Appendix 2

Updated Air Quality Impact Assessment

prepared by

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(Total No. of pages including blank pages = 159) northstar

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Monaro Rock Quarry Project

Updated Air Quality Impact Assessment

Addressee(s):	R.W. Corkery & Co. Pty. Limited
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Quality Control

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

M Doyle **30 June 2026**

NON-TECHNICAL SUMMARY

R.W. Corkery & Co. Pty Limited engaged Northstar Air Quality Pty Ltd on behalf of Monaro Rock Pty Ltd to perform an air quality impact assessment and greenhouse gas assessment for the proposed operation of the Monaro Rock Quarry located near Royalla, NSW.

The assessment forms part of the Environmental Impact Statement prepared to accompany the development application for the project under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The air quality impact assessment has been performed in accordance with the requirements of the NSW Approved Methods for the Modelling and Assessment of Air Pollutants in NSW document and meets the requirements of the planning Secretary's Environmental Assessment Requirements. This updated air quality impact assessment also addresses comments made by NSW Environment Protection Authority on the original assessment.

The air quality impact assessment predicts that the Project can be operated to achieve annual average air quality criteria for TSP, PM_{10}, $PM_{2.5}$, dust deposition, respirable crystalline silica, and nitrogen dioxide. It can also be operated to achieve short term air quality criteria associated with odour, PM_{10}, $PM_{2.5}$, nitrogen dioxide, and volatile organic compounds. Although no additional exceedances of any of the short-term criteria adopted are predicted, Monaro Rock Pty Ltd proposes to implement an air quality monitoring program which would inform, in real-time, management measures to be adopted to minimise particulate emissions at the site to ensure that the potential for any additional exceedances would be avoided.

In relation to greenhouse gas, the assessment indicates that direct emissions associated with the Project are likely to be of the order of approximately 19 531 t CO_2-e per annum. Monaro Rock Pty Ltd is committed to continue to investigate ways to minimise the emission of greenhouse gas, and to reviewing any schemes which may provide opportunity to modernise plant and increase productivity, under the NSW Government Net Zero Plan Stage 1: 2020-2030.

In conclusion, the project can be constructed and operated in accordance with best management practice, to minimise the concentrations of air pollutants on the surrounding environment.

CONTENTS

FIGURES

TABLES

1. INTRODUCTION

R.W. Corkery & Co. Pty Limited (RWC) has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Monaro Rock Pty Ltd (the Applicant) to perform an air quality impact assessment (AQIA) and greenhouse gas assessment (GHGA) for the proposed operation of the Monaro Rock Quarry (the Quarry) located near Royalla, NSW (the Quarry site). The proposed operation of the Quarry, and all other related elements is referred to as 'the Project' and occupies the following land (also referred to as the 'Project Site'). Refer to Figure 1 for the location of the Project.

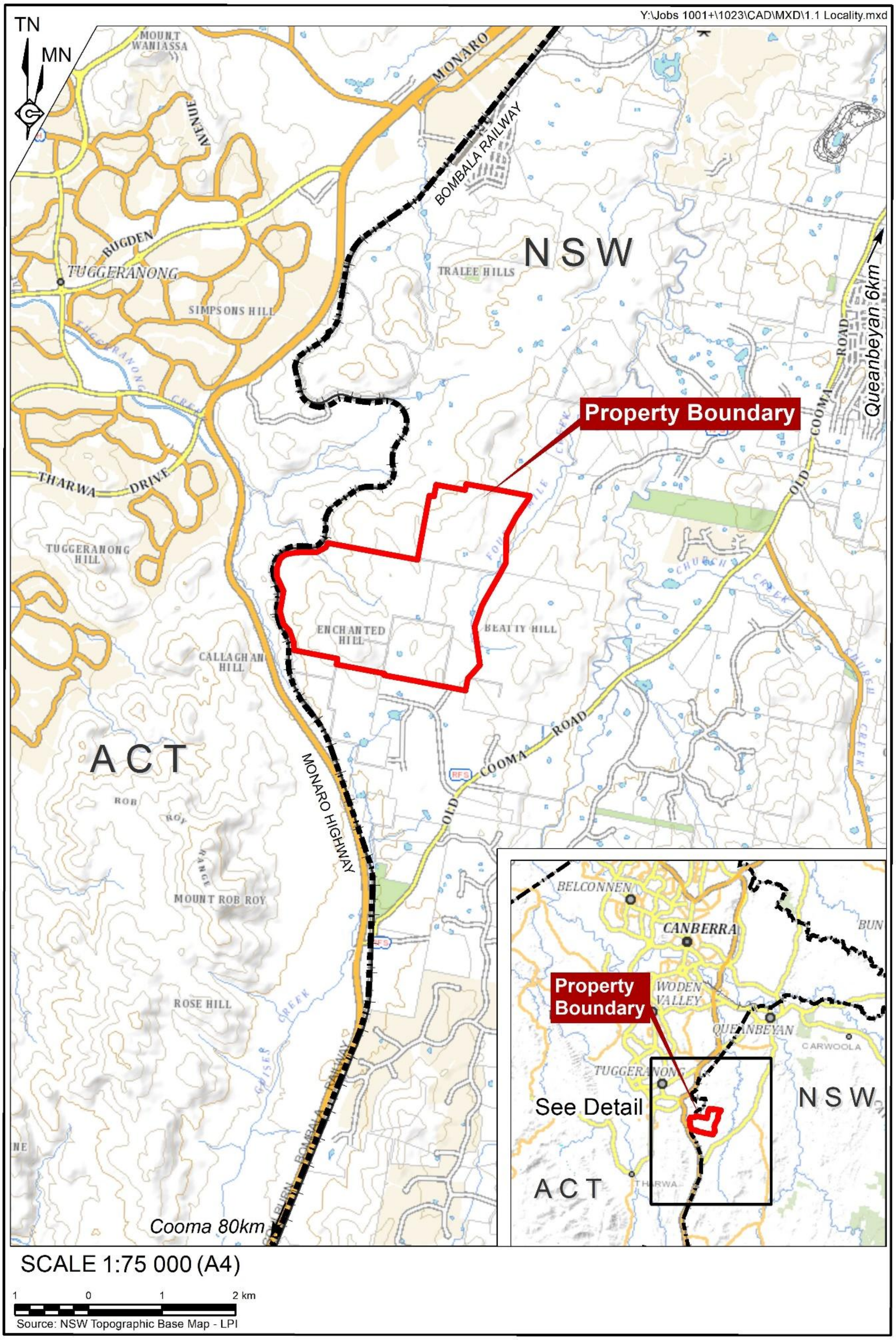
- Lots 1 and 2 of Deposited Plan (DP) 555380;
- Lots 6, 152, 255, 256, 257, 258, 259, 282, 283, 301 and 302 of DP 754912; and
- Lot 7002 of DP 1019607.

The AQIA presents an assessment of the impacts of activities associated with the operational phases of the Project. The AQIA has used a quantitative dispersion modelling approach, performed in accordance with the relevant NSW guidelines. The results of the assessment are presented as predicted incremental change, and as a cumulative impact accounting for the prevailing background air quality conditions.

The GHGA has been incorporated as part of this over-arching AQIA report. The GHGA presents a quantification of the likely GHG emissions associated with the operation of the Project and presents a comparison of these emissions with National and State GHG emissions totals. Opportunities for GHG reduction are also provided.

This AQIA (including the GHGA) forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the Quarry under Part 4 of the *Environmental Planning and Assessment Act* 1979.

Figure 1 Project Site location



Source: RWC

1.1. Assessment Requirements

Planning Secretary's Environmental Assessment Requirements (SEARs) have been provided for the Project by the NSW Department of Planning and Environment (DPE, now the Department of Planning, Housing and Industry [DPHI])) on 18 August 2023. A previous version of the SEARs included input from NSW Environment Protection Authority (EPA), which have not been updated. NSW EPA requirements dated 13 September 2021 have been considered within this AQIA. Table 1 provides a summary of the SEARs and other requirements relevant to this AQIA.

Table 1 Coverage of SEARs and other Government Agency requirements relevant to air quality

Authority	Requirement	Relevant section(s)
SEARs (DPE, 18 August 2023)	a detailed assessment of potential construction and operational air quality impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, with a focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy.	Section 6
	a greenhouse gas assessment of the operation of the development having regard to any applicable State or national policies, programs or guidelines.	Section 7
	details of proposed mitigation, management and monitoring measures.	Section 8
NSW EPA (13 September 2021)	Air Quality Management, including the assessment of all activities at the premises that may generate emissions, including dust, odours and fumes, and the cumulative air quality impacts and human health impacts to nearby sensitive receivers.	Section 6, Section 8

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

- *Environmental Planning and Assessment Act* 1979 (EP&A Act);
- *Protection of the Environment Operations (POEO) Act* 1997;
- *Mining Act* 1992;
- Mining Regulation 2016;
- Environmental Planning and Assessment Regulation 2021 (EP&A Regulation);
- Protection of the Environment Operations (Clean Air) Regulation 2022; and
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2022).

1.2. NSW EPA Advice on Environmental Impact Assessment

NSW EPA has reviewed the AQIA and provided comments on 23 September 2025. Presented in Table 2 is a summary of the comments provided, a response, and the section of this report where additional information can be located.

Table 2 NSW EPA comments on original AQIA

Matter to be addressed[(a)]	Response	Section
1. Provide dispersion modelling predictions based on a meteorological dataset that adequately capture an appropriate level of calm conditions; or 2. Include a sensitivity analysis, where meteorological data measured at the Tuggeranong AWS is used as an observational station in CALMET, and the predicted ground level concentrations for this sensitivity analysis are presented.	Two additional methods of meteorological modelling have been performed. 1. Inclusion of the Tuggeranong AWS data in the TAPM modelling. 2. Inclusion of the Tuggeranong AWS data in the CALMET modelling. The meteorological modelling provided as part of the original AQIA resulted in 0 % of calm wind conditions at the Project Site over the 2021 modelling year. Option 1 above resulted in the prediction of 3.1 % calm winds, and option 2 resulted in 5.3 %. Given that data from Tuggeranong AWS was used in the analysis, no validation can be performed at that location. Analysis of CALMET outputs (both options) indicates that calm wind conditions decrease in frequency as distance from the Tuggeranong AWS increases, with 22.9 % calms at Tuggeranong AWS, and 12.9 % at a location approximately mid-way between the Tuggeranong AWS and the Project Site. This indicates that topographical influences may act to reduce the calm wind conditions at the Project Site, as predicted by the model. In any case, a sensitivity analysis has been performed with the modelled meteorological data output by option 2, and a comparison of dispersion model results provided in Appendix E. The Applicant has committed to installing a real-time meteorological monitoring station as part of the TARP (refer Section 8.1.2).	Section 4.2, Appendix B, Appendix E.
The emission control efficiency for water application on unpaved haulage routes is provided as 90 %. Further justification should be provided to support this value.	Additional detail regarding the calculation of the quoted 90 % emission control efficiency is provided in Section 2.10.2. It is emphasised that water AND chemical suppressants are options for the control of particulate emissions from haulage routes. The Applicant has indicated that sufficient water would be available to meet a particulate control efficiency of 90 % (see section 6.4.1 of the Surface Water	Section 2.10.2

Matter to be addressed[a]	Response	Section
	Assessment (SEEC, 2025)), which has been calculated using the equation provided in (Buonicore & Davis, 1992). The equation takes into account local evaporation rates, traffic activity, and water application intensity and frequency. Should sufficient water not be available in any year to achieve the required control efficiency, chemical suppressants would be used. Emission control efficiencies of up to 99 % have been measured from the use of chemical suppressants on unpaved haulage routes at coal mines in NSW, with 90 % representing an average level of control.	
The effectiveness of the proposed TARP should be provided.	Re-performance of the assessment adopting updated meteorology which reflects a greater incidence of calm wind conditions (see above), indicates that although incremental particulate matter impacts are predicted to marginally increase at sensitive receptors, the distribution of particulate matter is such that the exceedances predicted in the original AQIA are no longer anticipated to be experienced. The TARP would be used to provide additional assurance that the Project can be operated to ensure that no additional particulate matter exceedances would eventuate as a result of the Project operation.	Appendix E, Section 6, Section 8.1.2
A diesel generator is proposed, include this in modelling and compare emissions concentrations with the POEO (Clean Air Regulation) 2022.	The AQIA has been updated to include emissions from a diesel generator, and a comparison with the POEO (CAR) regulations provided.	Section 3.3, Section 5.1.3.
Emissions from the asphalt plant are limited to odour emissions from the plant dryer stack only. Include emissions of NO_X and volatile organic compounds, and emissions from fugitive emissions sources (load-out, storage tanks)	The AQIA has been updated to include emissions of NO_X and VOCs from the asphalt batching plant, and fugitive emissions from asphalt load-out. A discussion of management of fugitive emissions from storage tanks is provided.	Section 2.7, Section 5.1.3, Section 6.3, Section 6.4, Section 6.5.

Note: (a): Comments have been paraphrased. Full advice can be viewed at https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=PAE-91944970%2120250923T061909.111%20GMT

2. THE PROJECT

A full description of the Project is provided in section 3 of the EIS. Details relevant to the AQIA / GHGA are presented in this section.

2.1. Overview

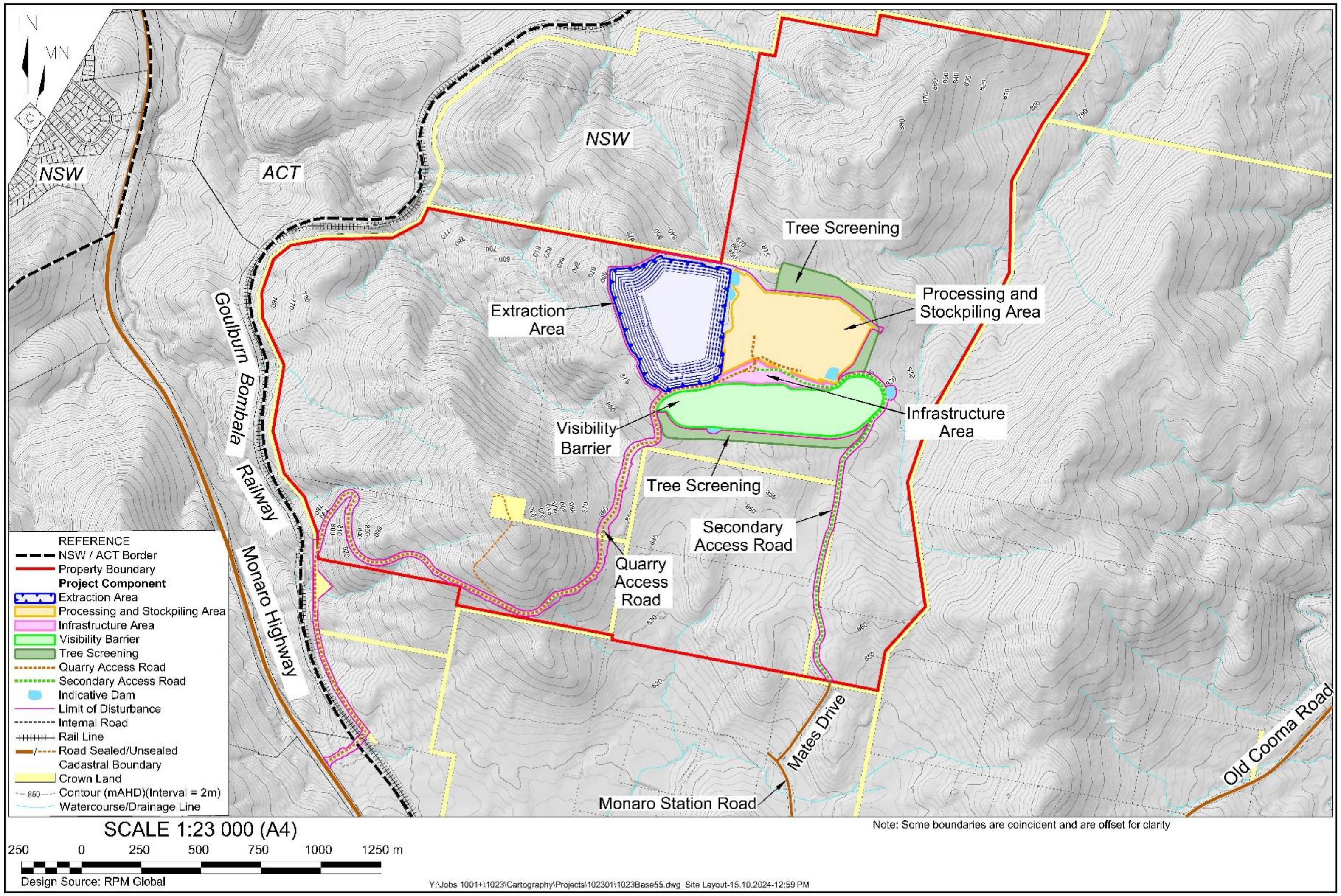
The Project would comprise a standard hard rock quarry development with key activities being the use of occasional blasting to fragment the in-situ resource before this material is loaded to haul trucks for relocation to the fixed or mobile processing plant. After crushing and shaping, the material would be temporarily stored within the Project Site before being despatched to customers via the public road network.

