	15.2	15.3
R15	31.0	26.7	57.7	0.4	15.2	15.6
R16	17.3	26.7	43.9	0.5	15.2	15.7
R17	14.6	4.1	18.7	0.4	15.2	15.6
R18	22.3	28.7	51.0	0.4	15.2	15.6
R19	7.1	18.5	25.6	0.1	15.2	15.3
R20	17.9	2.1	19.9	0.4	15.2	15.6
R21	17.6	6.2	23.8	0.3	15.2	15.5
R22	9.6	4.1	13.7	0.2	15.2	15.4
R23	14.0	8.2	22.2	0.5	15.2	15.7
R24	16.2	<0.1	16.3	0.4	15.2	15.6
R25	20.4	6.2	26.5	0.3	15.2	15.5
R26	10.7	4.1	14.8	0.2	15.2	15.4
R27	13.6	10.3	23.9	0.5	15.2	15.7
R28	10.5	30.8	41.2	0.2	15.2	15.4
R29	12.8	34.9	47.6	0.6	15.2	15.8
R30	16.8	22.6	39.4	0.5	15.2	15.7
R31	17.4	26.7	44.0	0.4	15.2	15.6
R32	20.5	24.6	45.1	0.2	15.2	15.4
R33	6.8	2.1	8.9	0.2	15.2	15.4
R34	8.2	28.7	36.9	0.3	15.2	15.5
R35	18.4	6.2	24.5	0.3	15.2	15.5
R36	14.0	10.3	24.2	0.6	15.2	15.8

Receptor	Nitrogen dioxide (NO ₂) concentration (µg·m ⁻³)					
	1-hour average			Annual average		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R37	15.0	2.1	17.0	0.5	15.2	15.7
R38	21.8	22.6	44.4	0.5	15.2	15.7
R39	22.0	22.6	44.6	0.5	15.2	15.7
R40	14.0	28.7	42.7	0.5	15.2	15.7
R41	18.8	2.1	20.9	0.5	15.2	15.7
R42	17.4	10.3	27.7	0.4	15.2	15.6
R43	19.1	14.4	33.4	0.4	15.2	15.6
R44	18.6	26.7	45.3	0.5	15.2	15.7
R45	21.6	28.7	50.3	0.3	15.2	15.5
R46	19.9	34.9	54.8	0.6	15.2	15.8
R47	19.9	18.5	38.4	0.3	15.2	15.5

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Figure 11 Predicted maximum incremental 1-hour NO₂ impacts – Scenario 2



Source: Northstar

7.2.3. All Other Pollutants

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

Presented in Table 33 to Table 35 are the predicted concentrations of CO, SO₂, PAHs, VOCs, and CH₂O at varying averaging periods at the surrounding receptors.

A contour plot of the predicted maximum 1-hour incremental benzene impact is presented in Figure 12.

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

Table 33 Predicted 15-minute, 1-hour, and 8-hour average CO concentrations – Scenario 2

Receptor	Carbon monoxide (CO) concentration (mg·m ⁻³)								
	15-minute			1-hour			8-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	100			30			10		
Max. % of criterion	0.2	1.8	2.0	0.4	4.7	5.1	<1	11.0	11.5
R1	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R2	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R3	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R4	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R5	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R6	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R7	0.2	1.8	2.0	0.1	1.4	1.5	<0.1	1.1	1.2
R8	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R9	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R10	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R11	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R12	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R13	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R14	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R15	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R16	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R17	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R18	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R19	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R20	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R21	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R22	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R23	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R24	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R25	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R26	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R27	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R28	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R29	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R30	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R31	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R32	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R33	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R34	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R35	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R36	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R37	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2

Receptor	Carbon monoxide (CO) concentration (mg·m ⁻³)								
	15-minute			1-hour			8-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R38	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R39	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R40	0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R41	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R42	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R43	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R44	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R45	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R46	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2
R47	<0.1	1.8	1.9	<0.1	1.4	1.5	<0.1	1.1	1.2

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 34 Predicted 1-hour and 24-hour SO₂ concentrations – Scenario 2

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	215			57		
Max. % of criterion	< 0.1	20.0	20.0	< 0.1	15.1	15.2
R1	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R2	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R3	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R4	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R5	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R6	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R7	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R8	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R9	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R10	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R11	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R12	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R13	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R14	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R15	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R16	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R17	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R18	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R19	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R20	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R21	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R22	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R23	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R24	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R25	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R26	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R27	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R28	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R29	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R30	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R31	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R32	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R33	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R34	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R35	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R36	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R37	< 0.1	42.9	43.0	< 0.1	8.6	8.7

Receptor	Sulphur dioxide (SO ₂) concentration (µg·m ⁻³)					
	1-hour			24-hour		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R38	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R39	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R40	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R41	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R42	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R43	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R44	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R45	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R46	< 0.1	42.9	43.0	< 0.1	8.6	8.7
R47	< 0.1	42.9	43.0	< 0.1	8.6	8.7

Notes: Incr. – Incremental, Bkg. – Background, - Cumul. – Cumulative.

Table 35 Predicted maximum incremental 1-hour PAH, benzene, and formaldehyde concentrations – Scenario 2 (Proposal only)

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	0.8	<0.1	<0.1	0.1
R1	6.65E-10	4.48E-05	1.62E-05	1.13E-05	4.55E-06
R2	8.72E-10	5.88E-05	2.12E-05	1.48E-05	5.97E-06
R3	9.87E-10	6.65E-05	2.40E-05	1.67E-05	6.76E-06
R4	1.00E-09	6.76E-05	2.44E-05	1.70E-05	6.87E-06
R5	1.37E-09	9.21E-05	3.32E-05	2.32E-05	9.35E-06
R6	1.03E-09	6.95E-05	2.51E-05	1.75E-05	7.06E-06
R7	3.66E-09	2.46E-04	8.90E-05	6.20E-05	2.50E-05
R8	1.12E-09	7.56E-05	2.73E-05	1.90E-05	7.68E-06
R9	9.23E-10	6.22E-05	2.24E-05	1.56E-05	6.32E-06
R10	8.99E-10	6.06E-05	2.19E-05	1.52E-05	6.15E-06
R11	9.11E-10	6.14E-05	2.22E-05	1.54E-05	6.24E-06
R12	1.05E-09	7.05E-05	2.55E-05	1.77E-05	7.16E-06
R13	6.11E-10	4.12E-05	1.49E-05	1.04E-05	4.18E-06
R14	5.18E-10	3.49E-05	1.26E-05	8.77E-06	3.54E-06
R15	1.08E-09	7.26E-05	2.62E-05	1.83E-05	7.37E-06
R16	1.01E-09	6.80E-05	2.45E-05	1.71E-05	6.90E-06
R17	1.07E-09	7.22E-05	2.60E-05	1.82E-05	7.33E-06
R18	6.27E-10	4.22E-05	1.52E-05	1.06E-05	4.29E-06
R19	5.30E-10	3.57E-05	1.29E-05	8.99E-06	3.63E-06
R20	7.77E-10	5.24E-05	1.89E-05	1.32E-05	5.32E-06
R21	3.61E-10	2.43E-05	8.78E-06	6.12E-06	2.47E-06
R22	2.58E-10	1.74E-05	6.28E-06	4.38E-06	1.77E-06
R23	6.42E-10	4.32E-05	1.56E-05	1.09E-05	4.39E-06
R24	5.94E-10	4.00E-05	1.44E-05	1.01E-05	4.06E-06
R25	3.84E-10	2.58E-05	9.33E-06	6.50E-06	2.62E-06
R26	4.66E-10	3.14E-05	1.13E-05	7.89E-06	3.19E-06
R27	6.51E-10	4.39E-05	1.58E-05	1.10E-05	4.46E-06
R28	5.54E-10	3.73E-05	1.35E-05	9.38E-06	3.79E-06
R29	6.86E-10	4.62E-05	1.67E-05	1.16E-05	4.70E-06
R30	7.25E-10	4.88E-05	1.76E-05	1.23E-05	4.96E-06
R31	7.17E-10	4.83E-05	1.74E-05	1.22E-05	4.91E-06
R32	6.66E-10	4.49E-05	1.62E-05	1.13E-05	4.56E-06
R33	3.17E-10	2.13E-05	7.71E-06	5.37E-06	2.17E-06
R34	6.41E-10	4.32E-05	1.56E-05	1.09E-05	4.38E-06
R35	3.75E-10	2.53E-05	9.13E-06	6.36E-06	2.57E-06

Receptor	Maximum 1-hour average concentration (mg·m ⁻³)				
	PAH	Benzene	Toluene (odour)	Xylene (odour)	Formaldehyde
R36	7.95E-10	5.36E-05	1.93E-05	1.35E-05	5.44E-06
R37	1.12E-09	7.58E-05	2.74E-05	1.91E-05	7.70E-06
R38	7.47E-10	5.03E-05	1.82E-05	1.27E-05	5.11E-06
R39	7.40E-10	4.99E-05	1.80E-05	1.25E-05	5.07E-06
R40	2.31E-09	1.56E-04	5.62E-05	3.92E-05	1.58E-05
R41	8.00E-10	5.39E-05	1.94E-05	1.36E-05	5.47E-06
R42	6.57E-10	4.42E-05	1.60E-05	1.11E-05	4.49E-06
R43	7.22E-10	4.86E-05	1.76E-05	1.22E-05	4.94E-06
R44	7.98E-10	5.38E-05	1.94E-05	1.35E-05	5.46E-06
R45	3.12E-10	2.10E-05	7.58E-06	5.28E-06	2.13E-06
R46	7.41E-10	4.99E-05	1.80E-05	1.26E-05	5.07E-06
R47	7.39E-10	4.98E-05	1.80E-05	1.25E-05	5.05E-06

Figure 12 Predicted maximum incremental 1-hour benzene impacts – Scenario 2



Source: Northstar

7.3. Comparison with POEO (Clean Air) Regulation Standards of Concentrations

Section 3.2 outlines the context of the POEO CAR and the emission standards applicable to activities and plants, categorised as scheduled or non-scheduled under the regulation.

As detailed in Section 2.2, the Proposal is expected to include the following relevant characteristics:

- 67 no. diesel generators, each with a capacity of 2.5 MW;
- 1 no. diesel generator, with a capacity of 0.5 MW;
- A maintenance testing regime totalling 192.83 hours per year; and
- Maximum fuel storage capacity of less than 2 000 t.

Clause 73, Part 5, Division 6 of the POEO CAR exempts emergency electricity generation using stationary reciprocal internal combustion engines from the air impurities standards for nitrogen dioxide (NO₂) and nitric oxide (NO) specified in Schedule 2, Part 2, Division 3, provided the engines operate for no more than 200 hours per year.

Based on the maintenance schedule presented in Table 7 and the anticipated diesel fuel storage capacity (refer Section 3.1) the Proposal site is considered a non-scheduled activity for electricity generation and chemical storage under the POEO Act. Correspondingly, the Proposal must comply with the concentration standards for non-scheduled activities outlined in Schedule 2, Part 3 of the POEO CAR (refer Section 3.2).

Table 36 below compares the emissions from individual data centre generators at the Proposal site against the respective concentration standards.

Table 36 POEO CAR – Standards of concentrations comparison

Air impurity	Standard of concentration (mg·m ⁻³) ^(A)	Standby generator emissions (mg·m ⁻³) ^(B)	
		MTU 20V4000G74F	MTU 16V2000DS1100
Solid particles (Total)	100	14.5	14.1

Notes: (A) Standard of emissions concentration under dry, 273 K, 101.3 kPa, 7 % O₂ conditions

(B) The Proposal's generator emissions above are based on the mg·Nm⁻³ generator emission data in Appendix F, assumed as dry, 273 K, 101.3 kPa and 5 % O₂ content, which were then converted into 7 % O₂ content as per the POEO CAR requirements.

Table 36 shows that the respective concentration standards can be met with the use of the standby diesel generators at the Proposal site.

8. DISCUSSION AND CONCLUSION

This AQIA has been prepared by Northstar on behalf of Goodman for the proposed development of a data centre, to be located at 132 McCredie Road, Smithfield NSW.

The assessment evaluates the potential air quality impacts during both construction and operation phases, with a focus on dust soiling and increased ambient PM₁₀ (including PM_{2.5}) concentrations due to dust arising from construction activities on the Proposal site, and combustion emissions from standby diesel generator engines during operations.

Data provided by the Proponent and publicly available environmental data were used.

8.1. Construction Phase Risk Assessment

The construction phase risk assessment for the Proposal, presented in Section 6 indicates that dust soiling impacts are associated with medium risks of all construction phase activities while human health impacts are associated with low risks of all construction phase activities if no mitigation measures were to be applied to control emissions.

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 C. With the implementation of the mitigation measures outlined in Appendix C, the remaining construction-phase risks associated with the Proposal are appropriate and acceptable.

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.

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.

8.2.1. Scenario 1 – Justified Worst Case Operations

Under the justified worst-case standby generator operational scenario (Scenario 1), a number of additional exceedances of the short-term air quality criteria for PM₁₀, PM_{2.5} and NO₂ are predicted.

Note: care must be applied when assessing 24-hour average impacts as the likely duration of a power outage event is likely to be significantly less than 24-hours, and as such the assessment should be considered to be highly conservative (i.e. relevant to the operation of all back-up generators for an entire 24-hour period).

That scenario assumes that all 68 no. generators would be operational at one time. The predicted incremental concentrations under Scenario 1 show exceedances of particulate matter and NO₂ at sensitive receptor locations if a power outage occurred, and all 68 no. emergency generators were operating at 100 % load continuously (refer Section 7.1).

An assessment of the probability (p) of an exceedance of the relevant short-term PM₁₀, PM_{2.5} and NO₂ criteria has been performed and is presented in Section 7.1.4. As a maximum across all receptors, the probability of an exceedance of the PM₁₀, PM_{2.5} or NO₂ criterion (where $p=0$ is an impossible event, and $p=1$ is a certain event) in any year is as follows:

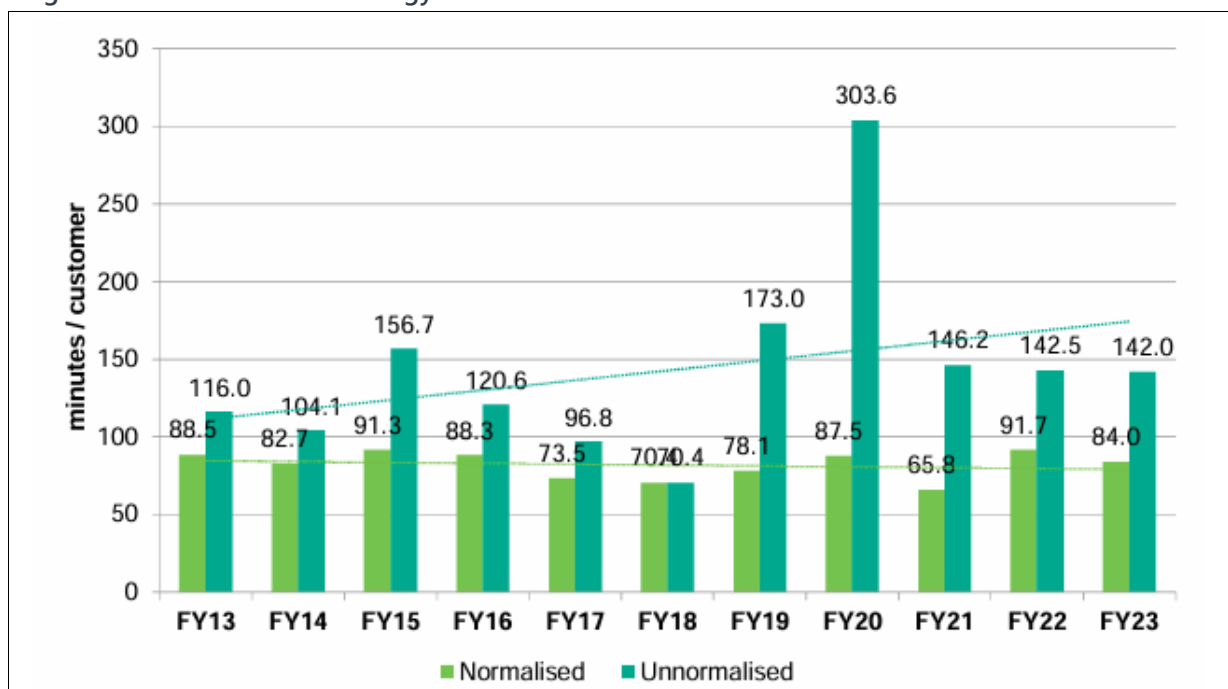
- PM₁₀: $p=0.0822$;
- PM_{2.5}: $p=0.2384$; and
- NO₂: $p=0.0919$.

To predict the likelihood of exceedances under the worst-case scenario (i.e. all 68 no. generators operating continuously at 100 % load), the reliability of the power network was considered against the latest information supplied in the 2024 Distribution Annual Planning Report (DAPR) from Endeavour Energy (Endeavour Energy, 2024).

Based on the DAPR and associated network reliability statistics, the average unplanned outage duration per year per customer from financial-year 2013 to financial-year 2023 equates to approximately 82.0 minutes, although exact duration of power outages requiring standby generators cannot be determined. Correspondingly, the likelihood of power interruptions occurring is approximately 0.016 % of the time per year ($82.0 / (8\,760 \times 60)$) or have a probability of $p=0.00016$.

Figure 13 depicts the normalised (i.e. Major Event Days data excluded) system average interruption duration index (SAIDI, in minutes) and unnormalised (i.e. inclusion of all events) SAIDI trends over an eleven financial-year period from 2013 to 2023.

Figure 13 Endeavour Energy SAIDI Performance Information



Source: (Endeavour Energy, 2024)

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 37 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.

Table 37 Chance of an exceedance during a power outage

Number of years	Percentage chance of an additional exceedance of the short-term criterion during a power outage (%)		
	24-hour PM ₁₀	24-hour PM _{2.5}	1-hour NO ₂
100	0.13	0.37	0.14
200	0.26	0.74	0.29
500	0.64	1.84	0.71
1 000	1.27	3.65	1.42
1 250	1.59	4.54	1.78

8.2.2. Scenario 2 – Realistic Operations

Annual average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}) resulting from Scenario 2 are all predicted to comply with the relevant impact assessment criteria, with no exceedances predicted.

Under Scenario 2, no additional exceedances of the cumulative impact assessment criteria for 24-hour PM₁₀ are predicted as a result of the Proposal. While several cumulative exceedances of the 24-hour PM_{2.5} criterion are identified in Table 32, these are attributable to elevated background concentrations that already exceed the relevant criterion and are not related to emissions from the Proposal. The Proposal does not contribute to any additional exceedances.

For 1-hour and annual average NO₂, no cumulative exceedances are predicted due to the Proposal. Predicted incremental and cumulative 1-hour NO₂ concentrations remain below the relevant criteria at all considered receptor locations.

Predicted concentrations of CO, SO₂, PAHs, VOCs, and formaldehyde (CH₂O) across all assessed averaging periods are also below the relevant impact assessment criteria at all receptor locations under Scenario 2.

Correspondingly, it is anticipated that under operation of the testing schedule as outlined in Table 7, or testing four (4) generators concurrently (two at 100 % load and two at 0 % load), and performed over a 24-hour period, no significant air quality impacts are predicted to be experienced at sensitive receptors.

8.2.3. POEO (Clean Air) Regulation – Standard of Concentrations

Section 7.3 assesses generator emissions against the applicable POEO CAR concentration standards for non-scheduled activities, demonstrating compliance with the total solid particles and VOC standards.

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. This is achievable under the proposed maintenance regime, whilst the likelihood of exceedance during the emergency scenario has been shown to be low.

8.2.4. Recommended Mitigation Measures

Based on the findings of the dispersion modelling assessment under Scenario 2, it is considered that the operation of the maintenance 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 2.2. Operation of the emergency generators should be minimised as far as practicably possible.

8.2.5. Additional Mitigation Measures

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

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 7.2) and correspondingly, the additional controls discussed in Appendix G have been reviewed to solely provide context for how air quality impacts may be further reduced.

8.2.6. Odour

Operational phase activities will not result in any odour emissions, with the exception of the periodic operation of the diesel-fuelled generators for testing and back-up power generation purposes only, as outlined.

Air emissions of VOCs have been assessed as benzene (C_6H_6) as a principal toxic air pollutant, with anticipated emissions of toluene (C_7H_8) and xylene (C_8H_{10}) assessed and compared against the relevant odour impact assessment criteria. No exceedances of the relevant odour criteria are predicted during either emergency or realistic operations.

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. With the implementation of the mitigation measures as part of a Construction Environmental Management Plan (CEMP) that the remaining construction-phase risks associated with the Proposal are appropriate and acceptable.

During the operational phase, based upon the information presented in this AQIA, the operation of the Proposal is not considered likely to result in additional exceedances of the relevant air quality criteria at any identified receptor location. 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 Abbreviations and Units

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

Commonly used SI-derived and non-SI units

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

Commonly used abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
ACT	Australian Commonwealth Territory
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
BOM	Bureau of Meteorology
C_6H_6	benzene

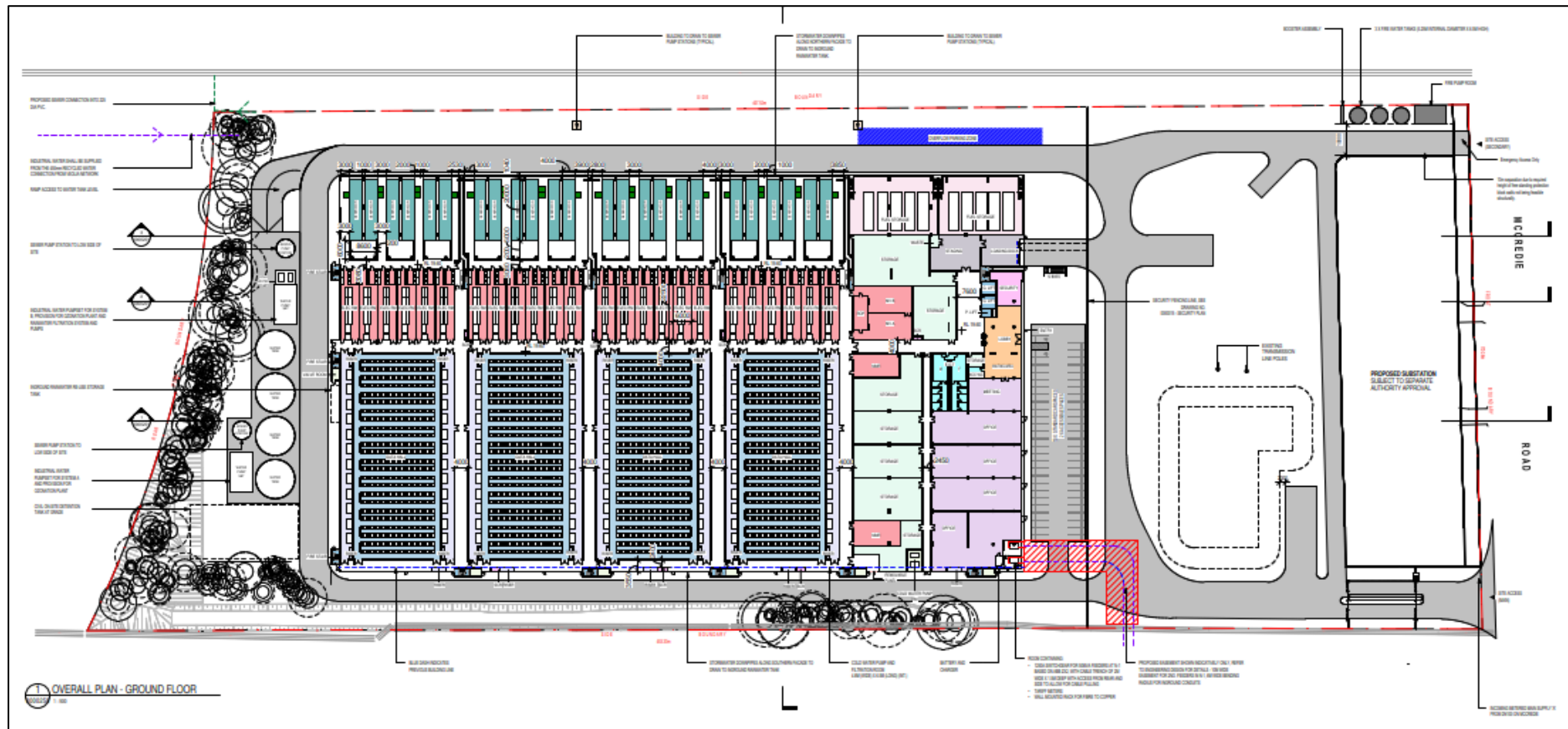
Abbreviation	Term
C ₇ H ₈	toluene
C ₈ H ₁₀	xylene
CEMP	construction environment management plan
CH ₂ O	formaldehyde
CH ₄	methane
CO	carbon monoxide
CO ₂	carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	digital elevation model
EETM	emission estimation technique manual
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 DPHI	NSW Department of Planning, Housing, and Infrastructure
NSW DPE	New South Wales Department of Planning and Environment
NSW EPA	New South Wales Environment Protection Authority
NT	Northern Territory
OEMP	operational environmental management plan
O ₃	ozone
OU	odour unit
OU·m ³ ·s ⁻¹	odour units times metres cubed per second
OU·s ⁻¹	odour units per second
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PM	particulate matter
PM ₁₀	particulate matter with an aerodynamic diameter of 10 µm or less