The principal components of the Project Site are presented in Figure 2 and include the proposed:

- Extraction Area that would be developed in four stages within an area of approximately 21.1 hectares (ha) and to approximately 87 metres below ground level (mbgl) (a final floor elevation of 795 m Australian Height Datum [AHD]);
- Processing and Stockpiling Area that would be developed in three stages covering an area of approximately 17.9 ha;
- Infrastructure Area comprising administration buildings, weighbridge, car parking area, fuel storage, and workshop within an area of approximately 2.7 ha;
- Quarry Access Road that would extend over approximately 4.0 kilometres (km) and connect the Project Site to the public road network via the Monaro Highway;
- Visibility Barrier that would be developed in two stages within an area of approximately 16.1 ha; and
- Tree Screening Area comprising vegetation intended to act as a further visual barrier.

Associated with these components would be additional infrastructure to support the Project.

Figure 2 Principal components of the Project



Source: RWC

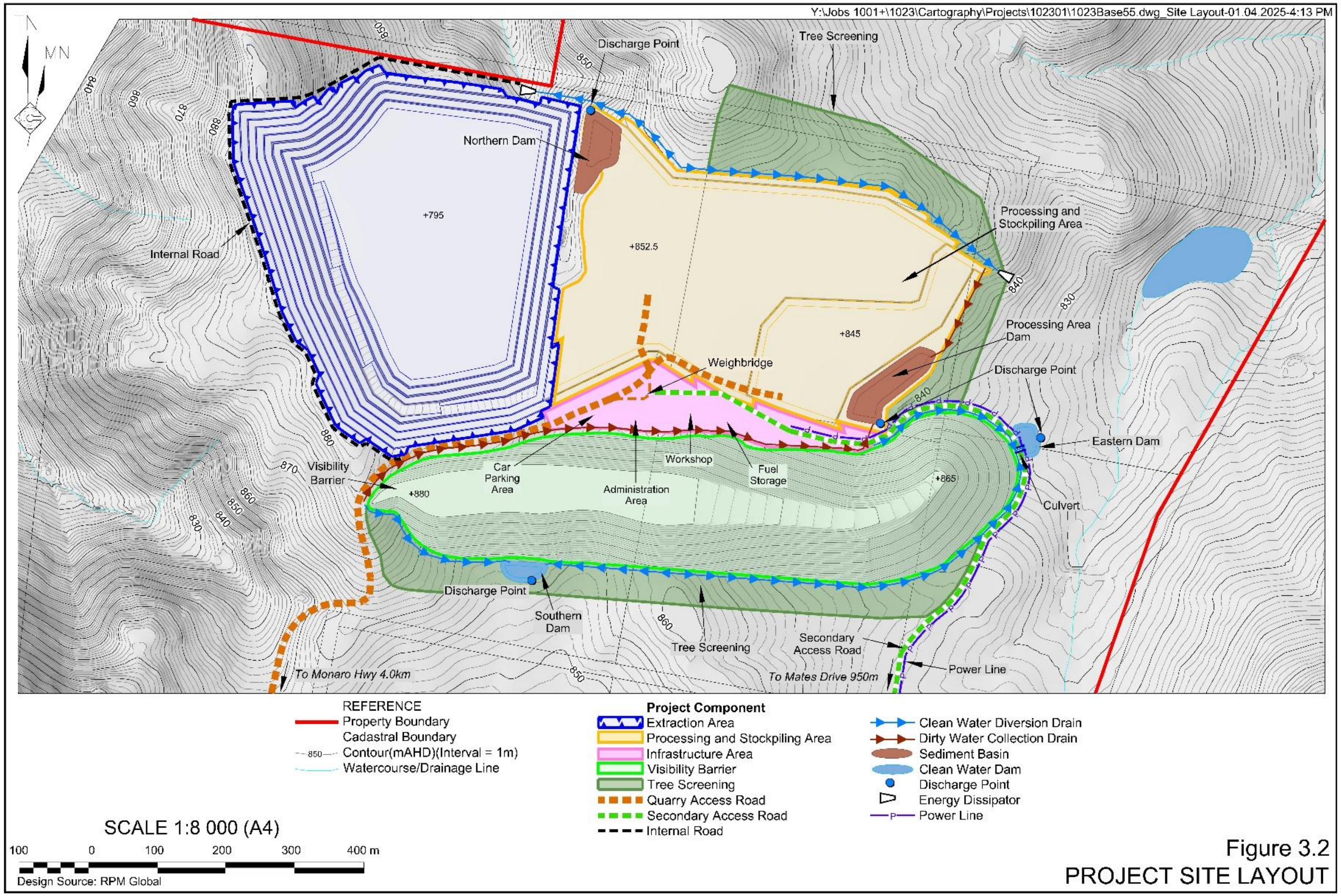
An overview of key Project elements is provided in Table 3, with a detailed Project Site layout presented in Figure 3.

Table 3 Project overview

Project element	Description
Infrastructure	Project-related infrastructure includes an Extraction Area, Processing and Stockpiling Area, Visibility Barrier, Infrastructure Area and sediment and erosion control infrastructure.
Project Site	An area of approximately 67.6 ha which would incorporate all quarrying-related infrastructure.
Limit of Disturbance	An area of approximately 79.2 ha that incorporates the Project Site and access roads. It is defined as the area in which the surface would be disturbed or used for quarrying activities and transportation.
Resource	A resource of high quality rhyodacite of approximately 27.9 million tonnes (Mt) of has been defined in the Extraction Area. Testing of the material indicates it is a high-quality resource ideal for concrete production, amongst other uses.
Overburden	Approximately 3.3 Mt of highly weathered material would be generated by the Project and would be used to construct Project Site components or incorporated in road base products for sale to customers, or used for rehabilitation works.
Extraction Method	Conventional drill, blast, load and haul methods that are standard in the quarrying industry.
Processing	Processing of hard rock material would produce a range of Quarry products. Processing would initially be undertaken using a mobile processing plant before the commissioning of fixed processing plant later in the Project Life.
Annual Production	Progressive ramp up of production to a limit of no greater than 1 Mt per year ($Mt{\cdot}yr^{-1}$).
Material Importation	Virgin excavated natural material (VENM) on excavated natural material (ENM) would be imported to support site establishment (such as road construction) and may be imported on an ongoing basis to support rehabilitation of the Project Site. No more than 150 000 $t{\cdot}yr^{-1}$ of VENM/ENM would be imported. Waste concrete would be imported to the Project Site for recycling and reuse in road base or similar products. No more than 20 000 $t{\cdot}yr^{-1}$ of concrete would be recycled.
Project Site Access	All products would be despatched via a dedicated Quarry Access Road. The road would be approximately 4.0 km from the weighbridge to its intersection with the Monaro Highway. It would feature a 2.7 km sealed section and include a railway bridge crossing. A dedicated intersection with the Monaro Highway would be constructed to permit access to the Quarry and for heavy vehicle transport activities.
Secondary Access	Secondary access to the Project Site (for light vehicles) would be provided by an unsealed Secondary Access Road extending approximately 1.5 km from the Infrastructure Area to its intersection with Mates Drive.
Infrastructure Area	An Infrastructure Area would include administration buildings (i.e. site office, lunch and bathroom facilities), car parking areas, a weighbridge, a stand-alone Workshop and a dedicated fuel storage and refuelling area.

Project element	Description
Ancillary Infrastructure	Additional infrastructure for use in activities that are ancillary to aggregate production would be developed. These activities would include the production of up to 50 000 cubic metres per year ($m^3 \cdot yr^{-1}$) of pre-mix concrete and 50 000 $t \cdot yr^{-1}$ of asphalt.
Product Transportation	Transportation of Quarry products involving a maximum of 25 laden heavy vehicles per hour and no more than 200 laden heavy vehicles per day and 50 concrete agitators per day.
Project Life	Ongoing operations for a period of 30 to 35 years from the commencement of operations

Figure 3 Project Site layout



Source: RWC

2.2. Project Staging

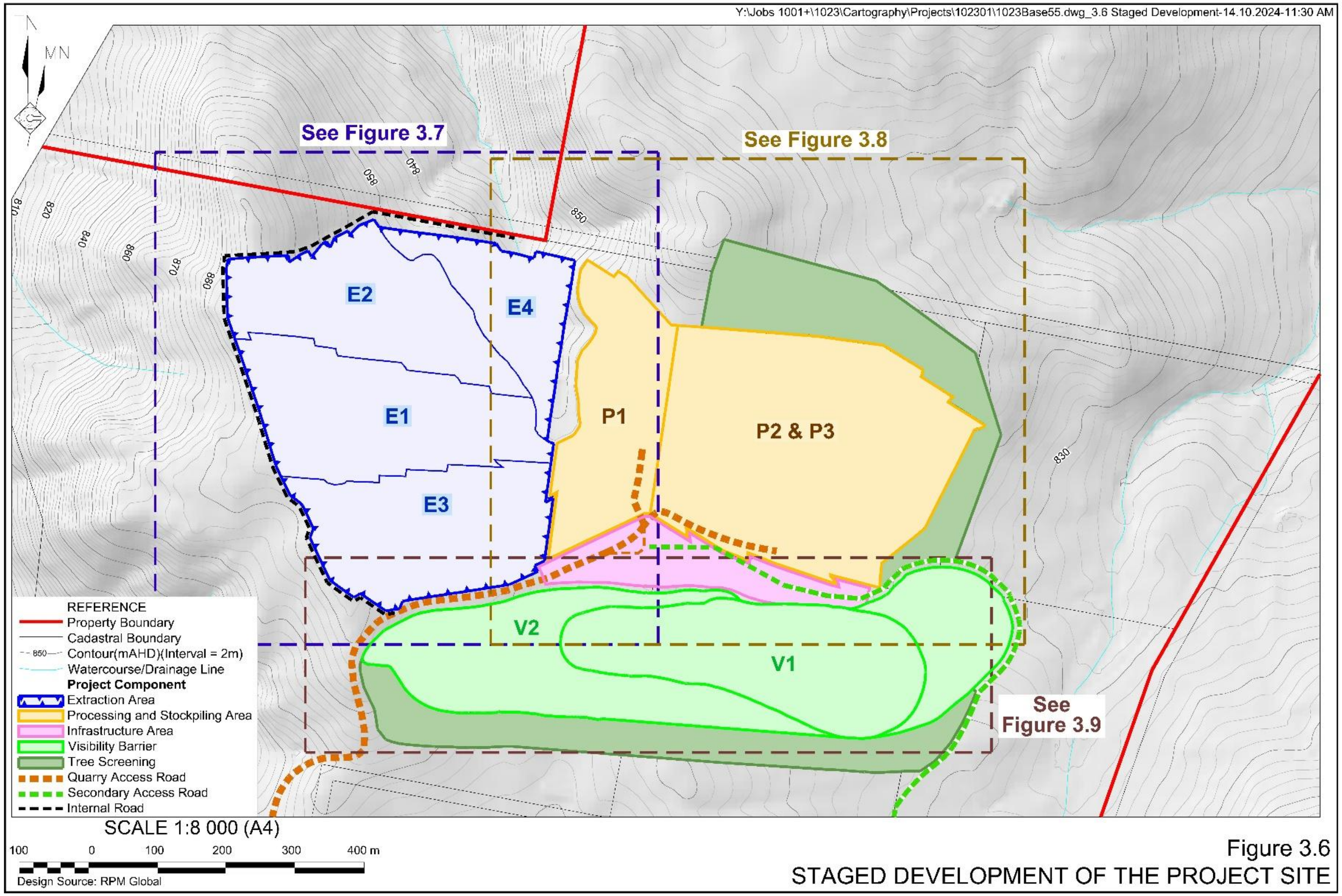
The sequence for development of the Extraction Area is presented in Figure 4 and is summarised as follows.

- Stage E1 – initial development within a footprint of 6.4 ha and to an elevation of approximately 852.5 m AHD.
- Stage E2 – lateral extension to the north of approximately 5.6 ha and same floor elevation as Stage E1 (852.5 m AHD).
- Stage E3 – lateral extension to the south of approximately 6.0 ha and to the same floor elevation (852.5 m AHD).
- Stage E4 – widening of the Extraction Area to the north east (an additional 3.1 ha to the full extent of 21.1 ha) and development to a final floor elevation of 795 m AHD.

The proposed rate of production would be progressively increased to meet demand. The triggers for production rates would coincide with the staging of development of the Processing and Stockpiling Area as the space available in this area would need to grow to provide stockpiling space and the management of various product types. Timing for each stage would be dependent on customer demand but it is anticipated that Stage 2 would be commenced within five years of approval.

- Project Site Establishment - Processing and despatch of up to 100 000 $t{\cdot}yr^{-1}$ during site establishment using mobile processing plant which would initially be located within the Extraction Area.
- Stage 1 - Processing of up to 250 000 $t{\cdot}yr^{-1}$ using a mobile processing plant which would be located within the Stage P1 Processing Area. A Pugmill would also be used during this stage.
- Stage 2 - Once a production rate of 250 000 $t{\cdot}yr^{-1}$ is reached, the Stage P2 Processing Plant area would be constructed.
- Stage 3 Production using mobile processing equipment would continue up to a level of 750 000 $t{\cdot}yr^{-1}$. At this level, or earlier if needed, a fixed processing plant would be commissioned and built. The fixed processing equipment would then be used for production up to the limit of 1 $Mt{\cdot}yr^{-1}$.

Figure 4 Project staging



Source: RWC

2.3. Material Extraction

Extraction would occur using standard drill and blast, load and haul methods. Blasting would generate between 25 000 t and 100 000 t of raw material for each blast event. Blasted rock would be loaded to haul trucks by excavator or front-end loader and hauled from the Extraction Area to the mobile or fixed processing plant.

Blasting would be limited to at most, weekly blast events. Blasting may need to be repeated in the event of a misfire, however this would be rare.

2.4. Material Processing

2.4.1. Mobile Processing Plant

Both mobile and fixed processing plants would be utilised throughout the Project life. The mobile crushing and screening equipment would include the following indicative components.

- A primary jaw crusher e.g. Terex Finlay J-1480 or similar.
- Secondary and tertiary cone crushers e.g. Terex Finlay C-1550P or similar.
- Two screening decks e.g. Terex Finlay 984 or 893 screeners or similar.
- Conveyor belts, stackers, bins and hoppers.
- Pugmill.
- A quaternary Vertical Shaft Impactor e.g. TwisterTrac VS350E or similar.

The mobile processing plant would have an indicative production capacity of 300 tonnes per hour ($t \cdot hr^{-1}$) when producing hard rock aggregates and up to 400 $t \cdot hr^{-1}$ when producing road base products. It is anticipated that on average, production would be split 60 % / 40 % between aggregates and road base.

2.4.2. Fixed Processing Plant

For all production at levels greater than 750 000 $t \cdot yr^{-1}$ the Applicant would use fixed processing plant (Stage P3 Processing Plant). The fixed processing plant would include the following components.

- A primary jaw crusher.
- Secondary and tertiary cone crushers.
- A quaternary vertical shaft Impactor
- Five screening decks.
- Conveyor belts, stackers, bins and hoppers.

- Pugmill.

All new processing plant would be constructed in accordance with standard practice for the quarrying industry and incorporate suitable enclosures and other mitigation for potential noise and dust impacts.

- The fixed processing plant would have an indicative production capacity of 350 $t \cdot hr^{-1}$ when producing hard rock aggregates and up to 600 $t \cdot hr^{-1}$ when producing road base products. The proposed processing and stockpiling area stages is illustrated in Figure 3.8 of the EIS, which is reproduced as Figure 5 in this AQIA.

2.5. Concrete Recycling

- The Applicant would import and process approximately 20 000 $t \cdot yr^{-1}$ of concrete and use the material as a component of blended products for sale. The proposed location of the concrete recycling plant within the Project Site is shown in Figure 3.4 of the EIS, reproduced in Figure 5 in this AQIA.

Recycling of concrete material would involve the import, crushing and screening, temporary storage and blending, depending on raw feed characteristics and desired product specification. Incoming concrete material volumes would vary over the short and long term but would not exceed 20 000 $t \cdot yr^{-1}$. The principal source of concrete for recycling would be concrete washout material that is likely to be transported to the Project Site by trucks returning from concrete plants (i.e. backloading). However, this would be dependent on the material source and may not always be the case.

2.6. Concrete Batching Plant

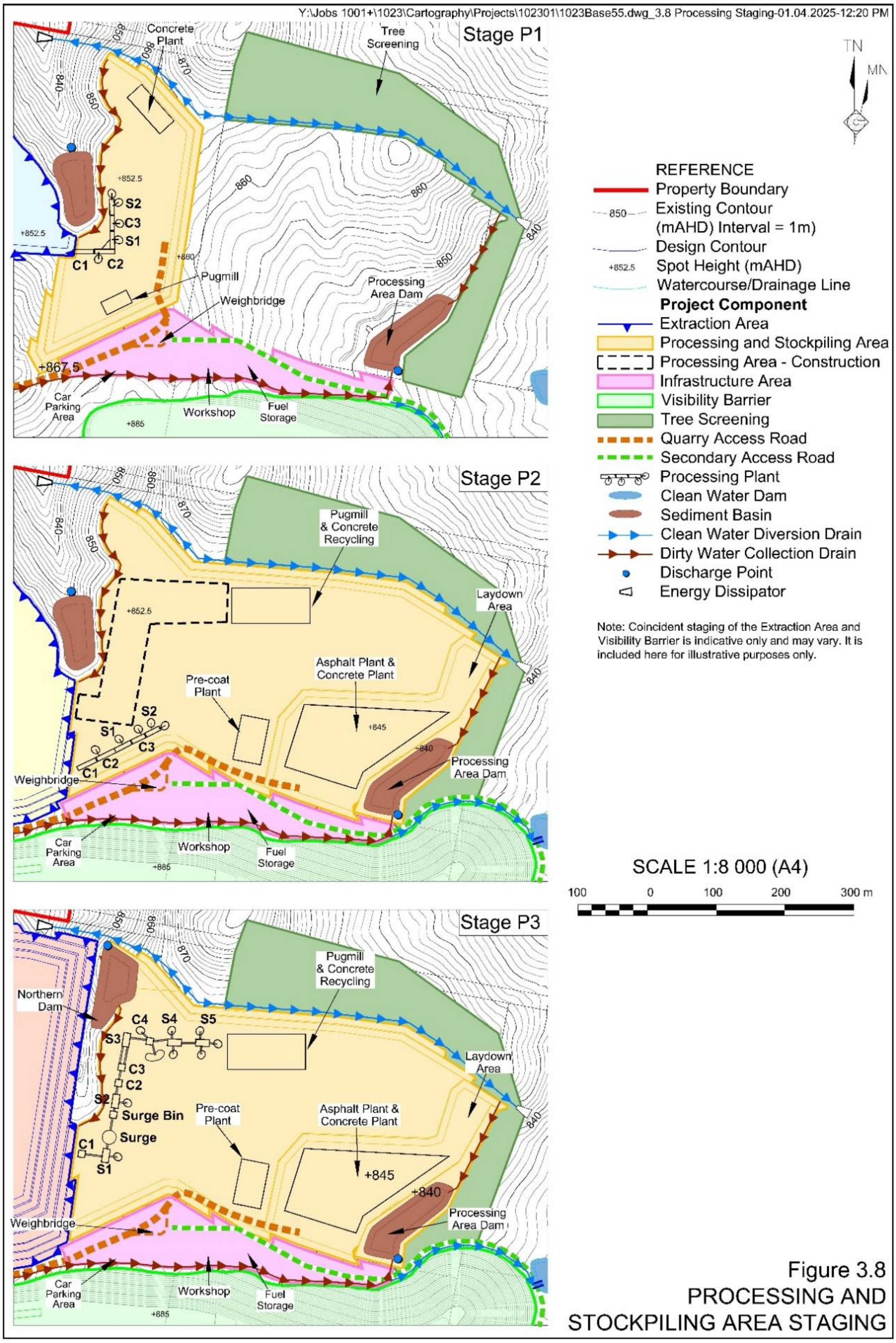
A conventional concrete batching plant would be developed within the Processing and Stockpiling Area. The plant would have the capacity to produce and despatch up to 50 000 m^3 of concrete per annum and up to 300 m^3 of concrete per day. It is not expected that the concrete batching plant would be constructed during site establishment but would commence later in the Project life.

The location of the concrete batching plant is provided in Figure 5 and an indicative layout provided in Figure 3.9 of the EIS which is reproduced as Figure 6. The exact configuration of the required infrastructure would be determined upon commissioning of construction. Concrete batching would involve the following key activities.

- Receipt and storage of concrete raw materials (in designated material bins, cementitious storage silos and tanks).
- Loading of aggregates and sand into a hopper using a Front-end Loader.
- Conveying of aggregates and sand to batching bins.

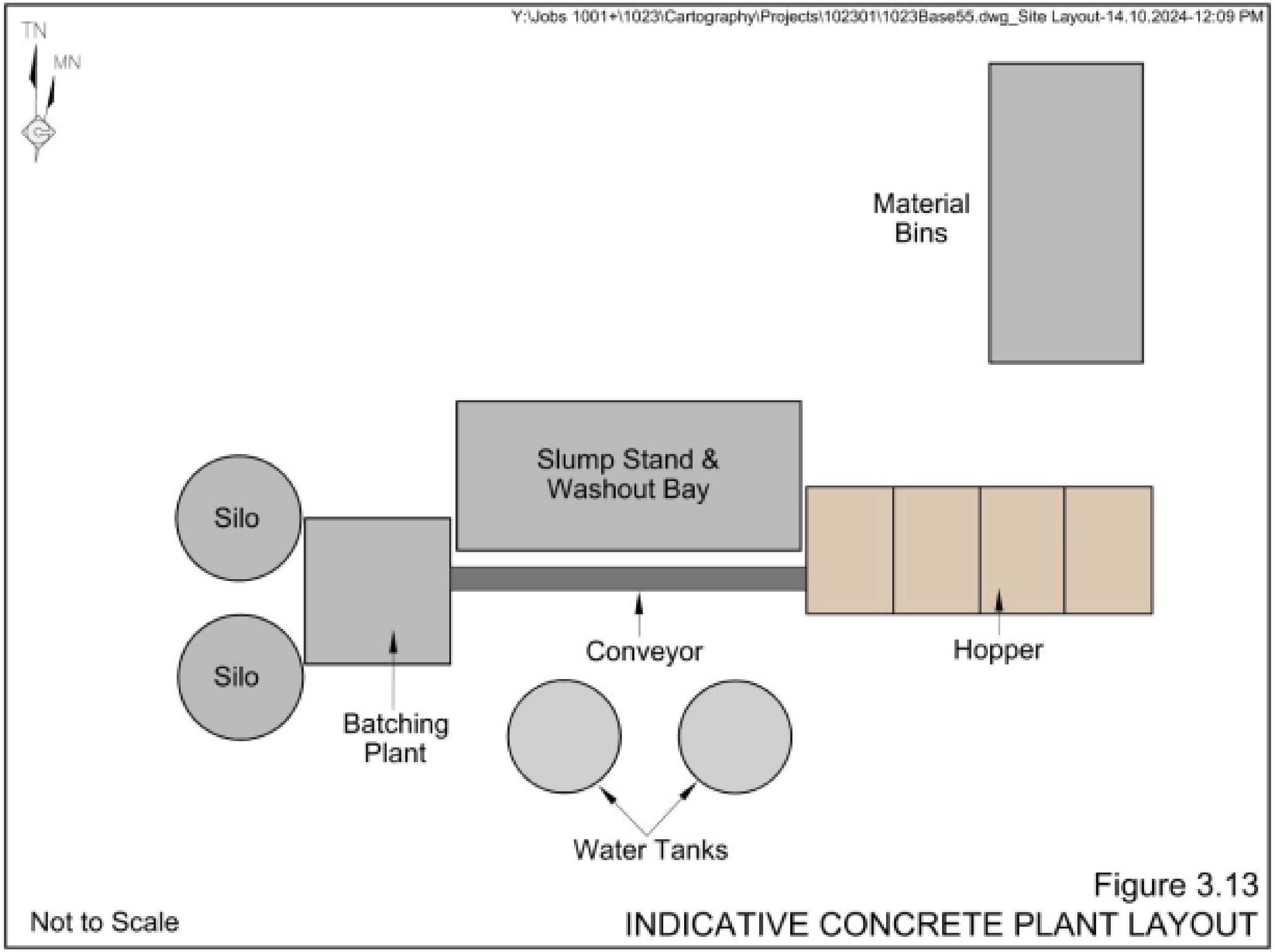
- Blending of concrete raw materials.
- Despatch of concrete to customers in concrete agitators.
- Washout of returning concrete agitators.

Figure 5 Processing and stockpiling area stages



Source: RWC

Figure 6 Indicative concrete plant layout



Source: RWC

2.7. Asphalt Plant

An asphalt plant would also be constructed within the Processing and Stockpiling Area to produce asphalt for road construction and maintenance. The plant would have the capacity to produce and despatch up to 50 000 t of asphalt per year and up to 1 000 t of asphalt per day. The location of the asphalt plant is provided in Figure 5 and an indicative layout provided in Figure 3.14 of the EIS which is reproduced as Figure 7 in this AQIA. Construction of the asphalt plant would also not occur during site establishment but occur later in the Project life.

Asphalt production principally consists of mixing aggregate materials with bitumen in a heated environment to create a heated mix that is then applied in road construction. Aggregates of varying type and size are used in the process as well as additional materials that are called 'fillers' that fill voids in the paving mix and improve the cohesion of the asphalt binder.

The model of asphalt plant and its components may change over time. Improvements in manufacturing are constantly being introduced, and the Applicant may utilise alternate models of asphalt plant to meet the specific needs of road surfacing and resurfacing projects. The asphalt plant would be fixed or mobile and include the following components.

- cold aggregate feed bins;
- a cold feed conveyor;
- a diesel burner;
- a rotary drum drier/mixer;
- a wet scrubber and water eliminator;
- an exhaust stack;
- a wet scrubber / dust collector;
- an output conveyor;
- an elevated hot asphalt storage hopper;
- a diesel generator (approximately 500 kW); and
- a control house.

Aggregates and fillers are loaded into the cold feed aggregate bins using a front-end loader before being drawn down from individual feeder bins using weigh feeders and conveyed into the drum drier/mixer and heated to approximately 165 ºC by a burner. Bitumen is added to the hot aggregates at the end of the mixing process to produce hot-mix asphalt. The hot-mix asphalt would then be conveyed into the overhead storage hopper and discharged into trucks for transfer to the point of use. Materials would be transferred between components by conveyor before being transferred directly to heavy vehicles for transport.

Most aggregates for asphalt production would be sourced within the Project Site with all other materials imported as needed and stored within dedicated storage bays. Hard rock aggregates of varying size would be used, but reclaimed asphalt pavement (RAP) and steel slag also have a similar role in asphalt mixes.

The use of fillers is a standard practice in asphalt production with the predominant filler being lime, however, other materials such as fly-ash, dust, glass, plastics and crumbed rubber may be used. The use of additional materials in asphalt production provides a variety of benefits to asphalt performance as well as the economic and environmental benefits associated with the beneficial reuse of waste materials. For example, steel furnace slag is a waste product of steel making and can be used to improve the anti-skid properties of asphalt.

As an example, for the production of 1 000 t of asphalt the raw materials used would include:

- 830 t of coarse aggregates (various sizes);
- 100 t fine aggregates (typically <5mm);
- 20 t filler; and
- 50 t bitumen.

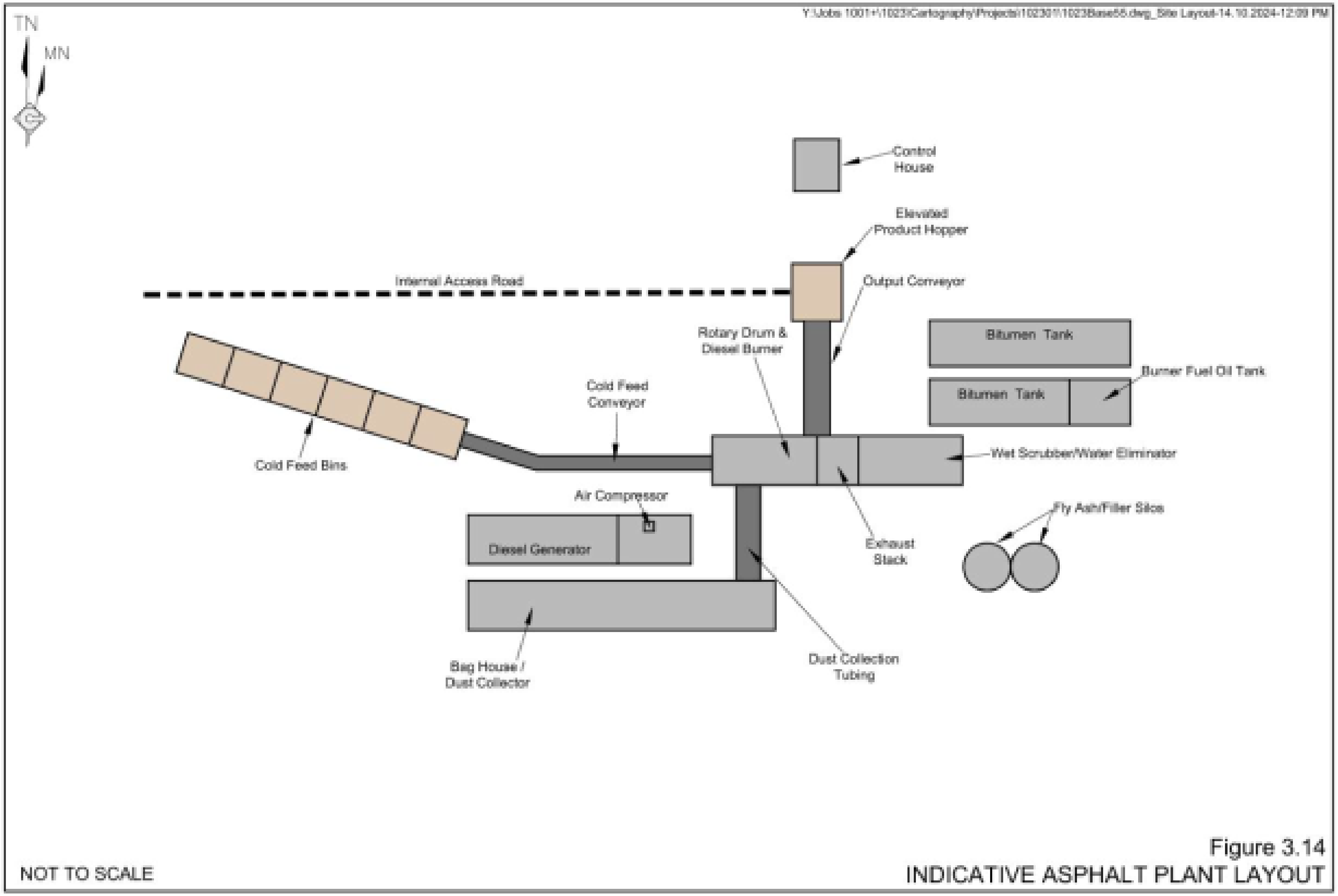
Filler materials such as lime would be stored within silos adjacent to the asphalt plant. Aggregates imported to the Project Site would be stored in dedicated storage bins. Bitumen would be stored in a bunded bitumen storage tank with a 36 000 L capacity.

Vapours/fumes from the heated bitumen tanks would be captured using a series of pipelines connecting each bitumen storage tank to a charcoal vapour trap located at ground level. This trap treats any vapours emitted from the bitumen tanks during the loading from the bitumen delivery tankers (working losses), and from maintaining the bitumen temperature during storage (breathing losses). VOC emissions from the dryer stack and load out area have been modelled within this AQIA, with breathing and working losses from bitumen storage tanks assumed to be negligible. The low impacts predicted (refer Section 6.5) suggest that impacts associated with VOCs at surrounding sensitive receptors are negligible.

Diesel required to power the burner in the asphalt plant would be supplied from a dedicated asphalt plant fuel storage area that includes a bunded above-ground tank with a 20 000 L capacity.

Some materials required for asphalt production would be imported to the Project Site. A variety of heavy vehicles may be required for this purpose including pneumatic tankers, semi-trailers or truck-and-dog configuration vehicles. Walking floor semi-trailers and truck and dog configuration heavy vehicles would be used to transport asphalt from the Project Site.