Abbreviation	Term
PM _{2.5}	particulate matter with an aerodynamic diameter of 2.5 µm or less
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
TSP	total suspended particulates
TVOC	total volatile organic compounds
TWA	time weighted average
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VIC	Victoria
VLLW	very low-level waste
VOC	volatile organic compound

APPENDIX B

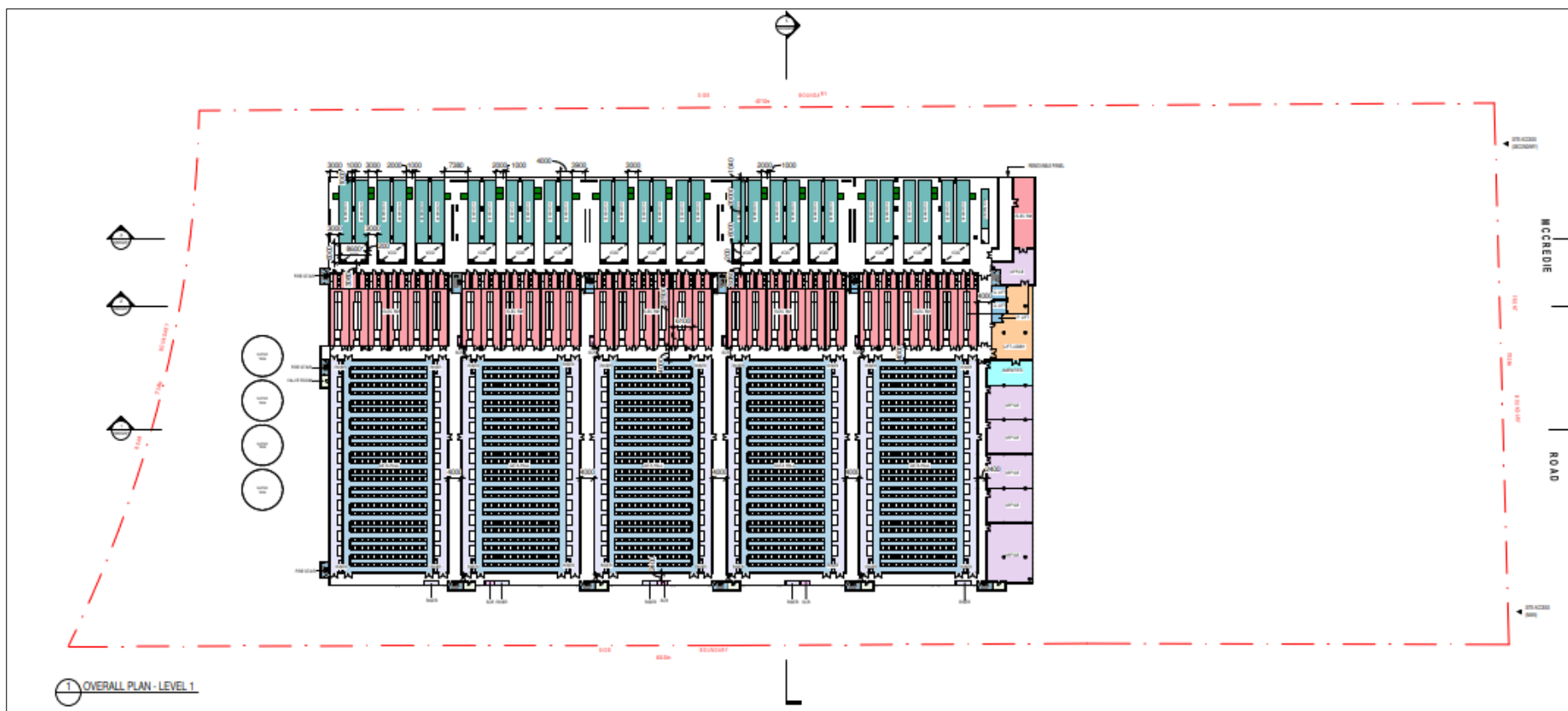
Proposal Site Layouts

Figure B1 Proposal site layout – overall plan – ground level



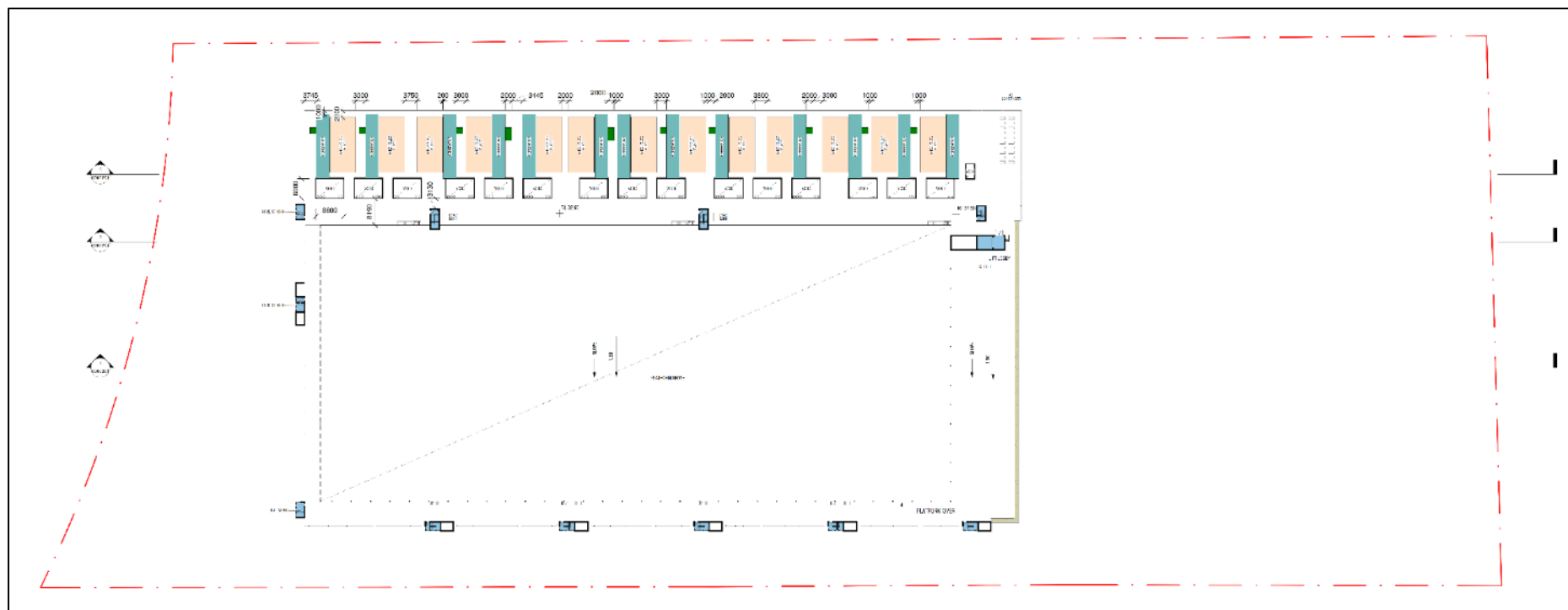
Source: Greenbox Architecture – Drawing 240028-GBA-XX-DR-AR-0000020 Issue A2 – 04.04-2025

Figure B2 Proposal site layout – overall level 1 floor plan



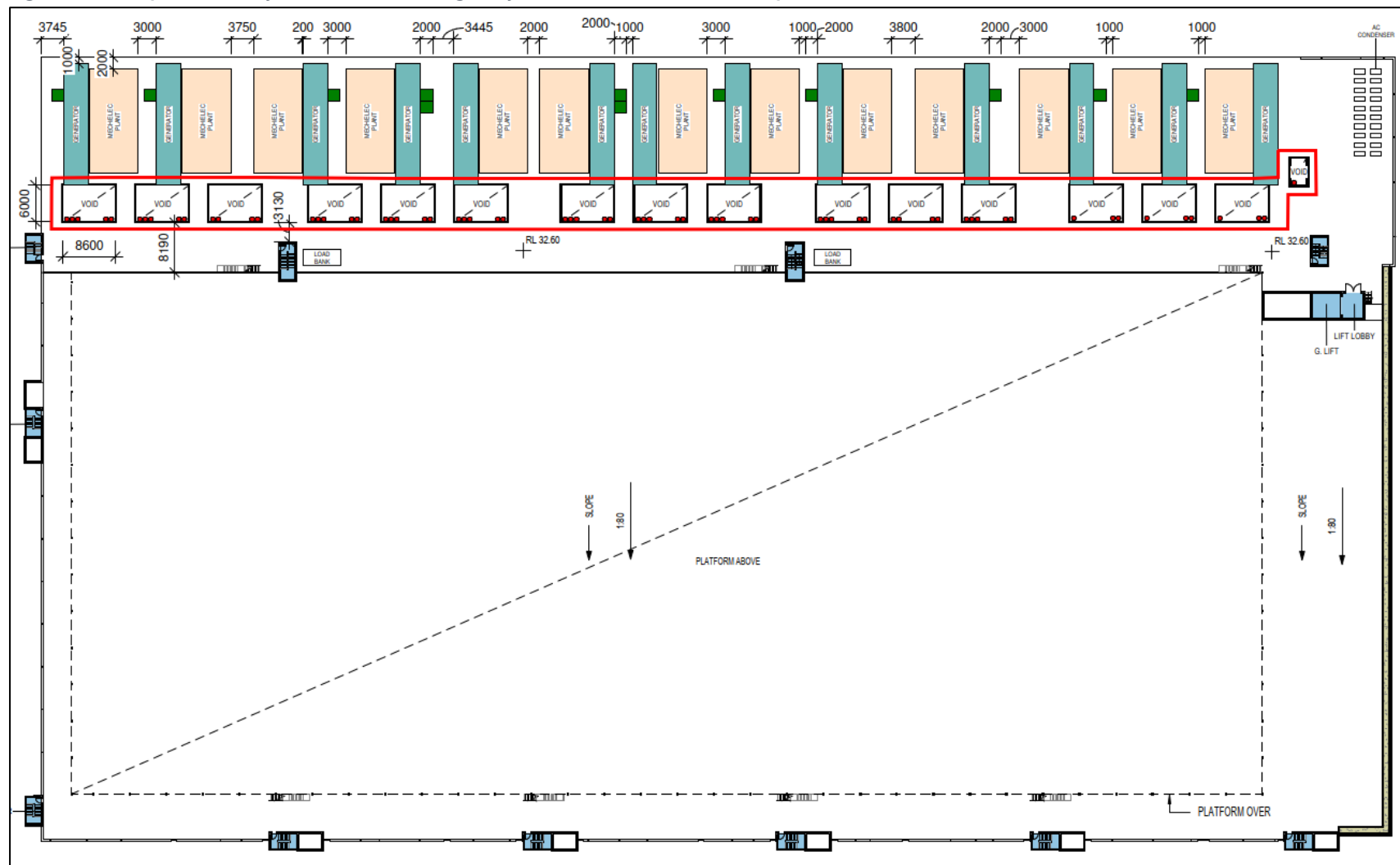
Source: Greenbox Architecture – Drawing 240028-GBA-XX-DR-AR-0000021 Issue A2 – 04.04-2025

Figure B3 Proposal site layout – overall roof gantry level



Source: Greenbox Architecture – Drawing 240028-GBA-XX-DR-AR-0000022 Issue A1 – 04.04-2025

Figure B4 Proposal site layout – overall roof gantry level (flue location markup)



Source: Adapted from Greenbox Architecture – Drawing 240028-GBA-XX-DR-AR-000022 Issue A1 – 04.04-2025