Figure 7 Indicative asphalt plant layout



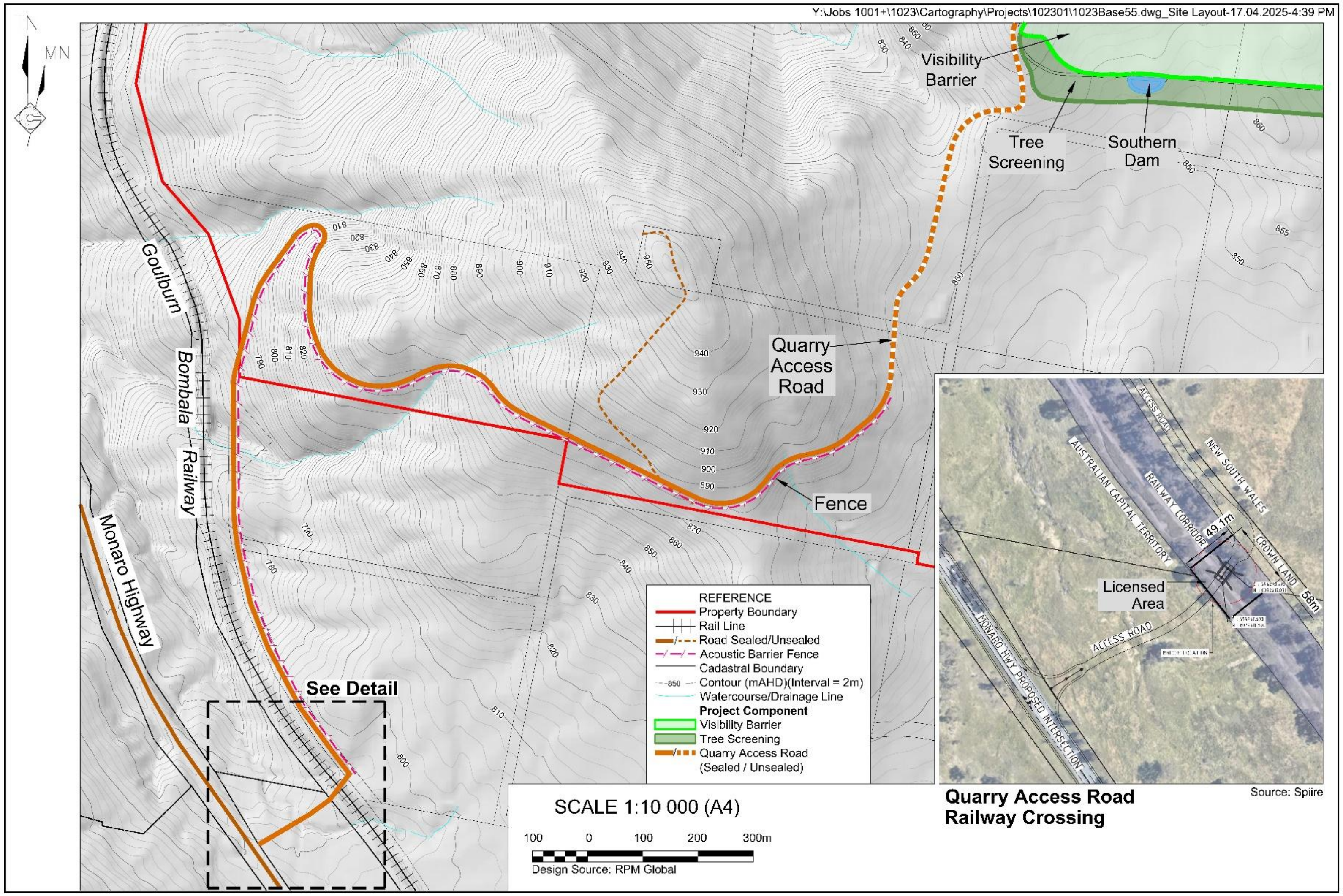
Source: RWC

2.8. Transportation

A dedicated Quarry Access Road would be constructed between the operational areas of the Project Site and the Monaro Highway. The road would be approximately 4 km in length and include a crossing of the Goulburn Bombala Railway Line (not currently operating). After the crossing, the road would pass into the Australian Capital Territory (ACT) with a short road constructed to a dedicated intersection with the Monaro Highway. Figure 3.15 of the EIS presents the proposed Quarry Access Road, which is reproduced as Figure 8 in this AQIA.

The Quarry Access Road would be sealed for a length of 2.7 km from the intersection with the Monaro Highway and a 3 m high colorbond or wooden fence constructed on one side of the sealed section of road. The sealing and fencing would be in place to mitigate noise propagation and dust dispersion. The remainder of the road from the Quarry operating area to the south towards Enchanted Hill would be unsealed and graded. The Applicant would monitor and maintain the condition of the entire road to limit noise and dust generation as much as practically possible.

Figure 8 Quarry access road



Source: RWC

The bulk of quarry products would be despatched from the Project Site using truck and dog trailers of various configurations (typically 32.5 t and 37.5 t capacity), and smaller quantities of products would be despatched by semi-trailers (typically 27.5 t to 30 t capacity) or rigid trucks (typically 12.5 t to 18 t capacity). Larger capacity vehicles may be used depending on customer requirements.

Daily traffic would vary over the life of the Project, dependent on demand, and it is the nature of the construction business for there to be peaks and troughs in demand. In order to meet the anticipated peaks in demand a peak daily traffic level of 200 heavy vehicle laden loads is proposed and a limit of no more than 25 laden loads in any given hour. Up to 50 laden loads of concrete may be despatched on a peak day by concrete agitator (in addition to heavy vehicle traffic). For the purpose of assessment and for setting limits, traffic levels are considered in terms of movements to take into account the movement to the Project Site and the movement departing the Project Site (that is, laden loads are a one-way measure, and movements account for both directions).

Ancillary activities would also generate traffic with the following traffic levels expected.

- **VENM / ENM import:** The Applicant is proposing the importation of up 150 000 $t{\cdot}yr^{-1}$ of VENM or ENM for site construction and rehabilitation activities. Where possible, material would be transported to the Project Site using trucks returning from the delivery of quarry products to customers (i.e. backloading). The transportation of VENM / ENM materials would be included in daily and hourly limits for the Project and measured at the weighbridge.
- **Concrete Recycling:** The Applicant is proposing to import up to 20 000 $t{\cdot}yr^{-1}$ of hardened concrete for recycling. It is likely that concrete would be transported to the Project Site by trucks returning from concrete plants (i.e. backloading). However, this would be dependent on the material source and may not always be the case. The transportation of concrete materials would not be expected to exceed 10 loads on any day and would be included in the heavy vehicle daily and hourly limits for the Project and measured at the weighbridge.
- **Concrete Production:** The Applicant would produce concrete at a rate of up to 50 000 $m^3{\cdot}yr^{-1}$ and up to 300 $m^3{\cdot}day^{-1}$. Raw materials for concrete production may be delivered in a variety of vehicles including pneumatic tankers, semi-trailers and truck-and-dog configuration heavy vehicles. Raw material delivery would be included in the daily and hourly limits for the Project. Concrete would be despatch in various sized concrete agitators with up to 50 loads despatched in a day (assuming an average payload of 6 m^3).
- **Asphalt Production:** The Applicant would produce and despatch up to 50 000 $t{\cdot}yr^{-1}$ and up to 1 000 $t{\cdot}day^{-1}$ of asphalt. As asphalt would be produced in campaigns to meet demand it is not expected to be despatched on each day. Raw materials for asphalt production may be delivered in a variety of vehicles including pneumatic tankers, semi-trailers and truck-and-dog configuration heavy vehicles. Asphalt would be despatched in various sized heavy vehicles depending on customer requirements. Up to 40 loads of asphalt may be despatched in a day (assuming an

average payload of 25 t) and would be included in the heavy vehicle daily and hourly limits for the Project and measured at the weighbridge.

A summary of total traffic generation at the Project Site is presented in Table 3.5. of the EIS, which has been reproduced as Table 4.

Table 4 Predicted transport types and levels

<table>
<tr><th rowspan="2">Transport type</th><th rowspan="2">Most common vehicle type</th><th colspan="3">Transport levels (loads / movements)</th></tr>
<tr><th>Average daily(A)</th><th>Peak daily</th><th>Cumulative daily(B)</th></tr>
<tr><td>Aggregate dispatch</td><td rowspan="4">Truck-and-dog</td><td>99 / 190</td><td>200 / 400</td><td rowspan="4">200 / 400</td></tr>
<tr><td>VENM / concrete import</td><td>15 / 30</td><td>60 / 120</td></tr>
<tr><td>Concrete / asphalt raw material delivery</td><td>3 / 6</td><td>5 / 10</td></tr>
<tr><td>Asphalt dispatch</td><td>14 / 28</td><td>40 / 80</td></tr>
<tr><td>Concrete dispatch</td><td>Concrete agitator</td><td>28 / 56</td><td>50 / 100</td><td>50 / 100</td></tr>
</table>

Notes (A) assumes 302 operating days in a 12-month period and an average load of 35 t

(B) Represents the maximum number of traffic loads/movements in any day across all transport types. That is, peaks in one type of traffic would require a decrease in other traffic types on a given day to a level no greater than the cumulative daily limit.

Although vehicle types would vary over any day, the maximum for heavy vehicle truck and trailer configuration vehicles would remain at 200 loads per day and the maximum for concrete agitators involved in the despatch of concrete would be 50 loads per day. Concrete despatch would be managed separately given the small volume despatched in each concrete agitator. Various types of service vehicles and light vehicles would enter and leave the Project Site on any given day depending on the activities occurring at the time and for the transport of employees.

2.9. Hours of Operation

Table 5 lists the proposed hours of operation for the range of activities that would be undertaken throughout the life of the Project.

Table 5 Proposed Hours of Operation

Activity	Monday to Friday	Saturdays	Sundays or Public Holidays
Construction activities	7:00 am to 6:00 pm	8:00 am to 1:00 pm	Nil
Extraction and processing operations including use of Pugmill and concrete recycling	7:00 am to 6:00 pm	7:00 am to 6:00 pm	Nil
Blasting operations	9:00 am to 5:00 pm	Nil	Nil
Product despatch and material importation	5:00 am to 6:00 pm	5:00 am to 6:00 pm	Nil
Concrete / asphalt production	7:00 am to 6:00 pm	8:00 am to 1:00 pm	Nil
Maintenance	24 hours / day	24 hours / day	Nil

The hours nominated in Table 5 are those that the Applicant would operate within, not that they would be operating throughout the entire nominated periods. That is, the nominated hours would provide the flexibility needed to undertake all Project-related activities, when required.

The flexibility achieved by the proposed operating hours would be important in order that the Applicant can respond to large volume or urgent orders from its customers.

2.10. Air Quality Management

A number of measures are proposed to be implemented as part of the Project to minimise air pollutant emissions. These are described in the following sections.

2.10.1. Visibility Barrier

The Applicant would utilise the area to the south of the Extraction Area and Processing and Stockpiling Area to construct a Visibility Barrier (see Figure 2 to Figure 4). The barrier would have a dual purpose of providing a stable and vegetated barrier to shield operational components of the Project from residences and public vantage points to the south and southeast and as a storage location for overburden material that may not be suitable for sale. The Visibility Barrier would principally be constructed from highly and moderately weathered material removed during the development of the Extraction Area and Processing and Product Stockpiling Area. In addition to being proximal to the Extraction Area, thus resulting in shorter haul distances for material, the principal selection criterion for the location of the Visibility Barrier was to make use of the natural landform as much as possible in establishing an effective topographic barrier.

The development of the Visibility Barrier would be staged as follows to ensure that impacts are mitigated to the greatest extent practicable during the progressive development of the Quarry:

- **Stage V1 Visibility Barrier** – construction of the initial barrier would commence during site establishment using weathered material removed from operational areas. The barrier has been designed to reach an elevation of 865 m AHD with a footprint of 6.9 ha. The total volume of material required to construct the barrier would be approximately 556 000 m^3 (loose cubic metres [lcm]).
- **Stage V2 Visibility Barrier** – Extension of the Visibility Barrier to the northeast to obscure the development of the processing area and to the west to obscure further development of the Extraction Area. The barrier would extend the existing structure to an elevation of 880 m AHD and cumulative area of 16.1 ha. Development of the Stage V2 Visibility Barrier would require 1.2 Mm^3 (lcm) of material and is likely to commence with the extension of the Processing and Stockpiling Area (Stage P2 Processing Area).

During both stages of Visibility Barrier construction, the southern faces of the barrier would be constructed first with infill occurring progressively to the north. The barrier would be constructed in lifts of between 3 m to 5 m. This would permit the southern faces to be stabilised and revegetated as soon as practical and would provide the benefit of mitigating possible views of the Project Site while obscured areas of the barrier continue to be developed.

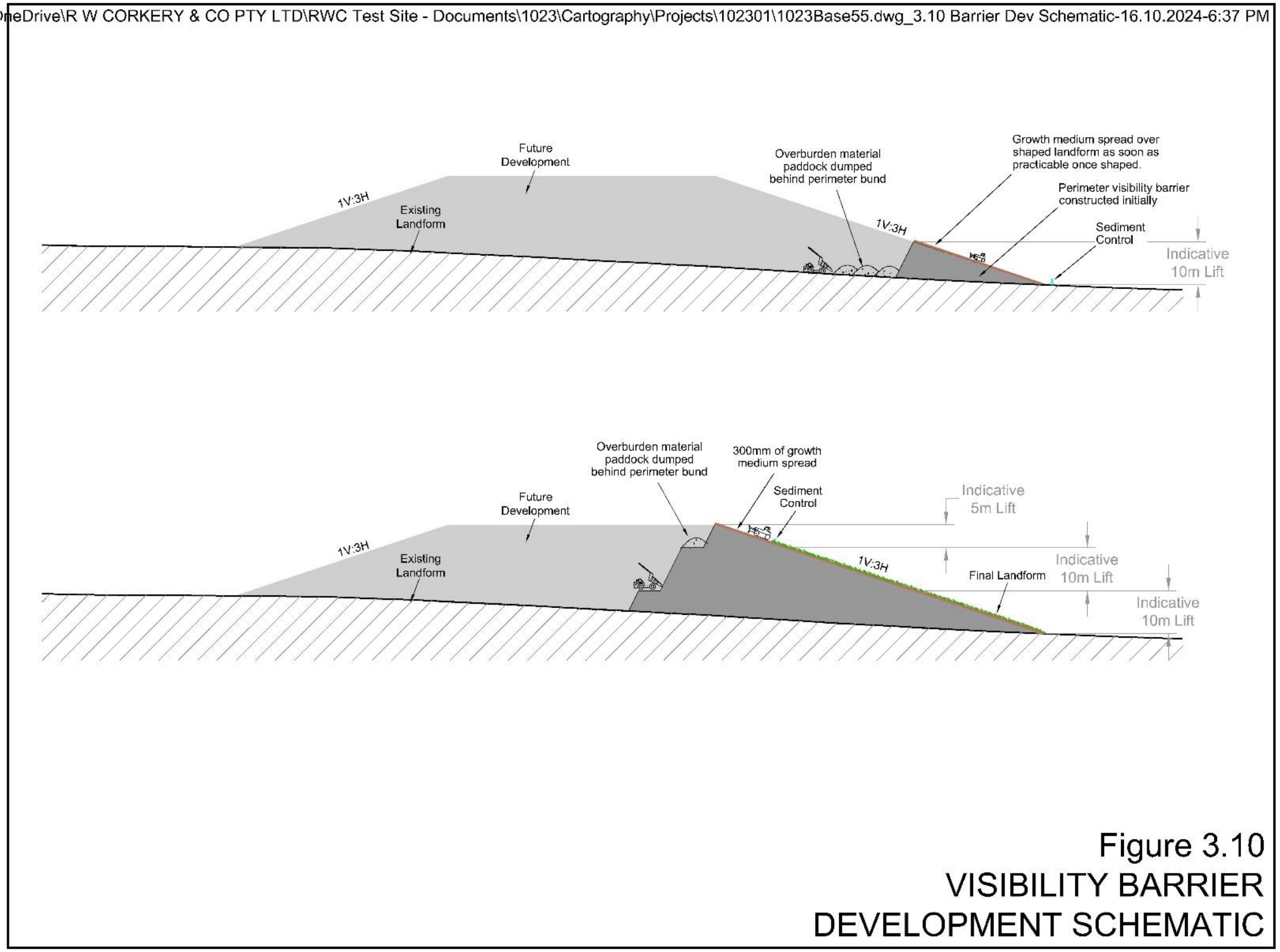
Figure 9 presents a schematic of progressive barrier development to illustrate this approach. Note that the figure indicates a slice through the visibility barrier from north (on the left) to the south (on the right).