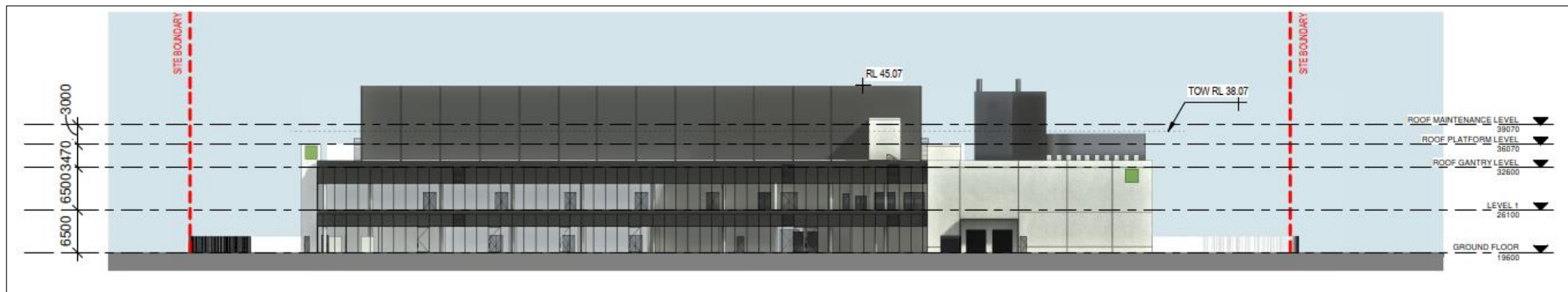
Note: Flue locations marked in red

Figure B5 Proposal site layout – building sections – cross section



Source: Greenbox Architecture – Drawing 240028-GBA-XX-DR-AR-0000201 Issue A4 – 04.04-2025

Figure B6 Proposal site layout – site elevations – north elevation



Source: Greenbox Architecture – Drawing 240028-GBA-XX-DR-AR-0000250 Issue A2 – 04.04-2025

APPENDIX C

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 adaptations made by Northstar from the IAQM published methodology are:

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

Step 1 – Screening Based on Separation Distance

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

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

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

Table C1 overleaf presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table C1 Construction phase impact screening criteria distances

Receptor ID	Location	Land use	Screening distance (m)		
			Proposal site boundary (250 m)	Proposal site entrance (250 m)	Proposal site construction route(s) (50 m)
R1	McCredie Road, Smithfield	Industrial	59	65	48
R2	McCredie Road, Smithfield	Industrial	112	182	178
R3	McCredie Road, Smithfield	Industrial	156	253	252
R4	McCredie Road, Guildford West	Residential	200	300	299
R5	McCredie Road, Guildford West	Industrial	228	339	339
R6	Fairfield Road, Guildford West	Industrial	249	423	423
R7	Guildford West Sportsground	Recreational	87	409	409
R8	Foray Street, Yennora	Industrial	118	577	577
R9	Hemingway Crescent, Fairfield	Residential	161	577	577
R10	Solo Crescent, Fairfield	Residential	206	606	594
R11	McCredie Road, Smithfield	Industrial	176	464	434
R12	McCredie Road, Smithfield	Industrial	24	233	223
R13	McCredie Road, Smithfield	Industrial	84	168	107
R14	McCredie Road, Smithfield	Industrial	89	154	70
R15	Palmer Street, Guildford Street	Childcare	907	1 006	1 005
R16	McCredie Road, Guildford West	Residential	461	561	561
R17	Fairfield Road, Guildford West	Residential	423	569	569
R18	Chisholm Street, Smithfield	Residential	526	848	807
R19	McCredie Road, Smithfield	Industrial	194	307	248
R20	Fairfield Road, Yennora	Industrial	270	665	665
R21	Vineyard Avenue, Smithfield	Residential	691	961	908
R22	Low Street, Smithfield	Residential	859	1014	944
R23	Crosby Crescent, Fairfield	Residential	442	903	903
R24	The Horsley Drive, Smithfield	Residential	608	995	970
R25	The Horsley Drive, Smithfield	Residential	998	1276	1 220
R26	Warren Road, Woodpark	Residential	702	704	213
R27	Pavesi Street, Guildford West	Residential	540	600	454
R28	Sturt Street, Smithfield	Industrial	497	500	129
R29	Karani Avenue, Guildford West	Residential	463	548	543
R30	Queen Street, Guildford West	Residential	664	759	757
R31	Phillip Street, Guildford West	Residential	767	870	870
R32	Dennistoun Avenue, Yennora	Industrial	982	1 296	1 296
R33	Herbert Place, Smithfield	Industrial	545	613	527
R34	Warren Road, Smithfield	Industrial	363	405	195
R35	Smithfield Park, Smithfield	Recreational	851	1 120	1 064
R36	Tom Uren Park, Guildford West	Recreational	418	497	492
R37	Crown On McCredie, Guildford West	Hotel	333	438	435

Receptor ID	Location	Land use	Screening distance (m)		
			Proposal site boundary (250 m)	Proposal site entrance (250 m)	Proposal site construction route(s) (50 m)
R38	Guildford West Children's Centre	Childcare	890	982	979
R39	Guildford West Public School	School	916	1 010	1 007
R40	Guildford West Sportsground	Recreational	95	274	277
R41	Bernadette Park, Fairfield	Recreational	291	747	747
R42	Fairfield Road Park, Yennora	Recreational	604	1 045	1 045
R43	Cawarra Park, Fairfield	Recreational	695	1 152	1 152
R44	Little Lucy's Family Day Care	Childcare	676	773	771
R45	Smithfield Montessori Academy CCC	Childcare	1 287	1 577	1 522
R46	Helena St Reserve	Recreational	788	875	871
R47	Os Young Park	Recreational	848	959	960

With reference to Table C1, sensitive receptors are noted to be within the screening distance thresholds and therefore require further risk assessment as summarised in Table C2.

Table C2 Application of Step 1 screening

Construction impact	Screening criteria	Step 1 screening	Comments
Demolition	250 m from boundary 250 m from site entrance	Screened	No demolition as part of Proposal
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	100 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 – Risk from Construction Activities

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

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

Table C3 Dust emission magnitude activities

Activity	Small	Medium	Large
Demolition			
Total building volume*	< 12 000 m ³	12 000 m ³ to 75 000 m ³	> 75 000 m ³
Demolition height	< 6 m AGL	6 m and 12 m AGL	> 12 m AGL
Onsite crushing	no	no	yes
Onsite screening	no	no	yes
Demolition of materials with high dust potential	no	yes	yes
Demolition timing	wet months only	any time of the year	any time of the year
Earthworks			
Total site area	< 18 000 m ²	18 000 m ² to 110 000 m ²	> 110 000 m ²
Soil types	soil type with large grain size (e.g. sand)	moderately dusty soil type (e.g. silt)	potentially dusty soil type (e.g. clay which would be prone to suspension when dry due to small particle size)
Heavy earth moving vehicles	< 5 heavy earth moving vehicles active at any one time	5 to 10 heavy earth moving vehicles active at any one time	> 10 heavy earth moving vehicles active at any time
Formation of bunds	< 3 m AGL	3 m to 6 m AGL	> 6 m AGL
Material moved	< 20 000 t	20 000 t to 100 000 t	> 100 000 t
Earthworks timing	wet months only	any time of the year	any time of the year
Construction			
Total building volume	< 12 000 m ³	12 000 m ³ to 75 000 m ³	75 000 m ³
Piling	no	yes	yes
Concrete batching	no	yes	yes
Sandblasting	no	no	yes
Materials	metal cladding or timber	concrete	concrete
Trackout (within 100 m of construction site entrance)			
Outward heavy vehicles movements per day	< 20	20 to 50	> 50
Surface materials	low potential	moderate potential	high potential
Unpaved road length	< 50 m	50 m to 100 m	> 100 m
Construction Traffic (from construction site entrance to construction vehicle origin)			
Demolition traffic - total building volume	< 12 000 m ³	12 000 m ³ to 75 000 m ³	> 75 000 m ³
Earthworks traffic - total site area	< 18 000m ²	18 000 m ² to 110 000 m ²	> 110 000 m ²
Earthworks traffic – soil types	soil type with large grain size (e.g. sand)	moderately dusty soil type (e.g. silt)	potentially dusty soil type (e.g. clay which would be

Activity	Small	Medium	Large
			prone to suspension when dry due to small particle size
Earthworks traffic – material moved	< 20 000 t	20 000 t to 100 000 t	> 100 000 t
Construction traffic – total building volume	< 12 000 m ³	12 000 m ³ to 75 000 m ³	75 000 m ³
Total traffic heavy vehicles movements per day when compared to existing heavy vehicle traffic	< 10 % of heavy vehicle movement contribution by Proposal	10 % to 50 % of heavy vehicle movement contribution by Proposal	> 50 % of heavy vehicle movement contribution by Proposal

The site area of the Proposal site is estimated at 7.2 ha. The Proposal would involve bulk earthworks, construction of the data centre development as outlined in Section 2.2 and associated vehicle movements.

Based on review of the provided layouts of the Proposal (refer Appendix B), the proposed data centre is expected to be greater than 75 000 m³ (threshold for large dust emission magnitude [refer Table C3]). Given the volume of construction to be performed, it is expected that more than 50 vehicle movements would be required to service the Proposal site each day.

Based upon the above assumptions and the assessment criteria presented in Table C3, the dust emission magnitudes are as presented in Table C4.

Table C4 Construction phase impact categorisation of dust emission magnitude

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

Step 3 – Sensitivity of the Area

Step 3 of the assessment process requires defining the area's sensitivity, which considers:

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

When assessing the area's sensitivity to dust impacts and soiling, human health receptors are evaluated independently.

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 methodology provides guidance on the land use value with regard to dust soiling and human health impacts and is shown in Table C5 below. It is noted that user expectations of amenity levels (dust soiling) are dependent on existing deposition levels.

Table C5 IAQM guidance for categorising land use value

Land use value	Low	Medium	High
Health impacts	Locations where human exposure is transient.	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 the public are exposed over a time period relevant to the air quality objective for PM ₁₀ (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day).
Examples	Public footpaths, playing fields, parks, and shopping street.	Office and shop workers but would generally not include workers occupationally exposed to PM ₁₀ .	Residential properties, hospitals, schools, and residential care homes.

Land use value	Low	Medium	High
Dust soiling	The enjoyment of amenity would not reasonably be expected; or Property would not reasonably be expected to be diminished in appearance, aesthetics, or value by soiling; or There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.	Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.	Users can reasonably expect a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land.
Examples	Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.	Parks and places of work.	Dwellings, museums, and other culturally important collections, medium- and long-term car parks and car showrooms

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 C6 below.

Table C6 IAQM guidance for categorising the sensitivity of an area to dust soiling impacts

Land use value	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

Notes: (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'.

Due to construction activities, receptors within 250 m of the site are rated 'medium' for dust soiling sensitivity.

Figure C1 illustrates the extent of works considered for this AQIA, delineating the outer envelope boundary of the anticipated construction works, the IAQM distance bands and the positions of receptors.

The IAQM guidance does not necessitate precise counting of human receptors. Instead, it advises using professional judgment to estimate the approximate number of buildings within each distance band and that only the highest level of area sensitivity from Table C6 needs to be considered.

It is estimated that up to 10 receptors are within 100 m and up to 50 receptors within a distance of 250 m from the Proposal site boundary. 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'.

Figure C1 Scope of construction activities, buffer distances and surrounding environment



Source: Northstar

Human Health Impacts

The assessed land use value (as described in Table C5) 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 PM₁₀ concentration (in the case of potential health impacts) and other site-specific factors.

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

- Any history of dust generating activities in the area;
- The likelihood of concurrent dust generating activity on nearby sites;
- Any pre-existing screening between the source and the receptors;
- Any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant, the season during which the works would take place;
- Any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- Any known specific receptor sensitivities which go beyond the classifications given in (IAQM, 2024).

The IAQM guidance for assessing the sensitivity of an area to human health impacts is shown in Table C7.

The background annual average PM₁₀ concentration measured at Parramatta North AQMS in 2021 was 13.2 µg·m⁻³. Together with the calculated land use value, this classifies the areas sensitivity as 'low' for dust health impacts.

Table C7 IAQM guidance for categorising the sensitivity of an area of human health impacts

Land use value	Annual mean PM ₁₀ concentration (µg·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

Notes: (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'.

(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 are shown in Table C8 for each activity determine the risk category with no mitigation applied.

Table C8 Risk of dust impacts from construction related activities

Sensitivity of area	Pre-mitigated dust emission magnitude		
	Small	Medium	Large
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 health effects, and the dust emission magnitudes for the various construction phase activities as shown in Table C4, the resulting risk of air quality impacts (without mitigation) is as presented in Table C9.