The Visibility Barrier has been deliberately sized to permit space for the management of overburden material as well as to visibly obscure operations. This would enable material to be placed within the barrier as required. Where customer demand for road base or other materials requires blending with moderately or highly weathered material, it would be taken from the barrier.

Whilst primarily designed to shield the view of Project related activities from receptors to the south of the Project Site, the barrier would also result in reductions in noise and air quality impacts. In relation to air quality, the barrier would act to minimise the transportation of particulate matter from the extraction and processing area towards receptors in northerly and north westerly winds. Transportation of emissions generated during the barrier construction towards receptors would also be minimised through the design presented in Figure 9, i.e. all particulate generating activities would occur to the north of the barrier.

Whilst no specific published and quantified control factor is available for a barrier of this nature, literature indicates that emissions may be controlled by around 30 % for wind breaks, and the barrier would operate in a similar (although not identical) fashion. In the interests of conservatism, no reduction in particulate matter emissions has been assumed to be afforded by this barrier (applied control factor of 0 %), although in reality, this would reduce operational dust emission propagation.

Figure 9 Visibility barrier development schematic



Source: RWC

2.10.2. Transportation

A major source of particulate matter emissions at extractive industrial sites is associated with road haulage. Emissions can occur on both paved and unpaved haulage routes, where the vehicle interacts with the surface, either through direct contact via the tyres, or through the action of turbulence as vehicles pass over the road to resuspend settled particulate. In either case, the rate of emission is greater at higher vehicle speeds.

Typical measures to control dust generation at extractive industrial sites often include:

- Watering the road surface;
  - Watering helps to moisten unpaved road surfaces, temporarily resulting in the agglomeration of finer particles, reducing the ability of the wind to make those particles airborne. The level of control increases as the amount and frequency of water application increases. Typical values (NPI, 2012) indicate control efficiencies of between 50 % for application rates of 2 litres per square metre per hour ($L \cdot m^{-2} \cdot hr^{-1}$) and 75 % for application rates of greater than 2 $L \cdot m^{-2} \cdot hr^{-1}$. (US EPA, 1987) also provides calculations which allow the determination of control efficiency through inputs such as water application intensity, frequency, local evaporation rate, and road usage.
  - Watering of paved road surfaces helps to flush any silt material from the road, and has been shown in studies to result in particulate emissions reductions of between 30 % and 70 %. The additional use of road sweeping (with water flushing) can increase those reductions from between 35 % to 90 % (US EPA, 2011).
  - Challenges associated with the application of water include the rate of application, which may need to be increased in dry weather, the availability of a reliable water supply, and excess water causing mud which can be a safety issue.

- Applying chemical suppressants;
  - Dust suppressants are chemical agents which reduce the ability of dust to become airborne by binding particles together. As outlined in the literature (summarised in (Katestone, 2011)), the effectiveness of emissions controls can vary widely (30 % to 95 %) and is dependent upon the measures implemented. Recent studies performed at coal mines in NSW as part of the 'Dust Stop' program (under an EPA Pollution Reduction Program) provided data relating to the levels of dust control achieved through the implementation of controls (water, chemical suppressant). The average level of control achieved across 16 sites was 92 %, with the minimum being 80 % and the maximum 99 %.
  - Using chemical suppressants can reduce or eliminate water requirements for haul road dust suppression.

- Modifying the road surface;
  - Unpaved road surfaces can wear through the action of vehicle movements and stabilisation of those surfaces can occur through the addition of low silt aggregate for example, to minimise resuspension of particulate matter.

- Limiting vehicle speeds;
  - Reducing vehicle speeds on unpaved road surfaces limits dust generation through the friction between the road surface and the vehicle tyres, and also reduces turbulence between the road surface and the vehicle body. (Katestone, 2011) indicates that vehicle speed reductions on unpaved road surfaces from 75 $km \cdot hr^{-1}$ to 50 $km \cdot hr^{-1}$ can reduce particulate emissions between 40 % and 75 %, with speed reductions from 65 $km \cdot hr^{-1}$ to 30 $km \cdot hr^{-1}$ resulting in reductions of between 50 % and 85 %.
  - Reducing vehicles speeds on paved road surfaces can also limit the generation of airborne particulate matter, although less quantitative assessment of these reductions is available in the literature, given the dominance of unpaved haul road emissions to site particulate budgets. A control factor for particulate matter emissions resulting from reductions in vehicle speed on paved road surfaces was calculated using measurement data as detailed in the study by (Fitz and Bufalino, 2002). The US EPA AP-42 emission factor is applicable to vehicles travelling at up to 88 $km \cdot hr^{-1}$. Reduction in vehicle speeds from 80 $km \cdot hr^{-1}$ to 32 $km \cdot hr^{-1}$ was measured by (Fitz and Bufalino, 2002) to result in PM_{10} emissions reductions at 0.8 m above the road surface of 89 %. Vehicle speeds at the Project Site would be approximately 30 $km \cdot hr^{-1}$, and reductions of 89 % are therefore likely to be appropriate.

- Regular maintenance (roads and vehicles);
  - Regular grading and compacting of unpaved haulage routes can prevent the accumulation of loose material that can be pulverised by vehicle movements and generate dust. Regular sweeping and/or watering of paved roads can help to remove any accumulated silt.

- Wind breaks or vegetation;
  - Erecting fences or planting vegetation along trafficked routes can act as windbreaks, reducing the amount of particulate matter blown from the surface. Wind breaks and vegetative barriers can result in emissions reductions of between 30 % (wind breaks) to 80 % (wind screens/wind fences) (Katestone, 2011).

- Covering loads;
  - Covering vehicle loads is a common (and often mandatory) practice in the road haulage industry and minimises the disturbance of load surfaces and the dropping of material onto road surfaces, which can be pulverised by the action of vehicles and become a source of

dust. The requirement to cover loads is a regular condition of any Environment Protection Licence (EPL).

- Monitoring and enforcement;
  - Visual inspection of road surfaces can help in identifying areas which need maintenance and can be part of daily inspections at the Project site.
  - Ongoing air quality monitoring can also assist in the identification of broader particulate emissions which may need additional management. This is discussed further in Section 8.

For this AQIA, the following particulate control measures and efficiencies have been adopted. Note that where a range of efficiencies are quoted in the literature, the lower of those values has been adopted. This provides confidence that the potential for emission reductions are not being overstated, and that the actual impacts would be lower than those presented within the AQIA:

- Speed limits on paved and unpaved roads;
  - 40 % reduction in particulate emissions from unpaved roads; and
  - 44 % reduction in particulate emissions from paved roads (taken to be half of the calculated value, given the one reference adopted).
- Application of water or chemical suppressants on unpaved haulage routes to achieve a 90 % particulate control efficiency;
  - The water requirements for dust suppression on unpaved haulage routes at the Project Site have been calculated by Strategic Environmental and Engineering Consultancy (SEEC, pers comm), which indicate that to achieve a dust control efficiency of 90 %, water requirements would be 25.2 ML·yr^{-1} (on average), 27.3 ML·yr^{-1} (dry years), and 20.3 ML·yr^{-1} (wet years). The Applicant has indicated that sufficient water would be available to meet this requirement. Should sufficient water not be available in any year to achieve the required control efficiency, chemical suppressants would be used. As previously indicated, emission control efficiencies of up to 99 % have been measured from the use of chemical suppressants on unpaved haulage routes at coal mines in NSW, with 90 % representing an average level of control. Further justification for the adoption of the 90 % control efficiency for watering and/or chemical suppressant use is provided below.

Calculation of the control efficiency afforded by the application of water has been reviewed using the equation provided in (Buonicore & Davis, 1992), specifically:

$$C = 100 - \frac{0.8 \times p \times d \times t}{i}$$

Where:

C = control efficiency (%)

p = hourly evaporation rate (mm·hr^{-1})

d = maximum daily traffic rate (vehicles·hr^{-1})

t = time between water applications (hours)

i – water application intensity (L·m^{-2})

Hourly evaporation data has been calculated from mean daily evaporation rates measured at the BoM Canberra Airport Comparison AWS (station number 070014) and mean daily sunshine data.

Two site roads have been reviewed, namely the main Quarry access road with a maximum usage rate of 25 vehicles per hour, and the road from the extraction area to the processing plant, with a maximum calculated usage rate of 36 vehicles per hour during Scenario 2 operations.

The control efficiency required has been fixed to determine the changes in application intensity and time between application which would result in a 90 % control efficiency. Time between applications (hours) have been assessed at 1 hour and 4 hours, with the application intensity (L·m^{-2}) calculated. Further, application intensity has been fixed at 2 L·m^{-2} and the resulting time between applications (hours) calculated. Results are presented in Table 6.

Table 6 Sensitivity calculations of haulage route control efficiency

Road	Intensity fixed at 2 L·m^{-2}		Time between application fixed at 1 hour		Time between application fixed at 4 hours	
	Time between application (hours)		Application intensity (L·m^{-2})		Application intensity (L·m^{-2})	
	Min	Max	Min	Max	Min	Max
Quarry Access Road	1.1	3.4	0.6	1.8	2.3	7.1
Extraction Area to Processing and Stockpile Area	0.8	2.4	0.8	2.5	3.4	10.1

Note: Required to achieve a 90 % control efficiency

Whilst not presented here, the values presented in Table 6 vary by month, with the application of water required to achieve a 90 % control efficiency driven by the daily evaporation rates which are higher in summer months (requiring addition of more water, more often), and lower in winter months (requiring less water, less often).

The results in Table 6 suggest that a control efficiency of 90 % on both the Quarry Access Road, and the route between the Extraction Area and Processing and Stockpile Area are achievable in all months, but a balance between the application intensity and time between application is required. In summer months, the time between application should be shorter, otherwise a significantly greater volume of water is required to achieve the same result, with the extended time between application creating a risk of uncontrolled emissions. This risk is likely to be lower in cooler months.

The use of chemical suppressants would result in similar control efficiencies, and these can be used alone, or in concert with water application (reducing the amount of water required to achieve the same control efficiency). The use of this dual approach to haulage road particulate management can be viewed as a best-practice control measure that allows adaptive management of haulage route emissions while maintaining compliance with adopted assessment assumptions.

- Application of water on paved haulage routes;
  - 30 % reduction in particulate emissions from paved roads.
- Use of a colorbond fence as a wind break, and planting of vegetation along the paved haulage route from the Project Site;
  - 75 % reduction in particulate emissions from paved roads (combined fence and vegetation screening).

2.10.3. Wind Erosion

The minimisation of land disturbance is a critical control, and this has been integrated into the staging plans for the Project (see Section 2.2). The rate of dust emissions from undisturbed land is essentially 'background' which is discussed in Section 4.3 and accounted for in the assessment of cumulative air quality impacts for the Project in Section 6.

Where land is disturbed, various controls may be applied to minimise the rate of dust emission through wind erosion.

Katestone (2011) provides a summary of dust control measures that are routinely considered / applied for open area wind erosion sources, including:

- Watering exposed areas;
- Stockpile moisture content measured and controlled;
  - The efficacy of watering to control particulate emissions is discussed in Section 2.10.2. A control factor of 50 % may be assumed for the watering of stockpiles at a rate equivalent to 2 $L \cdot m^{-2} \cdot hr^{-1}$. This is applicable for control of emissions from stockpiles, as the quantum of water required to control emissions from the Project site as a whole would be prohibitive.
- Topsoil stripping when moisture is elevated but not sodden;
- Minimising the area of disturbance;
  - The staging plan for the Project is designed to minimise the area of disturbance. Undisturbed land, which is achieved by Project staging, is essentially controlled by 100 % and forms a part of the overall background conditions for the Project site.

- Progressive rehabilitation;
- Suppressant on stockpiles and exposed areas;
  - Chemical suppressants may be applied as additives to water sprays to Application of chemical suppressant during the processing of materials, reducing particulate emissions by between 70 % and 84 % (Katestone, 2011), including during loading to temporary stockpile activities;
- Long term stockpiles revegetated;
  - Progressive rehabilitation is considered to represent a best practice measure for the control of wind erosion from disturbed and exposed areas, including stockpiles (e.g. the progressive stabilisation and revegetation of the Visibility Barrier, as discussed in Section 2.10.1). This is often achieved through the application of hydraulic mulch and seeding with appropriate native vegetation.
- Wind barriers.

2.10.4. Other Activities

Air quality management measures would be employed across a range of activities being performed as part of the Project, and would include:

- The use of fabric filters on drill rigs, reducing particulate emissions by 99 % (NPI, 2012);
- Minimising the drop height from trucks when unloading, reducing particulate generation by 30 % (Katestone, 2011);
- Application of chemical suppressant during the processing of materials, reducing particulate emissions by between 70 % and 84 % (Katestone, 2011), including during all material transfer and loading to temporary stockpile activities;
- The use of a reverse pulse filter on the raw materials silos at the concrete batching and asphalt plant, reducing particulate emissions by 99.8 % (NPI, 1999a);
- The use of a dust shroud when concrete blending at the concrete batching plant, reducing particulate emissions by 70 % (NPI, 1999a);
- Enclosing the area around the concrete agitator truck load-out, reducing emissions by 70 % (NPI, 1999a); and
- The use of charcoal filters to control VOC emissions from the bitumen storage tanks at the asphalt plant (emissions assumed to be negligible).

Once again, it is noted that where a range of efficiencies are quoted in the literature, the lower of those values has been adopted in the AQIA. This provides confidence that the potential for emission reductions are not overstated, and that the actual impacts would be lower than those presented within the AQIA:

2.11. Identified Potential for Emissions to Air

The processes which may result in the uncontrolled emission of pollutants to air during Project operations would include:

- Quarry:
  - Drilling and blasting;
  - Loading of haul truck in the Extraction Area and transport to Processing Plant and Stockpiling Area, or Visibility Barrier;
  - Unloading of material, loading of processing equipment, processing of rock, and storage in stockpiles;
  - Receipt and unloading of materials for concrete and asphalt production;
  - Operation of pugmill, concrete batching plant and asphalt plant;
  - Loading of product trucks, and transport offsite;
  - Wind erosion of disturbed areas; and
  - Emissions from vehicle and equipment exhaust.
- Concrete Batching Plant:
  - Movement of vehicles around the Project site on paved and unpaved road surfaces;
  - Loading and unloading of materials to storage areas and hoppers;
  - Handling of materials;
  - Operation of the concrete batching plant; and
  - Loading of concrete to trucks.
- Concrete Recycling:
  - Movement of vehicles around the Project site on paved and unpaved road surfaces;
  - Loading and unloading of materials to storage areas;
  - Handling of materials;
  - Processing (crushing and screening) of concrete; and
  - Loading of product to trucks.
- Asphalt Batching Plant:
  - Movement of vehicles around the Project site on paved and unpaved road surfaces;
  - Loading and unloading of materials to storage areas and hoppers;
  - Handling of materials;
  - Operation of the asphalt batching plant (including diesel generator);
  - Operation of bitumen storage tanks; and
  - Loading of asphalt to trucks.

The specific pollutants of interest associated with those activities are:

- Quarry, Concrete Batching Plant and Concrete Recycling:
  - Total suspended particulate (TSP);
  - Particulate matter with an aerodynamic diameter of 10 microns (PM_{10});
  - Particulate matter with an aerodynamic diameter of 2.5 microns ($PM_{2.5}$); and
  - Respirable Crystalline Silica (RCS).

- Asphalt Batching Plant:
  - Total suspended particulate (TSP);
  - Particulate matter with an aerodynamic diameter of 10 microns (PM_{10});
  - Particulate matter with an aerodynamic diameter of 2.5 microns ($PM_{2.5}$);
  - Odour;
  - Volatile organic compounds (VOC); and
  - NO_X (from the dryer stack and diesel generator).

Emissions of oxides of nitrogen (NO_X) would be anticipated from blast fume, and (primarily) emissions of VOCs, NO_X, carbon monoxide (CO) and sulphur dioxide (SO_2) related to diesel combustion would also be experienced (in addition to particulates considered above).

Impacts associated with these pollutants from mobile equipment are likely to be minor and have not been considered. Impacts associated with VOCs, NO_X, and PM resulting from the operation of the asphalt plant dryer stack have been assessed, in addition to NO_X and PM from the diesel generator at the asphalt plant. Emissions of CO and SO_2 are likely to be minimal, based on experience in assessment of other projects.

In relation to blast fume, the timing of any blasts would be managed to ensure that meteorological conditions are appropriate for those to occur.

In relation to the proposed asphalt plant, emissions of specific pollutants of interest associated with those activities are generally particulate matter, which has been assessed. Emissions of combustion related pollutants (particulate matter, NO_X, CO, and SO_2 and emissions of odour, organic pollutants, metals, and polycyclic aromatic hydrocarbons (PAH)) might also be reasonably anticipated to occur from the asphalt plant dryer stack.

A study performed recently by Northstar (Northstar, 2021) assessed the potential for emissions associated with an asphalt batching plant, located within 100 m of sensitive receptor locations, and producing up to 3 000 t of asphalt per day (i.e. three times that proposed as part of this Project, with receptors over ten times closer than proposed as part of this Project). That assessment determined through quantitative modelling that impacts associated with CO, NO_2 and SO_2 emitted from the asphalt plant operation were well below relevant short- and longer-term criteria (incremental and cumulative impacts). At the throughput of the proposed asphalt plant, and at the separation distances proposed, impacts associated with these pollutants would be anticipated to be minimal, although at the request of NSW EPA, emissions of odour, NO_X and VOCs have been considered quantitatively in this assessment, from the dryer stack and load-out activities.

3. LEGISLATION, REGULATION AND GUIDANCE

This section outlines the relevant legislative requirements for the Project under applicable State and Commonwealth legislation and planning instruments.

3.1. Environmental Planning and Assessment Act 1979 and Regulation 2021

Under Clause 7 of Schedule 1 of the State Environmental Planning Policy (SEPP) (Planning Systems), a development for the purpose of extractive industry is classified as State Significant if the Project either:

- extracts more than 500 000 tonnes of material per year;
- extracts from a total resource (the subject of the development application) of more than 5 million tonnes; or
- extracts from an environmentally sensitive area of State Significance.

As the Project would extract a total resource of more than 5 million tonnes and would exceed the maximum annual extraction threshold of 500 000 $t \cdot yr^{-1}$, it is considered State Significant Development. The Development Application (DA) will therefore require assessment under Division 4.7 of Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

3.2. Protection of the Environment Operations (POEO) Act 1997

The 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.

Should the Project gain development approval, the operations would be classified as a scheduled activity under the POEO Act and as such the Project would require an Environmental Protection Licence (EPL).

3.3. Protection of the Environment (Clean Air) Regulation 2022

The Protection of the Environment Operations (POEO) (Clean Air) Regulation (2022) sets standards of concentration for emissions to air from both scheduled and non-scheduled activities. For the activities performed at the Project Site, the POEO (Clean Air) Regulation 2022 provides general standards of concentration for scheduled premises which are presented in Table 7 for the pollutants of relevance.

Table 7 POEO (Clean Air) Regulation – General standards of concentration

Air Impurity	Activity	Standard of concentration (Group 6)[(a)]
Solid particles (total)	Any activity or plant (except as listed below)	50 mg·m^{-3}
	Any crushing, grinding, separating, or materials handling activity	20 mg·m^{-3}
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both nitrogen dioxide and nitric oxide, as NO_2 equivalent	Stationary reciprocating internal combustion engines	450 mg·m^{-3}

Note: (a) Group 6 – pursuant to application made on or after 1 September 2005

Further to the requirements in Table 7, Part 4 Clause 20 of the POEO (Clean Air) Regulation 2022 requires that motor vehicles do not emit excessive air impurities which may be visible for a 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 Project Site or to transport materials to and from the Project Site will be maintained regularly and in accordance with manufacturers' requirements, where these vehicles are under the operational control of the operator.

As outlined in Appendix D, the diesel generator to be used as part of the asphalt batching plant would meet USEPA Tier 3 emission limits, which would result in a NO_X emission concentration of 326.8 mg·m^{-3}, compliant with the POEO (CAR) emission limit of 450 mg·m^{-3}, and a PM emission concentration of 1.2 mg·m^{-3}, compliant with the POEO (CAR) emission limit of 50 mg·m^{-3}.

3.4. NSW EPA Air Quality Criteria

3.4.1. Criteria Air Pollutants

State air quality guidelines adopted by the NSW EPA are published in the '*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW'* (NSW EPA, 2022) (the 'Approved Methods') which has been consulted during the preparation of this report.

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

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 are presented in Table 8.

Table 8 NSW EPA air quality impact assessment criteria

<table>
<tr><th>Pollutant</th><th>Averaging period</th><th>Units[e]</th><th>Criterion</th><th>Notes</th></tr>
<tr><td rowspan="2">Nitrogen dioxide (NO_2)</td><td>1 hour</td><td>$\mu g \cdot m^{-3}$ [a]</td><td>164</td><td rowspan="6">Numerically equivalent to the AAQ NEPM[b] standards and goals.</td></tr>
<tr><td>1 year</td><td>$\mu g \cdot m^{-3}$</td><td>31</td></tr>
<tr><td rowspan="2">Particulates (as PM_{10})</td><td>24 hours</td><td>$\mu g \cdot m^{-3}$</td><td>50</td></tr>
<tr><td>1 year</td><td>$\mu g \cdot m^{-3}$</td><td>25</td></tr>
<tr><td rowspan="2">Particulates (as $PM_{2.5}$)</td><td>24 hours</td><td>$\mu g \cdot m^{-3}$</td><td>25</td></tr>
<tr><td>1 year</td><td>$\mu g \cdot m^{-3}$</td><td>8</td></tr>
<tr><td>Particulates (as TSP)</td><td>1 year</td><td>$\mu g \cdot m^{-3}$</td><td>90</td><td></td></tr>
<tr><td rowspan="2">Particulates (as dust deposition)</td><td>1 year[c]</td><td>$g \cdot m^{-2} \cdot month^{-1}$</td><td>2</td><td rowspan="2">Assessed as insoluble solids as defined by AS 3580.10.1</td></tr>
<tr><td>1 year[d]</td><td>$g \cdot m^{-2} \cdot month^{-1}$</td><td>4</td></tr>
</table>

Notes: (a): micrograms per cubic metre of air

(b): National Environment Protection (Ambient Air Quality) Measure

(c): Maximum increase in deposited dust level

(d): Maximum total deposited dust level

Additional air quality criteria are provided by NSW EPA for individual toxic air pollutants in section 7.2 of the Approved Methods. The impact assessment criteria for the principal and individual toxic air pollutants of relevance to the Proposal are presented in Table 9. Pollutants of relevance have been identified through examination of National Pollution Inventory (NPI, 1999), and USEPA AP42 emission factors (USEPA, 2004). Impacts associated with benzene, toluene, ethylbenzene, and xylenes have been used as indicators of potential impact.

Within the Approved Methods, criteria for toluene and xylene are not included within the relevant tables for toxic air pollutants, but rather odorous air pollutants. The potential for impacts of these pollutants on the surrounding environment has been considered with respect to odour. In addition to the assessment criteria for individual odorous pollutants, the operation of the Project has also been assessed against complex mixtures of odorous pollutants.

Table 9 NSW EPA air quality standards and goals – principal & individual toxic and odorous air pollutants

Substance	Classification	Averaging period (99.9th percentile)	Impact assessment criteria ($mg \cdot m^{-3}$)(a)
Benzene	Toxicity	1 hour	0.029
Toluene	Odour	1 hour	0.36
Ethylbenzene	Toxicity	1 hour	8.0
Xylene	Odour	1 hour	0.19

Notes: (a): Gas volumes are expressed at 25°C (298 K) and at an absolute pressure of 1 atmosphere (101.3 kPa).

3.4.2. Respirable Crystalline Silica

Given the nature of the material to be extracted and processed at the Project Site, respirable crystalline silica (RCS) may be generated during those activities. NSW EPA do not provide air quality criteria for RCS, although Environment Protection Authority Victoria (EPA VIC) in their State Environmental Planning Policy (SEPP) Protocol for Environmental Management: Mining and Extractive Industries (PEM) (EPA VIC, 2007) do include an annual average criterion for RCS (assessed as $PM_{2.5}$) as 3 $\mu g \cdot m^{-3}$, which has been adopted from the California EPA Office for Environmental Health Hazard Assessment Reference Exposure Levels.

Furthermore, EPA South Australia (SA EPA) provide an interim criterion for RCS concentrations in ambient air associated with mining and extractive industries (EPA SA, 2022).

SA EPA, with input from SA Health, performed a literature review of the modern criteria for RCS in ambient air associated with mining and extractive industries. Based on that review, the SA EPA is adopting an interim respirable crystalline silica (RCS) criterion of 3 $\mu g \cdot m^{-3}$ (annual average) for the PM_{10} size fraction of dust in ambient air.

It is noted that EPA VIC and SA EPA have adopted the same averaging period and concentration (3 $\mu g \cdot m^{-3}$, annual average) although the size fraction of particulate to which the criterion applied differs, with EPA VIC referencing the $PM_{2.5}$ size fraction, and SA EPA referencing the PM_{10} fraction. PM_{10} concentrations are generally greater relative to $PM_{2.5}$ concentrations for quarry developments (refer Section 6), and therefore this AQIA has adopted the SA EPA criterion which is a conservative assumption.

This criterion is referenced in this assessment and calculates RCS by adjusting annual average PM_{10} modelling results on a *pro-rata* basis to account for the determined maximum free silica content of the extracted material (taken to be 40 % [w/w]). RCS is generally an occupational health and safety issue (i.e. on-site) rather than an environmental issue (i.e. off-site) when considering mining activities but has been presented within this AQIA for completeness.

3.4.3. Odour

Experience gained through odour assessments from proposed and existing facilities in NSW indicates that an odour performance goal of 7 OU is likely to represent the level below which "offensive" odours should not occur (for an individual with a 'standard sensitivity' to odours). Therefore, the Odour Technical Framework (DECC, 2006) recommends that, as a design goal, no individual be exposed to ambient odour levels of greater than 7 OU. In modelling and assessment terms, this is expressed as the 99th percentile value, as a nose response time average (approximately one second).

Odour assessment criteria need to consider the range in sensitivities to odours within the community to provide additional protection for individuals with a heightened response to odours. This is addressed in the Technical Framework (DECC, 2006) by setting a population dependent odour assessment criterion, and in this way, the odour assessment criterion allows for population size, cumulative impacts, anticipated odour levels during adverse meteorological conditions and community expectations of amenity. A summary of odour performance goals for various population sizes, as referenced in the Odour Technical Notes (DECC, 2006) is shown in Table 10. This table shows that in situations where the population of the affected community lies between 125 and 500 people, an odour assessment criterion of 4 OU at the nearest residence (existing or any likely future residences) is to be used. For isolated residences, an odour assessment criterion of 7 OU is appropriate.

Table 10 NSW EPA odour impact criterion

Population of affected community	Complex mixture of odours (OU)
Urban area (≥2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10 – 30	6.0
Single residence (≤2)	7.0

Source: The Odour Technical Notes, DECC 2006

Given the population density in the environment immediately surrounding the Project Site is < 500 persons·km^{-2}, an odour impact criterion of 4 OU would be most applicable, although the most stringent odour criterion of 2 OU has been adopted for this assessment.

3.5. NSW Voluntary Land Acquisition and Mitigation Policy

The NSW Government published the "*Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments*" (hereafter, the policy) in September 2018 (NSW Government, 2018). The policy is to be applied by consent authorities when assessing and determining applications for mining, petroleum and extractive industry developments that are subject to State Significant Development provisions of the *Environmental Planning and Assessment Act* 1979.

A number of policies and guidelines include air quality assessment criteria to protect the amenity, health and safety of people, including those outlined in Section 3.4. They typically require applicants to implement all reasonable and feasible avoidance and/or mitigation measures to minimise the impacts of a development. In some circumstances however, it may not be possible to comply with these assessment criteria even with the implementation of all reasonable and feasible avoidance and/or mitigation measures. This can occur with large resource projects where the resources are fixed, and there is limited scope for avoiding and/or mitigating impacts. However, as outlined within the policy it is important to recognise that:

- Not all exceedances of the relevant assessment criteria equate to unacceptable impacts.
- Consent authorities may decide that it is in the public interest to allow the development to proceed, even though there would be exceedances of the relevant assessment criteria, because of the broader social and economic benefits of the development.
- Some landowners may be prepared to accept higher impacts on their land, subject to entering into suitable negotiated agreements with applicants, which may include the payment of compensation.

Consequently, the assessment process can lead to a range of possible outcomes.

In the application of the policy, the applicant must demonstrate that all viable alternatives have been considered, and all reasonable and feasible avoidance and mitigation measures have been incorporated into the project design. Should acquisition or mitigation criteria (see Table 11 and Table 12) be exceeded as a result of the project operation then the applicant should consider a negotiated agreement with the affected landowner or acquisition of the affected land. Full details of the negotiated agreement and acquisition process is provided in the policy (NSW Government, 2018).

In relation to air quality, the policy applies specifically to particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition). Applicants are required to assess the impacts of the development in accordance with the Approved Methods guidance (NSW EPA, 2022a). Should exceedances of the relevant particulate matter criteria (refer Section 3.4) be predicted, then comparison with the mitigation and acquisition criteria is performed.

3.5.1. Voluntary Mitigation

As outlined in the policy, a consent authority should only apply voluntary mitigation rights where, even with the implementation of best practice management, the development contributes to exceedances of the mitigation criteria outlined in Table 11:

- At any residence on privately owned land; or
- At any workplace on privately owned land where the consequences of those exceedances in the opinion of the consent authority are unreasonably deleterious to worker health or the carrying out of business at that workplace, including consideration of the following factors:

- The nature of the workplace;
- The potential for exposure of workers to elevated levels of particulate matter;
- The likely period of exposure; and
- The health and safety measures already employed in that workplace.

Table 11 Particulate matter mitigation criteria

Pollutant	Averaging period	Units	Criterion	Impact type
$PM_{2.5}$	Annual	$\mu g{\cdot}m^{-3}$ (a)	8	Human health
	24 hour	$\mu g{\cdot}m^{-3}$ (b)	25	Human health
PM_{10}	Annual	$\mu g{\cdot}m^{-3}$ (a)	25	Human health
	24 hour	$\mu g{\cdot}m^{-3}$ (b)	50	Human health
Total suspended particulate (TSP)	Annual	$\mu g{\cdot}m^{-3}$ (a)	90	Amenity
Deposited dust	Annual	$g{\cdot}m^{-2}{\cdot}month^{-1}$ (b)	2	Amenity
		$g{\cdot}m^{-2}{\cdot}month^{-1}$ (a)	4	Amenity

Notes: (a): Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources)
(b): Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development)

Mitigation measures should be directed towards reducing the potential human health and amenity impacts of the development and must be directly relevant to the mitigation of those impacts.

3.5.2. Voluntary Acquisition

A consent authority should only apply voluntary acquisition rights where, even with the implementation of best practice management, the development is predicted to contribute to exceedances of the acquisition criteria in Table 12:

- At any residence on privately owned land; or
- At any workplace on privately owned land where the consequences of those exceedances in the opinion of the consent authority are unreasonably deleterious to worker health or the carrying out of business at that workplace, including consideration of the following factors:
  - The nature of the workplace;
  - The potential for exposure of workers to elevated levels of particulate matter;
  - The likely period of exposure; and
  - The health and safety measures already employed in that workplace.

- On more than 25 % of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls[1].

Table 12 Particulate matter acquisition criteria

Pollutant	Averaging period	Units	Criterion	Impact type
$PM_{2.5}$	Annual	$\mu g \cdot m^{-3}$ (a)	8	Human health
	24 hour	$\mu g \cdot m^{-3}$ (b)	25	Human health
PM_{10}	Annual	$\mu g \cdot m^{-3}$ (a)	25	Human health
	24 hour	$\mu g \cdot m^{-3}$ (b)	50	Human health
Total suspended particulate (TSP)	Annual	$\mu g \cdot m^{-3}$ (a)	90	Amenity
Deposited dust	Annual	$g \cdot m^{-2} \cdot month^{-1}$(b)	2	Amenity
		$g \cdot m^{-2} \cdot month^{-1}$(a)	4	Amenity

Notes: (a): Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources)
(b): Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

3.6. Greenhouse Gas Legislation and Guidance

The Australian Government Clean Energy Regulator administers schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions.

Schemes administered by the Clean Energy Regulator include:

- National Greenhouse and Energy Reporting Scheme, under the *National Greenhouse and Energy Reporting Act* (2007).
- Emissions Reduction Fund, under the *Carbon Credits (Carbon Farming Initiative) Act* (2011).
- Renewable Energy Target, under the *Renewable Energy (Electricity) Act* (2000).
- Australian National Registry of Emissions Units, under the *Australian National Registry of Emissions Units Act* (2011).

3.6.1. National Greenhouse and Energy Reporting Scheme

The National Greenhouse and Energy Reporting (NGER) scheme, established by the *National Greenhouse and Energy Reporting Act* (2007) (NGER Act), is a national framework for reporting and disseminating

[1] Voluntary land acquisition rights should not be applied to address particulate matter levels on vacant land other than to vacant land specifically meeting these criteria.

company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.