Table C9 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 impacts										
Med.	N/A	Med.	Large	Large	Large	N/A	Med.	Med.	Med.	Med.
Human health impacts										
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 C9 indicate that dust soiling impacts are associated with medium risks for all construction phase activities while human health impacts are associated with low risks for all construction phase activities if no mitigation measures were to be applied to control emissions.

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 C10 represents a selection of recommended mitigation measures recommended by the IAQM methodology for construction activities commensurate with the risks identified in Table C9.

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.

Table C10 Site-specific mitigation 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 local authority when asked.	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H
2.4	Hold regular liaison meetings with other high-risk construction sites within 250 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 local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars, and window sills within 100m of site boundary.	D
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results into a log book, and provide to the local authority when asked.	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H
4	Preparing and Maintaining the Site	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

Identified Mitigation		Unmitigated Risk
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	H
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	H
4.7	Cover, seed or fence stockpiles to prevent wind erosion	H
5	Operating Vehicle / Machinery and Sustainable Travel	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·h ⁻¹ on surfaced and 15 km·h ⁻¹ on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	D
5.5	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N
5.6	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	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

Identified Mitigation		Unmitigated Risk
9	Measures Specific to Construction	Medium
9.1	Avoid scabbling (roughening of concrete surfaces) if possible	D
9.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	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

APPENDIX D

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 D1.

Table D1 Meteorological monitoring stations proximate to the Proposal site

Site name	Source	Station #	Approximate location		Approximate distance (km)
			mE	mS	
Bankstown Airport AWS	BoM	066137	313 855	6 245 099	7.7
Horsley Park Equestrian Centre AWS	BoM	067119	301 708	6 252 298	9.0
Sydney Olympic Park AWS	BoM	066195	320 948	6 252 558	10.0

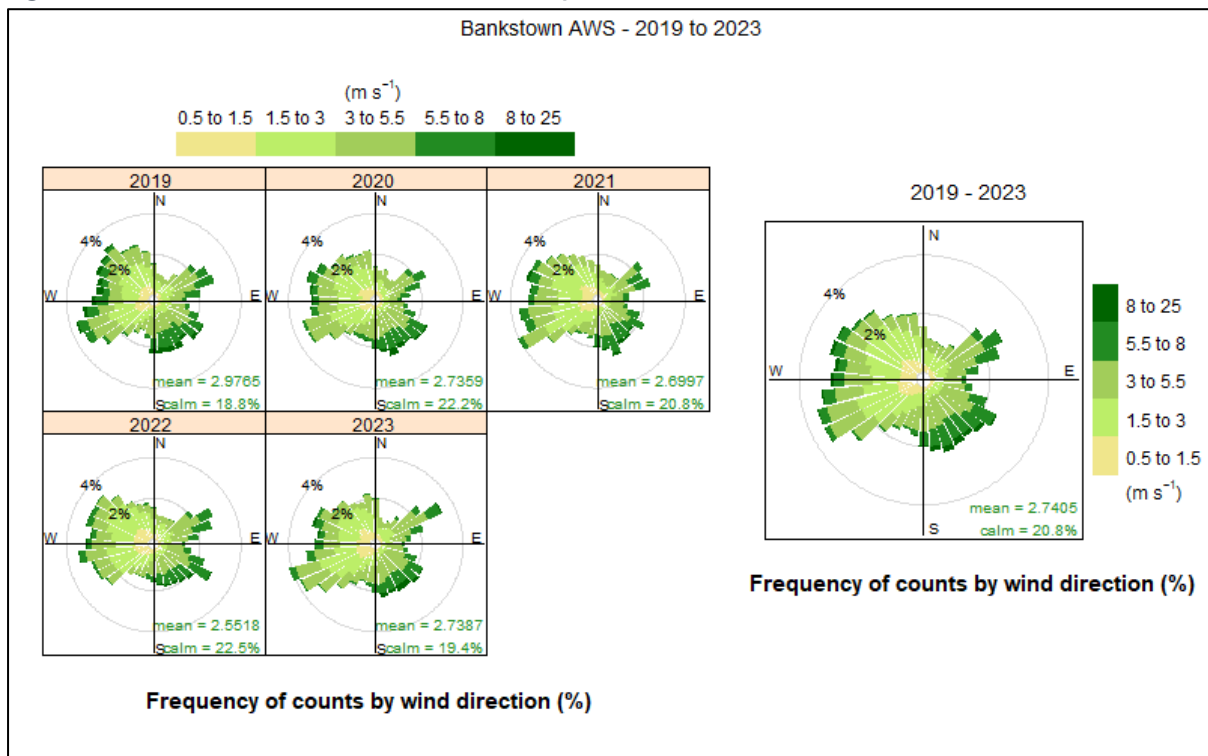
As discussed in Section 4.3, meteorological conditions at Bankstown Airport AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2019 to 2023) are presented in Figure D1. The annual wind speed frequency distribution for the five-year period is presented in Figure D2.

The correlation coefficient between each year and the five-year period for the distribution of wind speed, wind direction, PM₁₀ and PM_{2.5} are summarised in Table D2. The correlation coefficients were ranked and aggregated to select the representative year for the meteorological modelling. The rankings are also presented in Table D2.

The wind roses indicate that from 2019 to 2023, winds at Bankstown Airport AWS show similar wind distribution patterns across the years assessed, with no predominant wind direction.

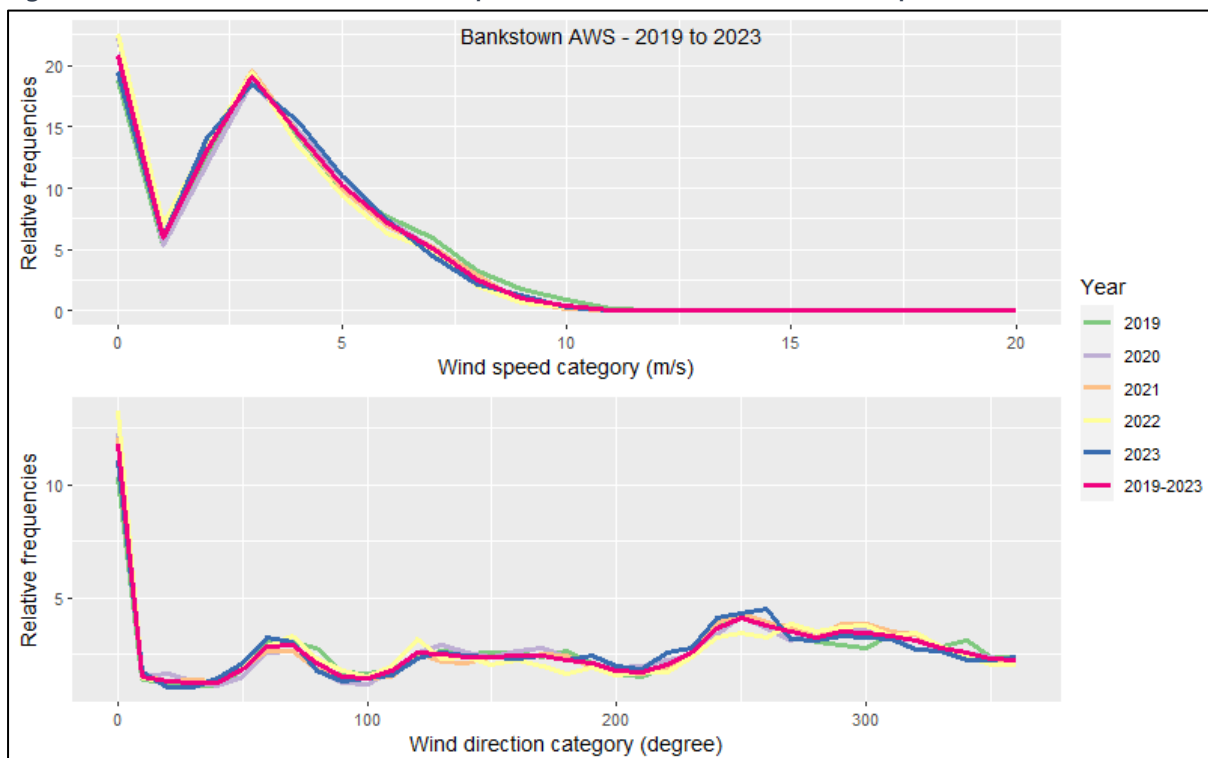
The majority of wind speeds experienced at Bankstown Airport AWS between 2019 and 2023 are generally in the range 0.5 meters per second (m·s⁻¹) to 8 m·s⁻¹ with the highest wind speeds (greater than 8 m·s⁻¹) occurring from generally south-easterly directions. Winds of this speed are rare and occur during 1.6 % of the observed hours during the years. Calm winds (less than 0.5 m·s⁻¹) are more common and occur during 20.8 % of hours on average across the years between 2019 and 2023.

Figure D1 Annual wind roses – Bankstown Airport AWS (2019 to 2023)



Source: Northstar

Figure D2 Annual wind direction and speed distributions – Bankstown Airport AWS (2019 to 2023)



Source: Northstar

Table D2 Correlation coefficient analysis – Bankstown Airport AWS and Parramatta North AQMS (2019 to 2023)

Parameter	Wind speed		Wind direction		PM ₁₀		PM _{2.5}		Aggregated rank
	Corr.	Rank	Corr.	Rank	Corr.	Rank	Corr.	Rank	
2019	0.9972	3	0.9843	5	0.9324	5	0.9365	5	5
2020	0.9977	2	0.9922	2	0.9876	3	0.9946	3	2
2021	0.9997	1	0.9952	1	0.9980	1	0.9954	2	1
2022	0.9967	5	0.9865	3	0.9627	4	0.9689	4	4
2023	0.9971	4	0.9862	4	0.9931	2	0.9969	1	3
2019-2023	1	-	1	-	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 2021 is the highest ranked for correlation against the wind speed over the five-year period.

Wind direction observations for each year are also well correlated against the wind direction over the five-year period, with each year having a correlation coefficient greater than 0.98. The year 2021 is the highest ranked for correlation against the wind direction over the five-year period.

Particulate matter concentrations for each year are also reasonably well correlated against particulate matter concentrations over the five-year period. Each year resulted in having a correlation coefficient greater than 0.93. The year 2021 is the highest rank for PM₁₀ while 2023 was the highest ranked year for PM_{2.5}.

The correlation coefficient analysis indicates that 2021 is the most representative year for meteorological modelling.

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 CALMET meteorological model in a format suitable for using in the CALPUFF dispersion model (refer Section 5.2.1).

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain and is the meteorological pre-processor for the CALPUFF modelling system. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each

grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

In this AQIA, CALMET has been run in no-observations (no-obs) mode using gridded prognostic data generated by The Air Pollution Model (TAPM, v 4.0.5), developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The TAPM model is cited in the 'Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia' (Barclay & Scire, 2011) as a suitable prognostic meteorological model for applications involving complex meteorological conditions.

TAPM is a prognostic model which 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 the outputs from an initial TAPM modelling run were compared to observed meteorological monitoring data collected at Sydney Olympic Park AWS. These data did not compare well and correspondingly, given the poor validation, that initial TAPM modelling run has not been used in this AQIA. Subsequently, a second TAPM run was performed which used observations at Sydney Olympic Park AWS to 'nudge' model predictions towards those observations, and this has been used in this AQIA.

Given that the adopted TAPM modelling output was performed using observed meteorological data, no validation at surrounding AWS has been performed and the second TAPM run is considered sufficient to represent meteorological parameters at the Proposal site for use in CALMET. Default TAPM databases for terrain, land use and meteorology were also used in the model.

The parameters used in TAPM and CALMET modelling are presented in Table D3.

Further, as per (Barclay & Scire, 2011), the seven critical parameters used in the CALMET modelling are presented in Table D4.