The objectives of the NGER scheme are to:

- Inform government policy;
- Inform the Australian public;
- Help meet Australia's international reporting obligations;
- Assist Commonwealth, state and territory government programmes and activities; and
- Avoid duplication of similar reporting requirements in the states and territories.

Further information on the NGER scheme, specifically the definitions of various scopes and types of greenhouse gas (GHG) emissions which have also been adopted for the purposes of this assessment, is provided in Section 5.2.

3.6.2. Relevant NSW Legislation

NSW Government has enacted the *Climate Change (Net Zero Future) Act* 2023, which aims to:

- Establish guiding principles for action to address climate change;
- Set targets for the reduction in net GHG emissions in NSW until 2050;
- Set an objective for NSW to be more resilient to a changing climate; and
- Establish the Net Zero Commission to independently monitor, review, and report on progress in NSW towards the targets, the adaptation objective and other matters.

NSW EPA also published their Climate Change Policy in 2023, and in May 2024 released the draft guide for 'large emitters' (emitting greater than 25 000 t CO_2-e per year), with a further guideline for general projects (emitting less than 25 000 t CO_2-e per year) to be published (currently being developed by the EPA) (NSW EPA, 2024).

The Project is anticipated to result in significantly less than 25 000 t CO_2-e emissions per year (refer Section 7), and given that guidelines for assessment are currently being developed for projects of this nature, the methodology outlined in Section 5.2 has been adopted.

3.6.3. Guidance

The GHG accounting and reporting principles adopted within this GHG assessment are based on the following financial accounting and reporting standards:

- Australian Government Department of Climate Change, Energy, the Environment and Water, Australian National Greenhouse Accounts, National Greenhouse Accounts Factors, 2024 (DCCEEW, 2024c);

- The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) GHG Protocol: A Corporate Accounting and Report Standard (WRI, 2004);
- ISO 14064-1:2018 (Greenhouse Gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removal);
- ISO 14064-2:2019 (Greenhouse Gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements); and
- ISO 14064-3:2019 (Greenhouse Gases – Part 3: Specification with guidance for the validation and verification of GHG assertions) guidelines (internationally accepted best practice).

4. EXISTING CONDITIONS

4.1. Surrounding Land Sensitivity

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

It is noted that 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 sensitive to changes in air quality does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the Project Site reside, population density data has been examined. Population density data based on the 2021 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km^2) grid, covering mainland Australia (ABS, 2022). Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities.

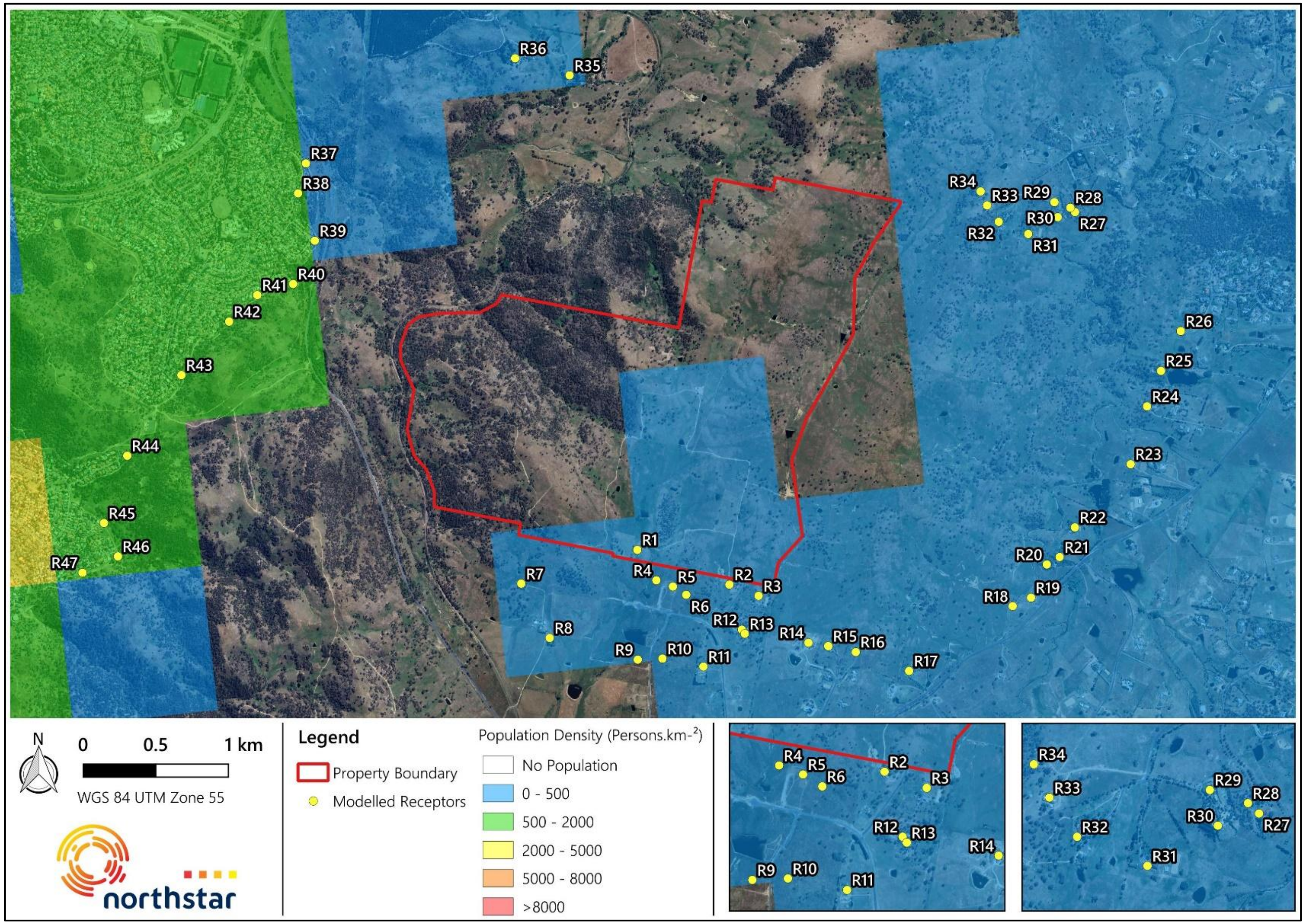
For clarity, the ABS use the following categories to analyse population density (persons·km^{-2}):

- Very high > 8 000
- High > 5 000
- Medium > 2 000
- Low > 500
- Very low < 500
- No population 0

Using ABS data in a GIS, the population density of the area surrounding the Project Site are presented in Figure 10. The Project Site is located in an area of low to very low population density (between 0 and <500 persons·km^{-2}).

A number of residential locations surrounding the Project Site have been identified and these receptors have been adopted for use within this AQIA as presented in Table 13.

Figure 10 Population density and sensitive receptors surrounding the Project Site



Note: Areas with no colour represents a 1 km^2 grid cell with zero population

Figure 10 identifies a number of 1 km^2 grids that are identified by the ABS as being populated. The desk-top mapping study performed for this AQIA examined those grid cells to ensure all relevant receptor locations had been identified. For a number of cells, sheds or unmaintained (assumed derelict) structures were identified that appear to have been erroneously assumed to be residential properties, and for other cells no structures were identified. Receptor 1 is identified as being Project related and is not considered further within this assessment. Results are provided at this location, but discussion of any impacts relates to privately owned receptor locations.

Table 13 Discrete sensitive receptor locations used in the study

Receptor ID	Address	Comment	Location (m, UTM 56)	
			Eastings	Northings
PR1	1995 Old Cooma Road Royalla, NSW	Project related	695 487	6 073 069
R2	37 Mates Drive Royalla, NSW	Residential	696 121	6 072 830
R3	20 Mates Drive Royalla, NSW	Residential	696 322	6 072 753
R4	220 Monaro Station Road Royalla, NSW	Residential	695 618	6 072 860
R5	212 Monaro Station Road Royalla, NSW	Residential	695 732	6 072 817
R6	188 Monaro Station Road Royalla, NSW	Residential	695 824	6 072 760
R7	Monaro Highway Royalla, NSW	Residential	694 688	6 072 837
R8	8814 Monaro Highway Royalla, NSW	Residential	694 884	6 072 463
R9	80 Holland Drive Royalla, NSW	Residential	695 490	6 072 314
R10	65 Holland Drive Royalla, NSW	Residential	695 660	6 072 321
R11	93 Monaro Station Road Royalla, NSW	Residential	695 942	6 072 266
R12	8 Mates Drive Royalla, NSW	Residential	696 207	6 072 520
R13	8 Mates Drive Royalla, NSW	Residential	696 227	6 072 492
R14	47 Moringol Place Royalla, NSW	Residential	696 665	6 072 430
R15	49 Moringol Place Royalla, NSW	Residential	696 801	6 072 407
R16	48 Moringol Place Royalla, NSW	Residential	696 991	6 072 366
R17	1616 Old Cooma Road Royalla, NSW	Residential	697 358	6 072 236
R18	1550 Old Cooma Road Royalla, NSW	Residential	698 071	6 072 682
R19	1548 Old Cooma Road Royalla, NSW	Residential	698 197	6 072 740
R20	1484 Old Cooma Road Googong, NSW	Residential	698 306	6 072 969
R21	1482 Old Cooma Road Googong, NSW	Residential	698 394	6 073 020
R22	1466 Old Cooma Road Googong, NSW	Residential	698 499	6 073 224
R23	1384 Old Cooma Road Googong, NSW	Residential	698 883	6 073 659
R24	1330 Old Cooma Road Googong, NSW	Residential	698 996	6 074 057
R25	1312 Old Cooma Road Googong, NSW	Residential	699 092	6 074 301
R26	1 Shillington Avenue Googong, NSW	Residential	699 228	6 074 575
R27	327 Fernleigh Drive Googong, NSW	Residential	698 500	6 075 394
R28	Fernleigh Drive Googong, NSW	Residential	698 468	6 075 424
R29	359 Fernleigh Drive Googong, NSW	Residential	698 358	6 075 462
R30	Fernleigh Drive Googong, NSW	Residential	698 381	6 075 359

Receptor ID	Address	Comment	Location (m, UTM 56)	
			Eastings	Northings
R31	361 Fernleigh Drive Googong, NSW	Residential	698 178	6 075 243
R32	360 Fernleigh Drive Googong, NSW	Residential	697 975	6 075 327
R33	358 Fernleigh Drive Googong, NSW	Residential	697 895	6 075 440
R34	Fernleigh Drive Googong, NSW	Residential	697 850	6 075 536
R35	Old Tuggeranong Road Tuggeranong, ACT	Residential	695 021	6 076 335
R36	174 Old Tuggeranong Road Tuggeranong, ACT	Residential	694 646	6 076 452
R37	18 Christmas Street Tuggeranong, ACT	Residential	693 206	6 075 729
R38	14 Mighell Place Tuggeranong, ACT	Residential	693 152	6 075 523
R39	35 Freda Gibson Circuit Tuggeranong, ACT	Residential	693 267	6 075 197
R40	16 Eltham Place Tuggeranong, ACT	Residential	693 118	6 074 899
R41	17 Bridgen Crescent Tuggeranong, ACT	Residential	692 871	6 074 823
R42	35 Goldfinch Circuit Tuggeranong, ACT	Residential	692 677	6 074 640
R43	7 Callister Crescent Tuggeranong, ACT	Residential	692 349	6 074 272
R44	36 Eaglemount Retreat Tuggeranong, ACT	Residential	691 976	6 073 717
R45	14 Banyule Grove Tuggeranong, ACT	Residential	691 816	6 073 254
R46	26 Aldor Green Tuggeranong, ACT	Residential	691 912	6 073 024
R47	9 Langker Place Tuggeranong, ACT	Residential	691 668	6 072 912

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

4.2. 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 Project Site have been characterised using data collected by surrounding Automatic Weather Stations (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

To provide a characterisation of the meteorology which would be expected at the Project Site, a meteorological modelling exercise has also been performed. In addition, a sensitivity analysis of modelled impacts to changes in the predicted meteorological conditions at the Project Site has been performed, in response to comments from NSW EPA.

A summary of the inputs and outputs of the meteorological modelling assessment is provided as Appendix B, with the results of the sensitivity analysis presented in Appendix E.

Three stations have been identified proximate to the Project Site. A summary of the relevant AWS is provided in Table 14 (listed by proximity).

Table 14 Details of meteorological monitoring surrounding the Project Site

Site Name	Station #	Source	Approximate Location (UTM)		Approximate distance (km)
			mE	mS	
Tuggeranong (Isabella Plains) AWS	070339	BoM	690 089	6 078 543	6.4
Canberra Airport	070351	BoM	700 049	6 090 490	16.6
Mount Ginni AWS	070349	BoM	660 667	6 066 812	34.9

It is considered that data collected at Tuggeranong (Isabella Plains) AWS is most likely to represent the conditions at the Project Site, based upon its proximity. The meteorological conditions measured at Tuggeranong (Isabella Plains) AWS for the period 2019 to 2023 (most recent five years of completed data) are presented in Appendix B.

The wind roses presented in Appendix B indicate that from 2019 to 2023, winds at Tuggeranong (Isabella Plains) AWS show similar wind distribution patterns across the years assessed, with a predominant north-westerly wind direction. An easterly wind direction component is also observable.

The majority of wind speeds experienced at Tuggeranong (Isabella Plains) AWS between 2019 and 2023 are generally in the range 0.5 meters per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from mostly north-westerly directions. Winds of this speed are rare and occur during 0.23 % of the observed hours during the years. Calm winds (< 0.5 $m \cdot s^{-1}$) are more common and occur during 22.6 % of hours on average across the years 2019-2023 at the Tuggeranong AWS.

The selection of an individual year to approximate 'representative' conditions at the Project Site has been based on the performance of a statistical analysis of wind direction and wind speed, and also measured PM_{10} and $PM_{2.5}$ concentrations. A full discussion of that analysis is presented in Appendix B, with the year 2021 selected as being the most representative year for further assessment.

4.3. 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 Project Site is located at significant distance (>150 km) from any of the air quality monitoring stations (AQMS) operated by NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) but given its location near to the Australian Capital Territory (ACT), air quality data measured by ACT Health has been reviewed. The locations of the nearest AQMS (listed by proximity) are briefly summarised in Table 15 and presented in Appendix C.

Table 15 Proximate AQMS relative to the Project Site

AQMS location	Approximate distance to Project Site (km)	Screening Parameters					
		2021 data	Measurements				
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Monash	6.4	✓	✓	✓	×	✓
Civic	18.6	✓	✓	✓	×	×
Florey	27.5	✓	✓	✓	×	✓

The closest representative AQMS with data available for the year 2021 (the selected representative year consistent with the meteorological modelling performed [refer Appendix B]) is noted to be located at Monash and is considered to be the monitoring location most reflective of the conditions surrounding the Project Site.

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

It is noted that none of the AQMS identified in Table 15 measure concentrations of TSP. This pollutant is of relevance to the expected emissions from the Project. Other sources of data have been adopted to allow representation of the TSP environment in the area surrounding the Project Site, and a full discussion is provided in Appendix C.

A summary of the air quality monitoring data and assumptions used to produce this AQIA are presented in Table 16. A discussion of measured exceedances of the 24-hour $PM_{2.5}$ in that background dataset is also provided in Appendix C.

None of the proximate AQMS measure any VOCs and the concentrations of these pollutants are assumed to be negligible. In any case, the Approved Methods requires the assessment of incremental impacts of these pollutants only.

The AQIA has been performed to assess the contribution of the operations at the Project Site to the air quality of the surrounding area. A full discussion of how the Project may impact upon air quality is presented in Section 6.