Table D3 CALMET and TAPM meteorological parameters

TAPM v 4.0.5	
Modelling period	1 January 2021 to 31 December 2021
Centre of analysis	326 566 mE, 6 251 046 mS (UTM Coordinates)
Number of grid points	40 × 40 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	Sydney Olympic Park AWS (Archery Centre)
CALMET	
Modelling period	1 January 2021 to 31 December 2021
Southwest corner of analysis	307 000 mE, 6 244 000 mS (UTM Coordinates)
Meteorological grid domain (resolution)	10 km × 10 km (0.1 km)
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1 200 m, 2 000 m, 3 000 m, 4 000 m)
Data assimilation	No-obs approach using TAPM – 3D.DAT file

Table D4 Seven critical meteorological parameters used in CALMET

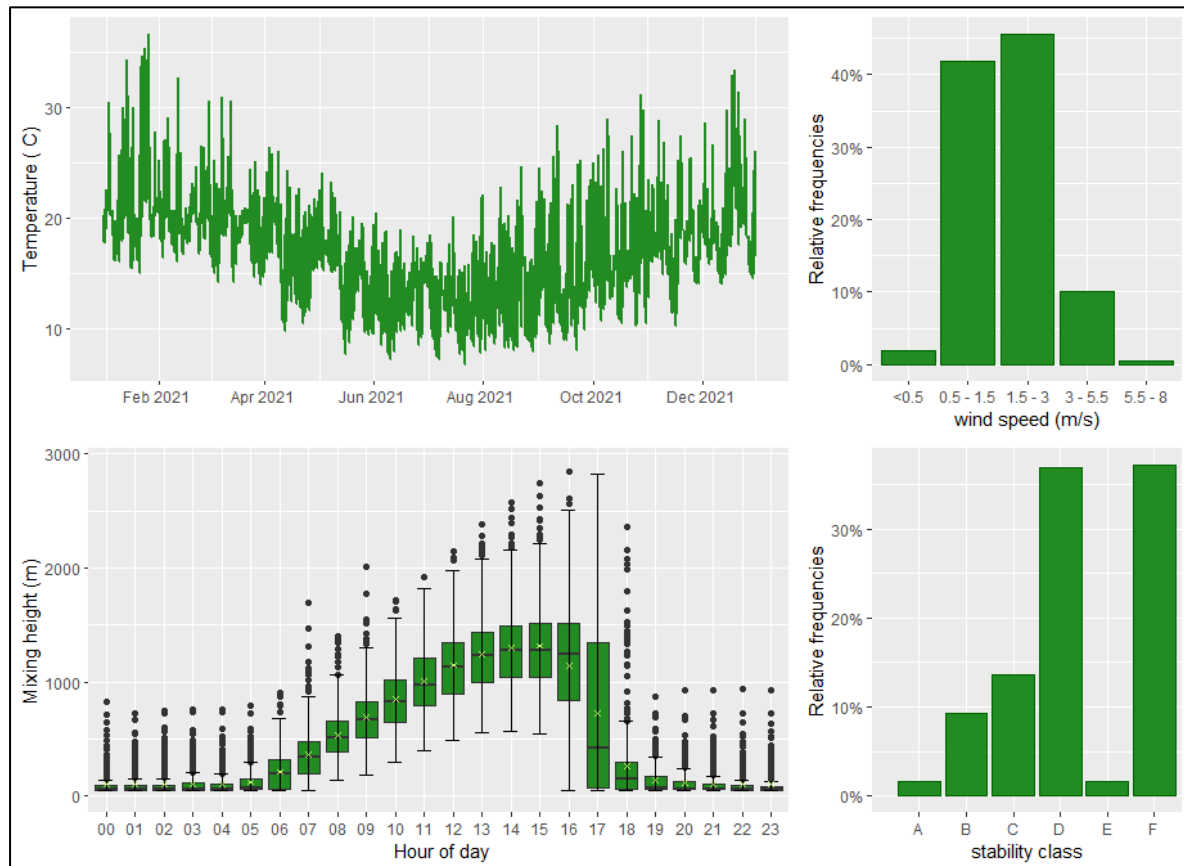
Parameter	Value
TERRAD	1.5
IEXTRP	1
BIAS (NZ)	0 × 1 0
R1 and R2	0, 0
RMAX1 and RMAX2	0, 0

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

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Proposal site during 2021 are illustrated in Figure D3.

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.

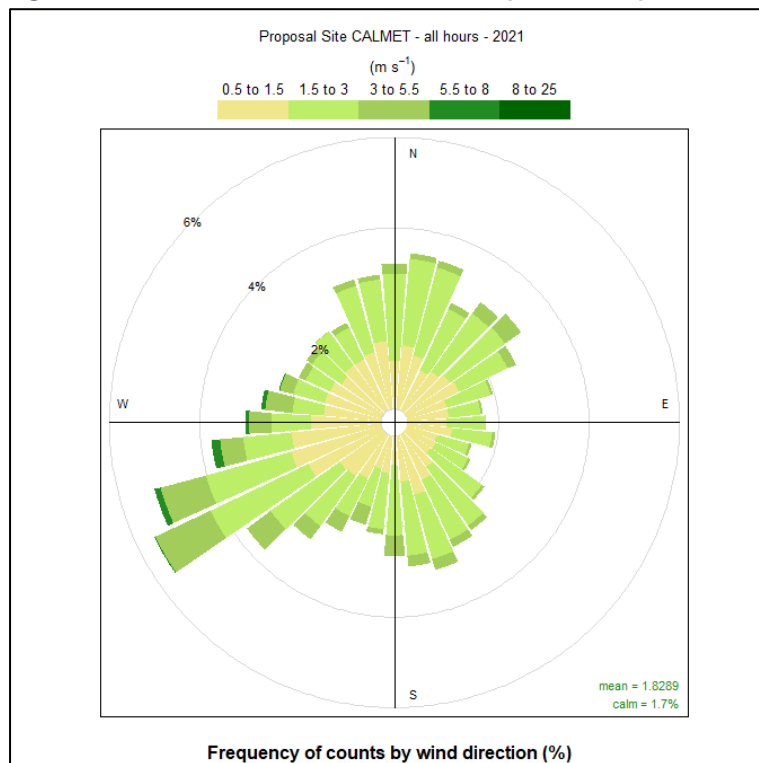
Figure D3 Predicted mixing height, wind speed and stability class frequency at the Proposal site (2021)



Source: Northstar

The modelled wind speed and direction at the Proposal site during 2021 are presented in Figure D4.

Figure D4 Predicted wind direction and speed – Proposal site (2021)



Source: Northstar

APPENDIX E

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 assessment. Determination of data to be used as a location representative of the Proposal site and during a representative year can be complicated by factors which include:

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

Four AQMS have been identified proximate to the Proposal site, operated by NSW DCCEEW. These locations (listed by proximity) are summarised in Table E5.

Table E5 Details of AQMS proximate to the Proposal site

AQMS location	Dates of operation	Distance to Proposal site (km)	Measurements						
			PM ₁₀	PM _{2.5}	TSP	NO ₂	CO	SO ₂	O ₃
Parramatta North	2017-present	6.8	✓	✓	✗	✓	✓	✗	✓
Prospect	2007-present	7.2	✓	✓	✗	✓	✓	✓	✓
Chullora	2002-present	9.5	✓	✓	✗	✓	✓	✓	✓
Liverpool	1988-present	9.9	✓	✓	✗	✓	✓	✗	✓

The closest active AQMS is noted to be located at Parramatta North and is generally considered to be the monitoring location most reflective of the conditions at the Proposal site. Correspondingly, given its proximate distance to the Proposal site and availability of data, air quality monitoring data observed at Parramatta North AQMS for the year 2021 (corresponding with the selected meteorological data [refer Appendix D]) have been adopted for use in this AQIA.

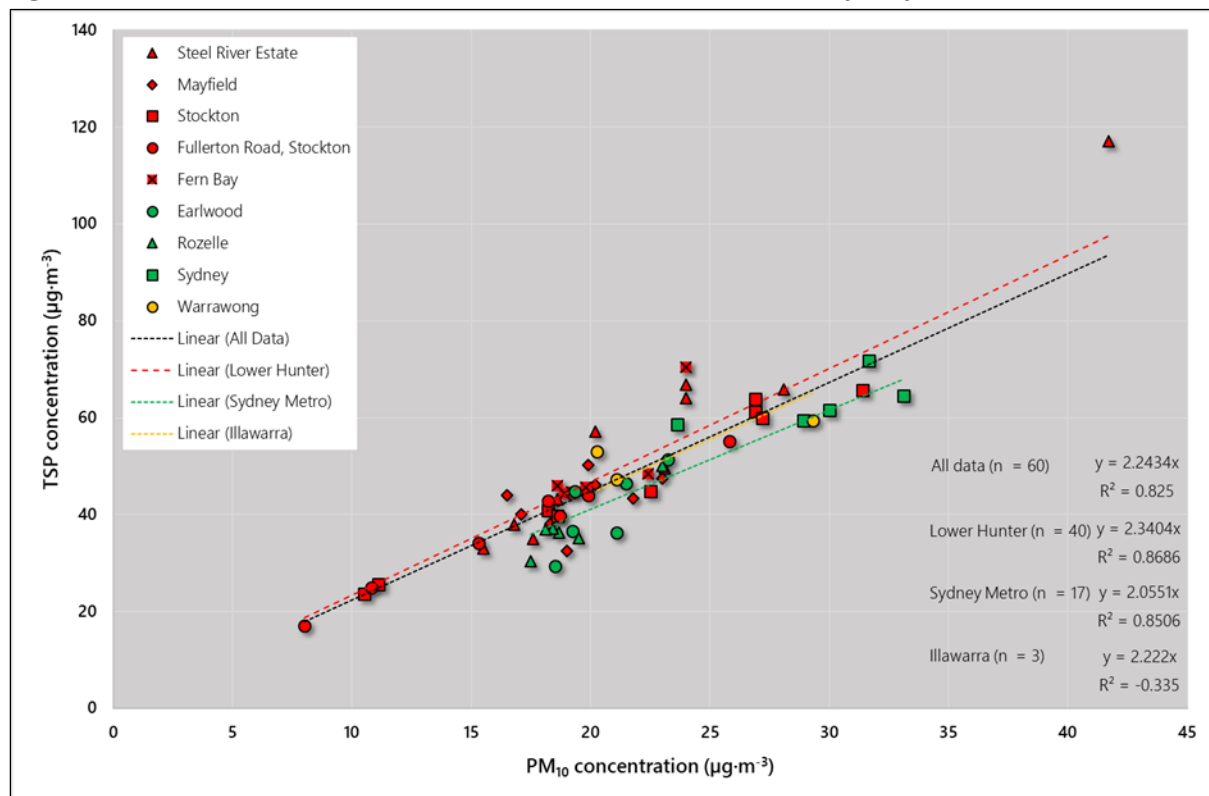
A statistical summary of the monitored concentrations of TSP, PM₁₀, PM_{2.5}, CO, SO₂ and O₃ for 2021 adopted in this assessment is presented in Table E6.

Concentrations of TSP are not measured at any AQMS surrounding the Proposal site. An analysis of co-located measurements of TSP and PM₁₀ in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in Figure E1.

The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM₁₀ ratio of 2.0551 : 1 (i.e. PM₁₀ 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 35.1 µg·m⁻³ being adopted.

Graphs presenting the daily varying PM₁₀ and PM_{2.5} data, and 1-hour average NO₂ data recorded at Parramatta North AQMS in 2021 are presented in Figure E2, Figure E3 and Figure E4 respectively.

Figure E1 Co-located TSP and PM₁₀ measurements – Lower Hunter, Sydney Metro, and Illawarra



Source: Northstar

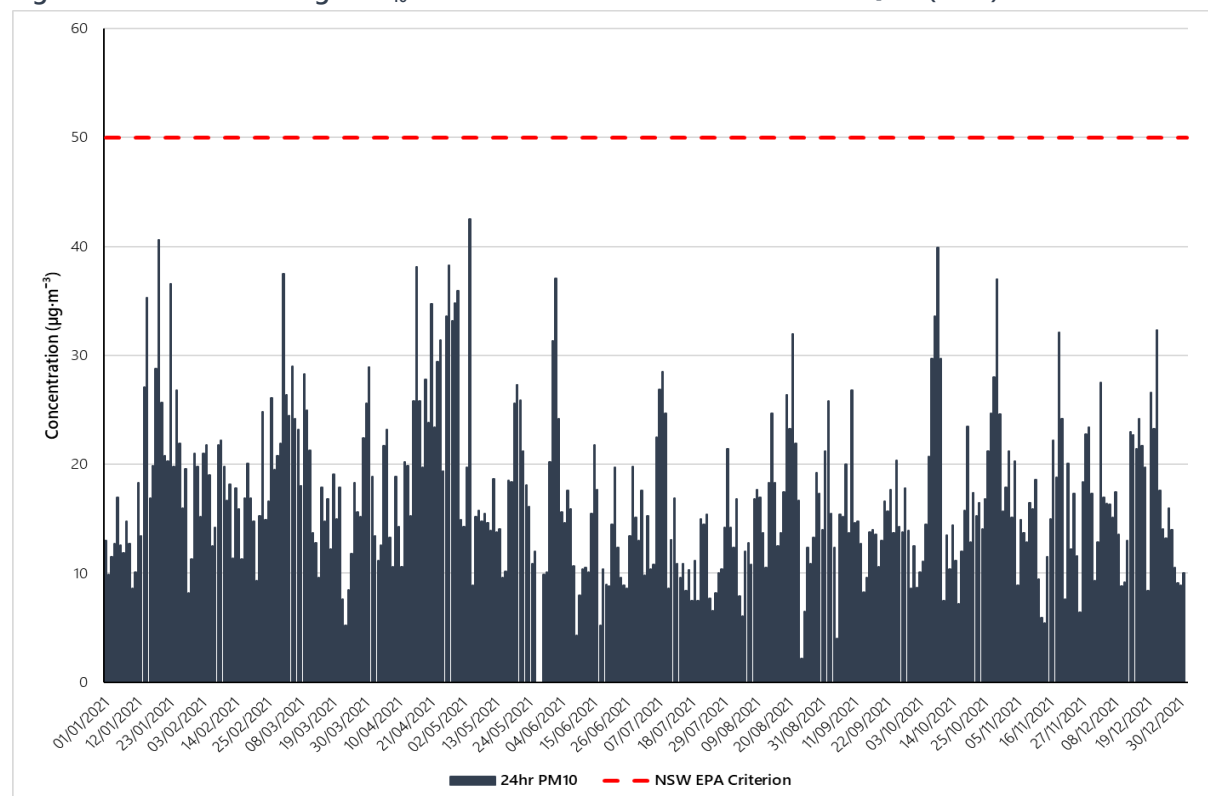
Table E6 Background air quality statistics – Parramatta North AQMS (2021)

Pollutant	TSP	PM ₁₀	PM _{2.5}	SO ₂	SO ₂	NO ₂	O ₃	CO	CO	CO
Units	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	µg·m ⁻³	mg·m ⁻³	mg·m ⁻³	mg·m ⁻³
Averaging period	Annual	24-hour	24-hour	24-hour	1-hour	1 hour	1 hour	15-min	1-hour	8-hour (rolling)
Data Points (no.)	363	363	361	360	8309	8293	8344	8192	8192	8685
Mean	35.1	17.1	6.6	1.5	1.4	15.2	34.0	0.4	0.3	0.3
Standard deviation	-	7.2	4.2	1.9	2.7	13.0	26.2	0.2	0.2	0.2
Skew ¹	-	0.9	1.9	1.1	4.7	1.0	0.7	2.0	2.0	1.9
Kurtosis ²	-	0.9	5.1	0.9	42.5	0.4	0.7	5.2	5.2	4.8
Minimum	-	2.2	0.5	0.0	-5.7	-2.1	0.0	0.0	0.0	0.0
Percentiles										
25 th	-	12.0	3.8	0.0	0.0	4.1	8.6	0.2	0.1	0.1
50 th	-	15.5	5.4	0.0	0.0	12.3	34.2	0.3	0.3	0.3
75 th	-	20.9	7.9	2.9	2.9	24.6	51.4	0.3	0.3	0.3
90 th	-	26.8	12.1	2.9	2.9	34.9	66.3	0.7	0.5	0.5
95 th	-	31.9	14.3	5.7	5.7	41.0	77.0	0.8	0.6	0.6
97 th	-	34.9	16.9	5.7	5.7	45.1	85.6	1.0	0.8	0.6
98 th	-	36.9	18.0	5.7	8.6	47.2	94.2	1.2	0.9	0.8
99 th	-	38.2	22.9	6.9	11.4	49.2	107.0	1.3	1.0	0.9
Maximum	-	42.5	27.4	8.6	42.9	96.4	173.3	1.8	1.4	1.1
Data Capture (%)	99.2	99.2	98.6	98.4	94.6	94.4	95.0	93.3	93.3	98.9

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

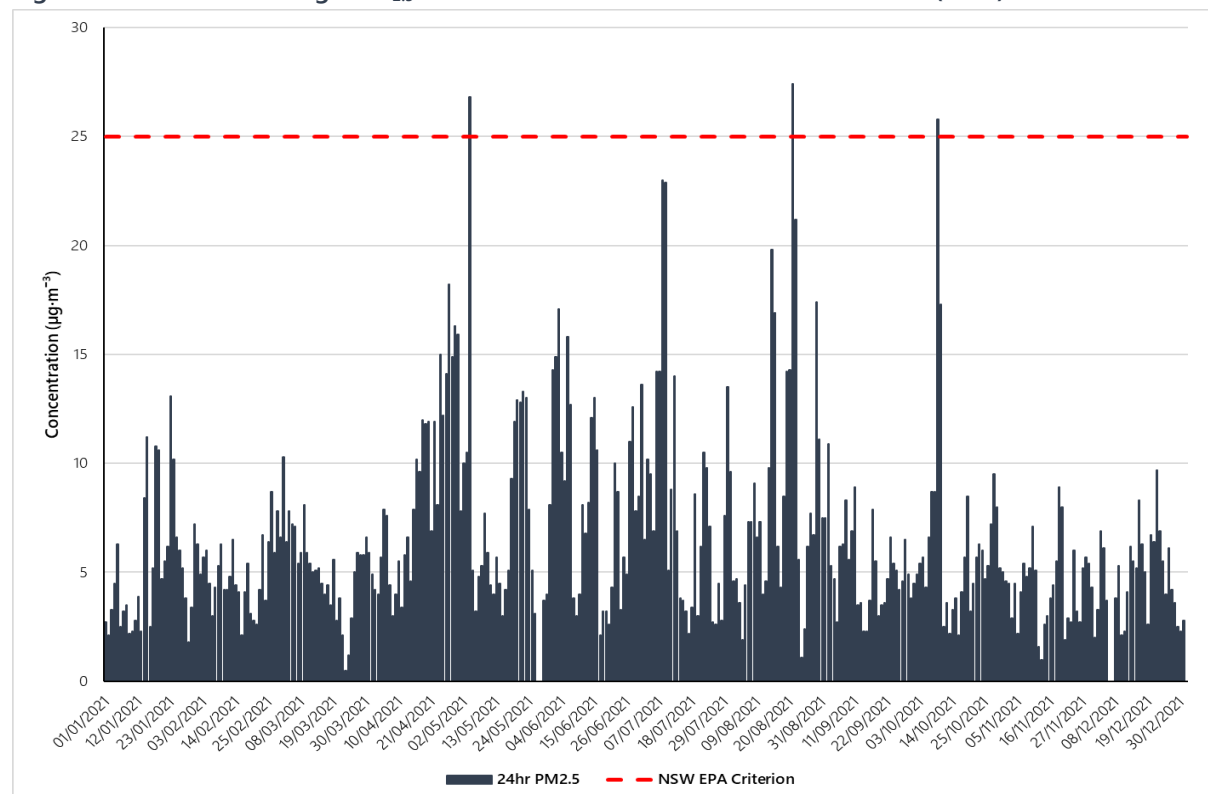
2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless

Figure E2 24-hour average PM₁₀ concentrations – Parramatta North AQMS (2021)



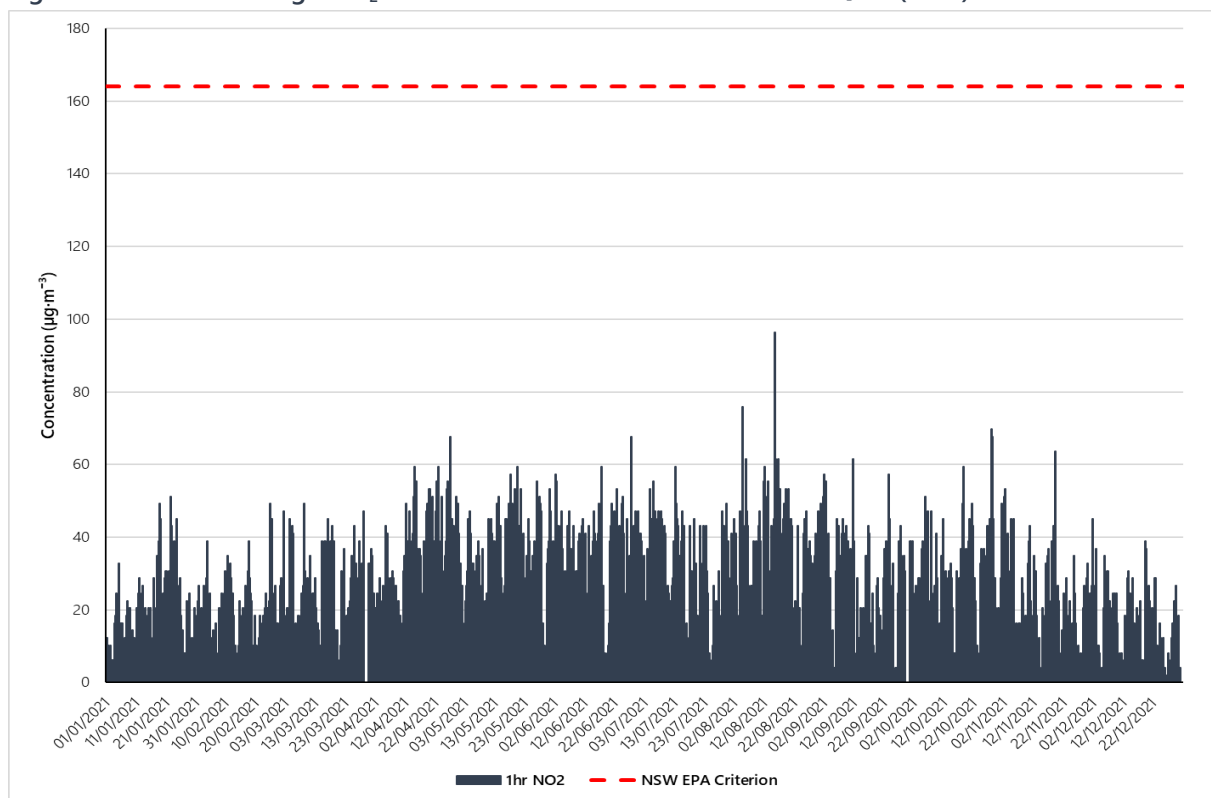
Source: Northstar

Figure E3 24-hour average PM_{2.5} concentrations – Parramatta North AQMS (2021)



Source: Northstar

Figure E4 1-hour average NO₂ concentrations – Parramatta North AQMS (2021)



Source: Northstar

APPENDIX F

Generator Technical Specifications

**Engine data**

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	16V2000G76F				
Application Group	3D				
Legislative body	NOx emission optimized				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN ^a values base on residual oxygen value of [%]	5				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	979	734	489	245	98
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	7.21	5.09	3.4	2.32	1.73
NOX-Emissions specific	g/kWh	7.23	6.7	6.54	8.39	14.87
CO-Emissions specific	g/kWh	0.55	0.66	1.16	2.67	5.17
HC1-Emissions specific	g/kWh	0.14	0.24	0.4	1.1	2.82
NOX+HC1-Emissions specific	g/kWh	7.37	6.94	6.94	9.5	17.69
PM-Emissions specific (Meas.)	g/kWh	0.046	0.083	0.176	0.118	0.998
NOX-Emissions (based on 5% O ₂)	mg/m ³ N	2604	2376	2244	2569	3655
NOX+HC1-Emissions (based on 5% O ₂)	mg/m ³ N	2655	2459	2381	2906	4347
CO-Emissions (based on 5% O ₂)	mg/m ³ N	199.5	234.2	396.8	818.7	1272
HC1-Emissions (based on 5% O ₂)	mg/m ³ N	50.3	83.6	137.5	337.6	691.8
PM-Emissions (based on 5% O ₂)	mg/m ³ N	16.7	29.6	60.4	36	245.1

Application data¹⁾

Engine		Emission optimized ²⁾	Combustion air requirements	Emission optimized ²⁾
Manufacturer		mtu	Combustion air volume: m ³ /s	128
Model		16V2000G76F	Max. air intake restriction: mbar	40
Type		4-cycle		
Arrangement		16V	Cooling/radiator system TB	
Displacement: l		35.7	Coolant flow rate (HT circuit): m ³ /hr	41.6
Bore: mm		135	Coolant flow rate (LT circuit for TB): m ³ /hr	17.5
Stroke: mm		156	Heat radiated to charge air cooling (TB): kW (NOx)	240
Compression ratio		17.5	Input pressure customer radiator (TB): bar (rel.)	1.4
Rated speed: rpm		1500	Max. pressure loss customer radiator (TB): bar	0.7
Engine governor		ADEC (ECU 9)	Heat dissipated by engine coolant: kW (NOx)	375
Speed regulation		± 0.25%	Heat radiated to ambient: kW	40
Max power: kWm		979	Air flow required for mech. radiator (40°C) cooled unit: m ³ /min	1462
Mean effective pressure: bar		21.9	Air flow required for mech. radiator (50°C) cooled unit: m ³ /min	1462
Air cleaner		dry	Engine coolant capacity (without cooling equipment): l	70
Fuel system			Radiator coolant capacity (40°C): l	74
Maximum fuel lift: m		5	Radiator coolant capacity (50°C): l	106
Total fuel flow: l/min		30	Max. coolant temperature (warning): °C	102
Fuel consumption ³⁾			Max. coolant temperature (shutdown): °C	105
At 100% of power rating:	l/hr	257	g/kwh	
At 75% of power rating:		180		
At 50% of power rating:		124		
Lube oil system			Exhaust system	
Total oil system capacity: l		102	Exhaust gas temp. (after turbocharger): °C	530
Max. lube oil temperature (alarm): °C		103	Exhaust gas volume: m ³ /s	3.35
Max. lube oil temperature (shutdown): °C		105	Maximum allowable back pressure: mbar	50
Min. lube oil pressure (alarm): bar		4.5	Minimum allowable back pressure: mbar	30
Min. lube oil pressure (shutdown): bar		4	Generator	
			Protection class	IP23
			Insulation class	H
			Voltage regulation (steady state)	± 0.25%
			Radi Interference class	N

1) All data refers only to the engine and is based on ISO standard conditions (25°C and 100m above sea level).

2) Emission optimized data refer to NOx emission optimized and NEA (ORR) optimized/Tier 2 compliant engines.

3) Values referenced are in accordance with ISO 3046-1. Conversion calculated with fuel density of 0.83 g/ml. All fuel consumption values refer to rated engine power.



A Rolls-Royce solution

Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G74F				
Application Group	3D				
Legislative body	Fuel-consumption optimized				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN ³ values base on residual oxygen value of [%]	Measured				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power		2670	2002	1335	667	267
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	36.49	30.61	15.72	6.76	5.91
NOX-Emissions specific	g/kWh	13.46	15.05	11.46	9.47	19.19
CO-Emissions specific	g/kWh	1.06	0.58	0.75	2.3	7.43
HC1-Emissions specific	g/kWh	0.21	0.23	0.31	0.67	2.94
NOX+HC1-Emissions specific	g/kWh	13.67	15.29	11.77	10.13	22.13
PM-Emissions specific (Meas.)	g/kWh	0.045	0.049	0.078	0.309	1.806
NOX-Emissions (based on O2 meas)	mg/m3N	4033	4358	2874	1562	1487
NOX+HC1-Emissions (based on O2 meas)	mg/m3N	4095	4425	2951	1668	1706
CO-Emissions (based on O2 meas)	mg/m3N	311.8	165.7	182.4	366.5	552.6
HC1-Emissions (based on O2 meas)	mg/m3N	62.5	66.1	76.7	105.9	218.8
PM-Emissions (based on O2 meas)	mg/m3N	13.3	13.9	19	49.2	134.5

Description of Revision Frequency		All industrial property rights reserved. Disclosure, reproduction or use for any other purpose is prohibited unless our express permission has been given. Any infringement results in liability to pay damages.	PDF	Name	Project no.	Size A4
			Configurator	Thales, Sandro (TVMG)	Order no.	
			Approver1	Kneifel, Alexander (TSLE)	EDS-ID	
			Approver2	Kollmer, Michael (TV)	2203-16.01.2023	
			Approver3			
Configuration-ID 1210	Documentation	Emissionstage Fuel-consumption optimized Emissionstage basis Fuel-consumption optimized	Approver4		Title Emission data sheet	
			User	APACChange		
			Engine model 20V4000G74F			
			Sheet of			

Application data ⁹

Engine			Liquid capacity (lubrication)		
Manufacturer	mtu		Total oil system capacity: l		390
Model	20V4000G74F		Engine jacket water capacity: l		205
Type	4-cycle		Intercooler coolant capacity: l		50
Arrangement	20V		Combustion air requirements		
Displacement: l	95.4		Combustion air volume: m³/s		2.64
Bore: mm	170		Max. air intake restriction: mbar		50
Stroke: mm	210		Cooling/radiator system		
Compression ratio	16.4		Coolant flow rate (HT circuit): m³/hr		80
Rated speed: rpm	1500		Coolant flow rate (LT circuit): m³/hr		32.5
Engine governor	ECU 9		Heat rejection to coolant: kW		980
Max power: kW/m	2670		Heat radiated to charge air cooling: kW		430
Air cleaner	dry		Heat radiated to ambient: kW		105
Fuel system			Fan power for electr. radiator (40°C): kW		70
Fuel specification	EN 590, Grade No.1-D/2-D (ASTM D975-00), EN 15940 (e.g. HVO)		Exhaust system		
Maximum fuel lift: m	5		Exhaust gas temp. (after turbocharger): °C		570
Total fuel flow: l/min	27		Exhaust gas volume: m³/s		8.0
Fuel consumption^a			Maximum allowable back pressure: mbar		85
At 100% of power rating:	l/hr	g/kwh	Minimum allowable back pressure: mbar		30
At 75% of power rating:	617.6	192			
At 50% of power rating:	463.2	192			
	321.7	200			

Standard and optional features

System ratings (kW/kVA)

Generator model	Voltage	fuel consumption optimized					
		without radiator			with mechanical radiator		
		kWel	kVA*	AMPS	kWel	kVA*	AMPS
Leroy Somer LSA53.2 M9 (Low voltage Leroy Somer standard)	380 V	2520	3150	4786	2480	3100	4710
	400 V	2520	3150	4547	2480	3100	4474
	415 V	2520	3150	4382	2480	3100	4313
Leroy Somer LSA53.2 ZL34 (Medium volt. Leroy Somer)	11 kV	2560	3200	168	2496	3120	164

* cos phi = 0.8

APPENDIX G

Additional Mitigation Measures

As outlined in Section 8.2.5, 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 is 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.

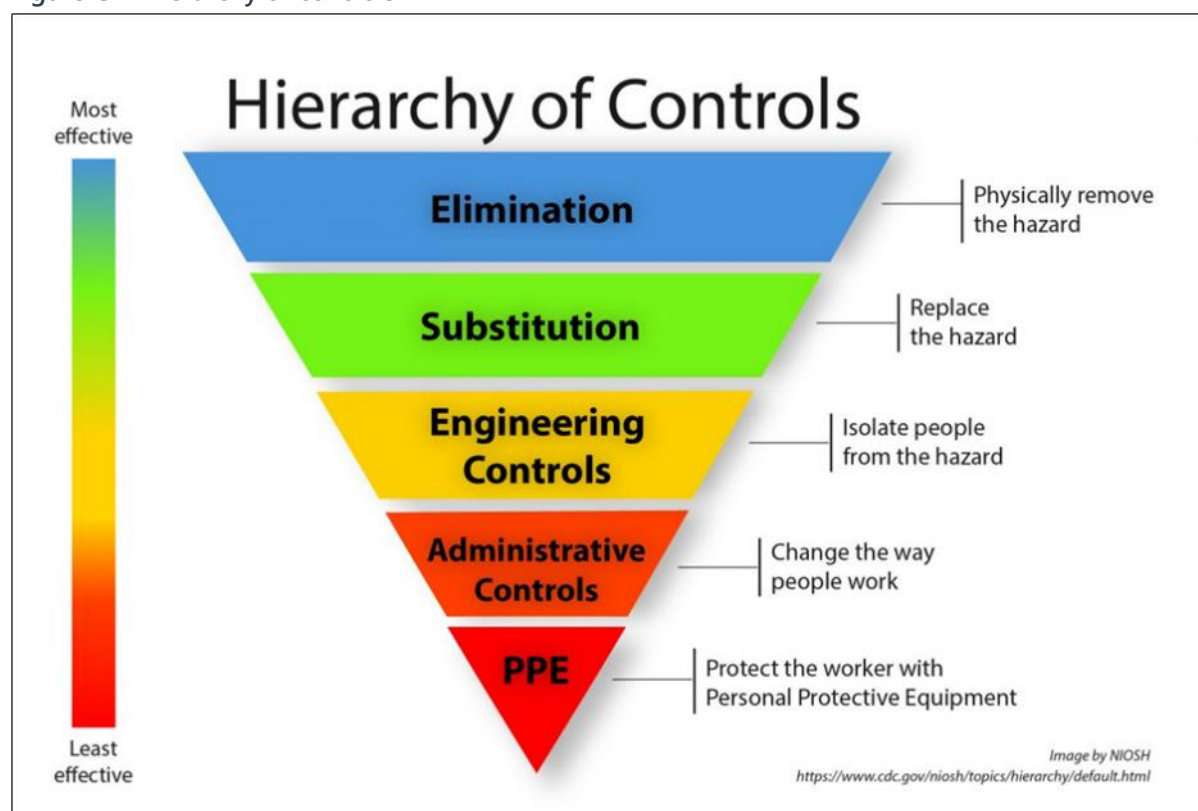
Identification of the SPR model allows for targeted management interventions to manage the environmental risks and prevent pollution from reaching sensitive areas.

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 G1.

The hierarchy of controls shows 'elimination of the hazard' as the most desirable control, then 'substitution of the hazard' (including engineered controls), to 'administrative controls' (i.e. protection from the hazard) being the least effective.

Figure G1 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 aid 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 3.1).

Schedule 2, Part 3 of the POEO CAR sets out emission limits relevant to standby electricity generators as a non-scheduled activity. Table G1 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 G1 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·m ⁻³
		Group B	250 mg·m ⁻³
		Group C	100 mg·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 NO_x 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 G2 provides details of the corresponding US EPA Tier 1 to Tier 3 emissions standards for engines rated above 560 kW and Table G3 outlines the respective requirements under US EPA Tier 4 emissions standards.

Table G2 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 G3 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 SO₂, 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 G4 provides the EU Stage V emissions limits for generators set engines rated above 560 kW.

Table G4 EU Stage V emissions limits by engine category

Engine category	Ignition type	Net power	Date	Emission limit (g-kWh)			
		(kW)		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·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 uninterrupted 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 aid 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 example⁵). 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 O₂ 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].

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

⁵ https://www.criticalairflow.com/site/assets/files/1080/critical_airflow_tristactech.pdf

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 CO₂ and water as byproducts.
- **Diesel Particulate Filters (DPF)** – filters particulate matter (PM) from the exhaust gas and is ‘burned off’ through either active or 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 N₂, water, and small amounts of CO₂.
- **Non-selective Catalytic Reduction (NSCR)** – use of a catalyst reaction to simultaneously reduce NO_x, CO, and hydrocarbon (HC) to water, CO₂, and N₂.

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 Agency⁶ (US EPA) indicates that DOCs are 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,

⁶ <https://www.epa.gov/sites/default/files/2016-03/documents/420f10031.pdf>

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 EPA⁷ 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 (N₂) 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 %⁸. 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 N₂ through the reaction with ammonia (NH₃) or urea (CH₄N₂O) 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 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

⁷ <https://www.epa.gov/sites/default/files/2016-03/documents/420f10029.pdf>

⁸ https://archive.epa.gov/international/air/web/pdf/default-file_dieselfact_0106.pdf

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 N₂. Simultaneously, VOCs and CO undergo oxidation, resulting in the formation of water and CO₂ 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 % O₂ 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 %⁹ [S12].

Various standby generator manufacturers have developed retrofit emission control device (RECD) systems¹⁰ 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 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

⁹ <https://www3.epa.gov/ttnca1/dir1/fnoxdoc.pdf>

¹⁰ http://www.jnmachineries.com/cummins_retrofit_emission_control_device.php

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 aid 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 aid 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 with residential land uses located to the south and 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 & Practice¹¹ 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.
- 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

¹¹ <https://www.phrp.com.au/issues/online-early/residential-indoor-air-quality-and-hepa-cleaner-use/>

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 G5 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 G5 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.
sustainability	We look beyond compliance to add value and identify opportunities. Our services range from sustainability strategies, ecologically sustainable development reporting and assessment, to bespoke greenhouse gas and energy estimation and reporting.

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