Table 16 Summary of background air quality used in the AQIA

Pollutant	Averaging period	Units	Measured Value	Notes
Nitrogen dioxide (NO_2)	1-hour	$\mu g \cdot m^{-3}$	Hourly varying	The 1-hour maximum NO_2 in 2021 at Monash was measured to be 73.8 $\mu g \cdot m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	6.5	Annual average in 2021
Particles (as TSP)	Annual	$\mu g \cdot m^{-3}$	24.1	Estimated on a TSP:PM_{10} ratio of 2.3404 : 1
Particles (as PM_{10})	24-hour	$\mu g \cdot m^{-3}$	Daily Varying	The 24-hour maximum PM_{10} in 2021 at Monash was measured to be 37.6 $\mu g \cdot m^{-3}$
	Annual	$\mu g \cdot m^{-3}$	10.3	
Particles (as $PM_{2.5}$)	24-hour	$\mu g \cdot m^{-3}$	Daily Varying	The 24-hour maximum $PM_{2.5}$ in 2021 at Monash was measured to be 27.9 $\mu g \cdot m^{-3}$ (exceeding the criterion)
	Annual	$\mu g \cdot m^{-3}$	6.9	
Particulates (as dust deposition)	Annual	$g \cdot m^{-2} \cdot month^{-1}$	2.0	Difference in NSW EPA maximum allowable and incremental impact criterion

Note: Reference should be made to Appendix C

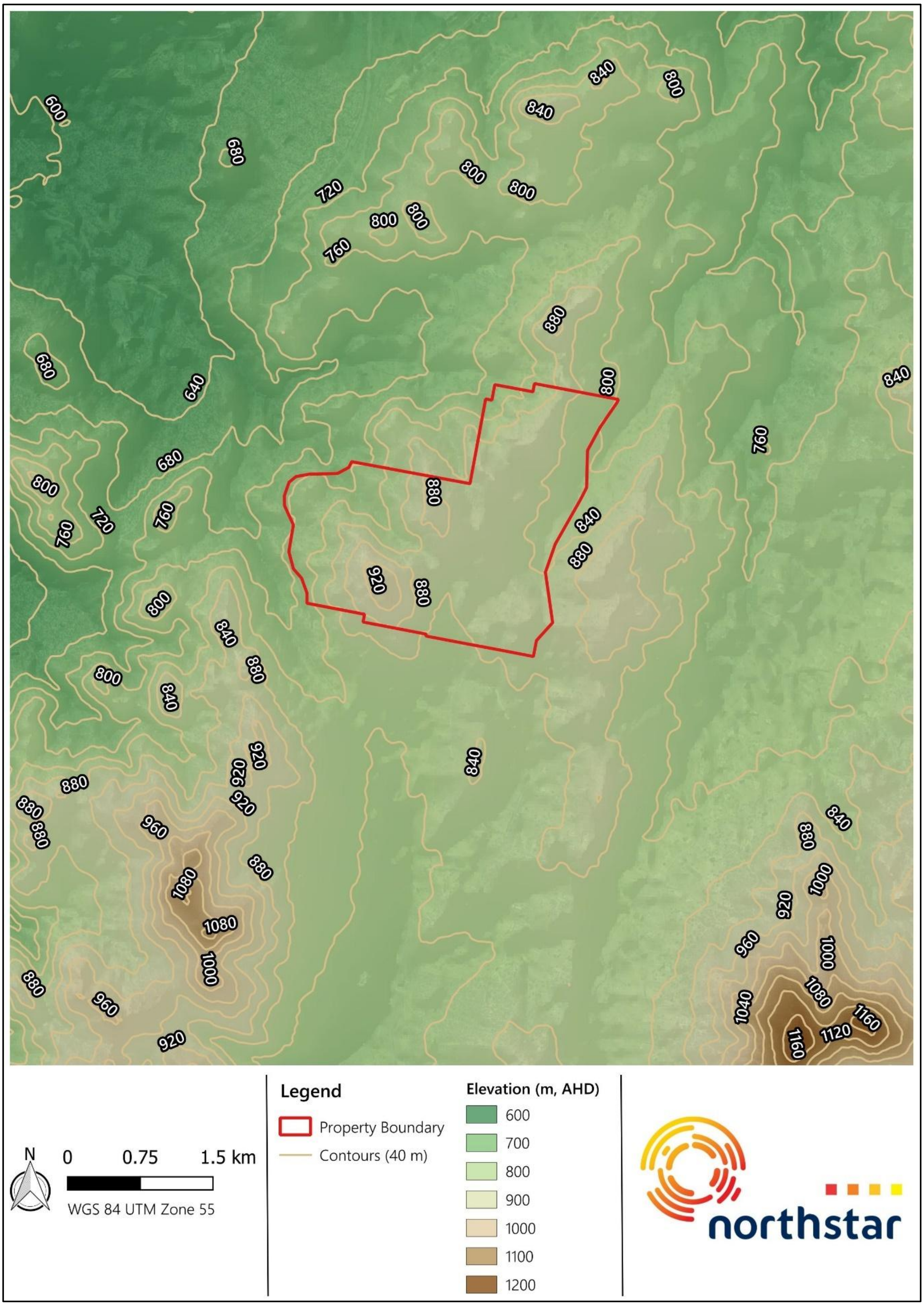
4.4. Topography

The Project Site is located within an undulating landscape (refer Figure 11) with the elevation of the Project Site between approximately 745 m and 956 m AHD. The topography of the area, and the locations of surrounding receptors in relation to the Project and surrounding topography has informed the approach to meteorological modelling (refer Section 5.1).

A graphical representation of the local topography, as obtained from the Elvis Elevation and Depth[2] system, hosted by the Intergovernmental Committee on Surveying and Mapping (ICSM) is presented in Figure 11.

2 https://elevation.fsdf.org.au/

Figure 11 Topography surrounding the Project Site



Source: Northstar

4.5. Potential for Cumulative Impacts

The area surrounding the Project Site is characterised by a mix of land uses mostly comprising of rural areas with higher density residential areas to the west. The Project Site occupies land zoned as Environmental Conservation and Rural Landscape.

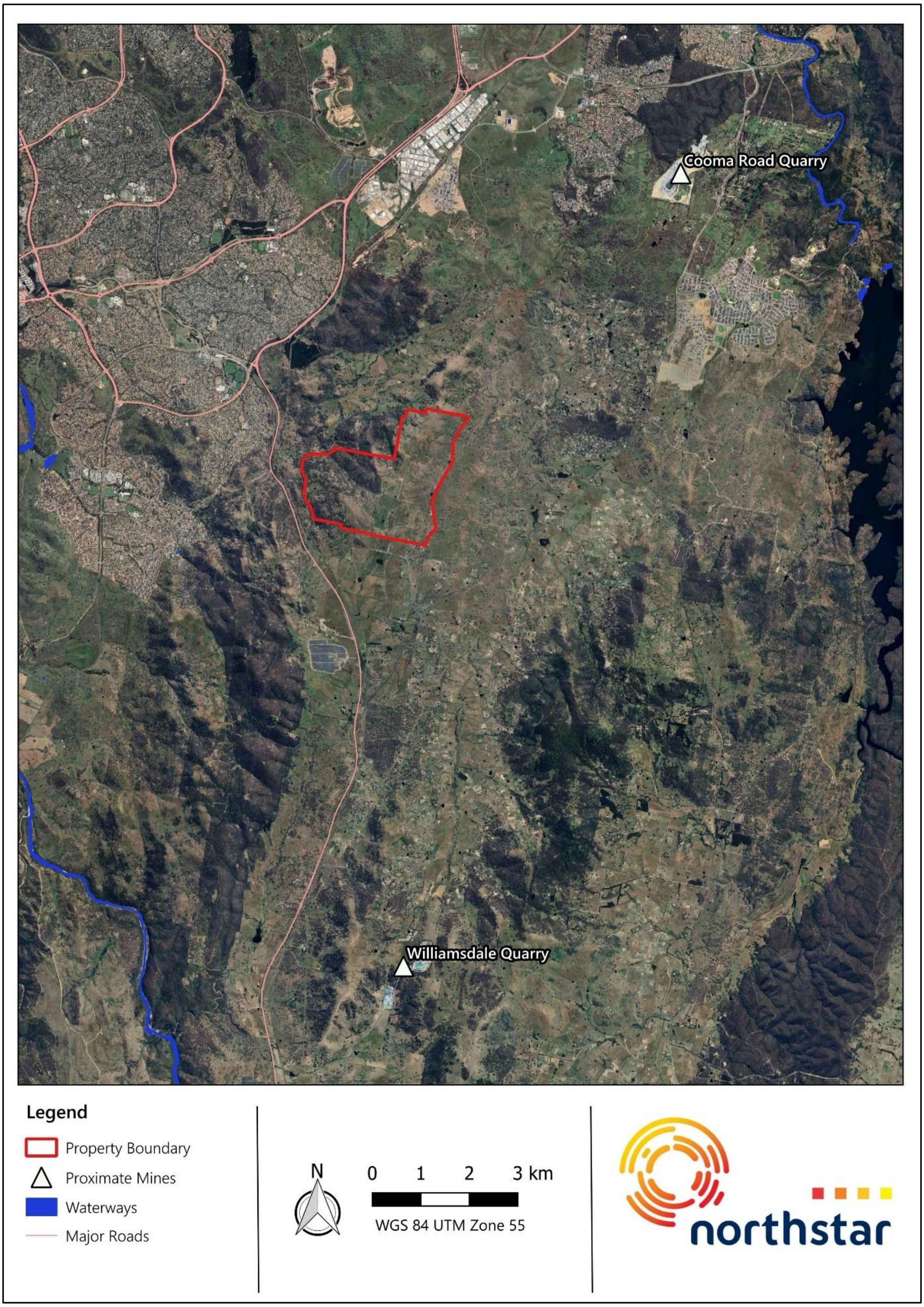
Two existing quarries have been identified proximate to the Project Site, known as Cooma Road Quarry operated by Holcim, and Williamsdale Quarry operated by Hanson. Given the distance of these quarry operations from the Project Site, it is not anticipated that any cumulative air quality impacts would occur, and these operations have not been considered further within this assessment. The adopted background air quality data as measured at the Monash AQMS is considered to provide an approximation of the air quality which would be experienced at the receptor locations, without the impact of the Project.

A summary of the identified existing quarrying operations is presented in Table 17 and Figure 12.

Table 17 Summary of surrounding Quarry operations

Name	Distance from the Project Site	Description	Scale of Production
Cooma Road Quarry	6.2 km NE	Hard rock quarry	Estimated up to 1.5 Mtpa (NSW DPIE, 2013)
Williamsdale Quarry	8.2 km S	Hard rock quarry	Estimated up to 2 Mtpa (NSW EPA, 2020)

Figure 12 Surrounding Quarry locations



Source: Northstar

4.6. Greenhouse Gases

Emissions of greenhouse gases (GHG) are tracked by the Commonwealth of Australia via the Australian National Greenhouse Accounts program. This program, and the reports and data submitted as part of the program, fulfils Australia's international and domestic reporting requirements. Carbon emission totals by State and Territory by year and by sector are reported in the 'State and Territory Greenhouse Gas Inventories' report each year.

These data are used to:

- meet Australia's reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC);
- track progress against Australia's emission reduction commitments; and
- inform policy makers and the public.

Data from the 2022 report for Australia (DCCEEW, 2024a) and NSW (DCCEEW, 2024b) have been obtained for the purposes of this GHG assessment. These reports are the most recent available at the time of reporting.

Scope 1 emissions of GHG from Australia in 2022 across all economic sectors were 432.6 Mt carbon dioxide equivalent (CO_2-e). Scope 1 emissions from the quarrying industry sector (including metal ore and non-metallic mineral mining and quarrying) accounted for 17.9 Mt CO_2-e, or 4.1 % of total Australian emissions (DCCEEW, 2024a). No disaggregation of these data is possible and are provided as "*metal ore and non-metallic mineral mining and quarrying*".

Scope 1 GHG emissions in NSW in 2022 were 111 Mt CO_2-e (total) with 14.5 Mt CO_2-e associated with the quarrying and mining sector (DCCEEW, 2024b).

5. APPROACH TO ASSESSMENT

5.1. Air Quality Impact Assessment

5.1.1. Dispersion Modelling

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, and is considered an appropriate model for this AQIA. 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 18 provides the model input configuration to assess the impact of particulate emissions from the Project, in consideration of the Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods (Barclay & Scire, 2011).

Table 18 General model parameters for CALPUFF dispersion modelling

Model parameter	Input
Model mode	CALPUFF Refined Mode CALMET Hybrid
Meteorological data	Prognostic Data (TAPM) Observations from Cabramurra SHMEA AWS
Terrain topography	SRTM1 (1 ARC Second)
Model / Grid domain size	57.9 km × 57.9 km × 4 km
Grid resolution / spacing	0.3 km

Given the variable topography, terrain data with a 1 arc-second resolution (approximately 30 m) were used, in consideration of (Barclay & Scire, 2011). The dispersion model was run over a 70 x 70 grid at 0.2 km resolution (14 km × 14 km) at ground level, encompassing the nearest sensitive receptors (refer Section 4.1) and covering all potentially impacted nearby land uses.

An assessment of the impacts of the operation of activities at the Project Site has been performed which characterises the likely day-to-day operation of the Project, approximating average operational characteristics which are appropriate to assess against longer term (annual average) criteria for NO_2, particulate matter and RCS. The likely peak activities at the Project Site have also been characterised to allow comparison of potential impacts against shorter term (1-hour and 24-hour) criteria for odour, NO_2, VOCs, and particulate matter.

The modelling scenarios provide an indication of the air quality impacts of the operation of activities at the Project Site. Added to these impacts are background air quality concentrations (where available and discussed in Section 4.2 and Appendix C) which represent the air quality which may be expected within the area surrounding the Project Site, without the impacts of the Project itself.

5.1.2. Modelling Scenarios

Two modelling scenarios have been developed to provide an indication of the air quality impacts of the operation of activities at the Project Site at the nearest sensitive receptors. The Project Site layout under both scenarios is presented in Figure 13 (Scenario 1) and Figure 14 (Scenario 2).

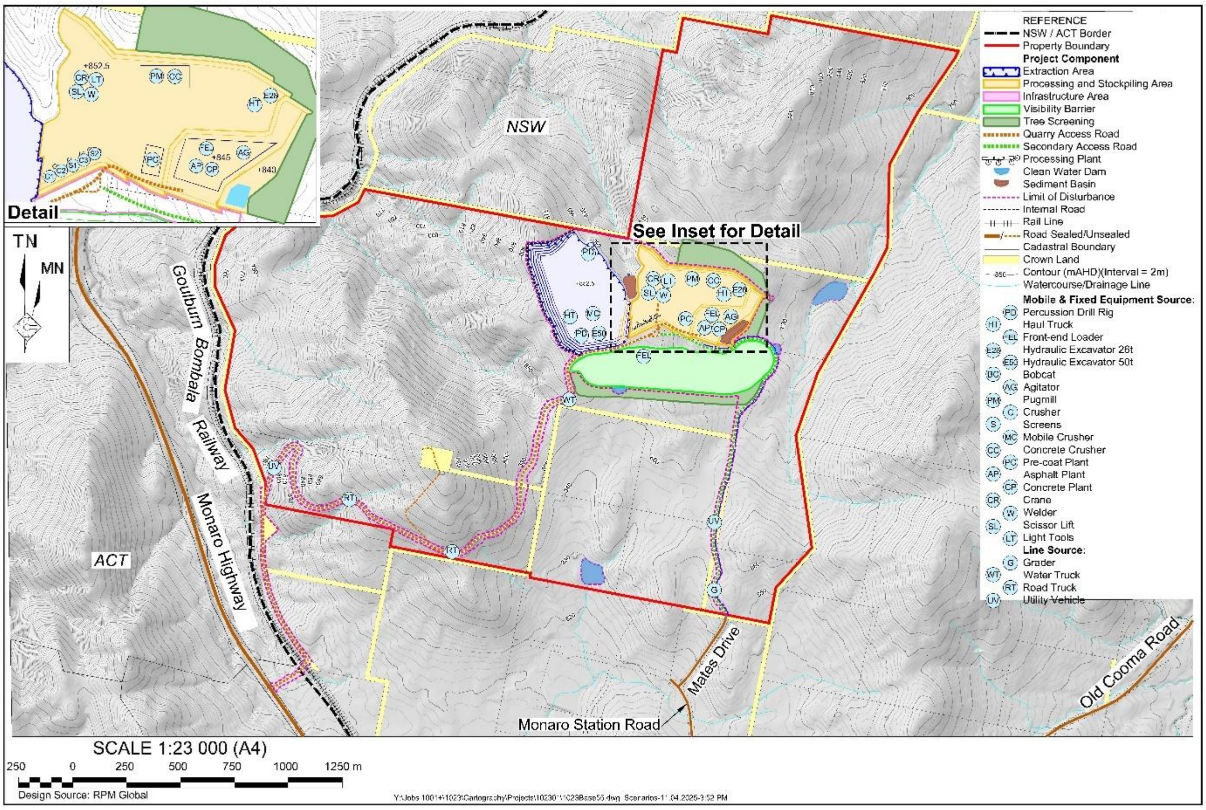
The main difference between the two scenarios is as follows:

- Scenario 1:
  - Quarry production rate of 750 000 $t \cdot yr^{-1}$; and
  - Material processing through a mobile processing plant.
- Scenario 2:
  - Quarry production rate of 1 $Mt \cdot yr^{-1}$; and
  - Material processing through a fixed processing plant.

Under both scenarios assessed, the production rates and associated materials handling rates for the Asphalt Batching Plant, Concrete Batching Plant, and Concrete Recycling activities are assumed to remain at the maximum rates for which approval is sought.

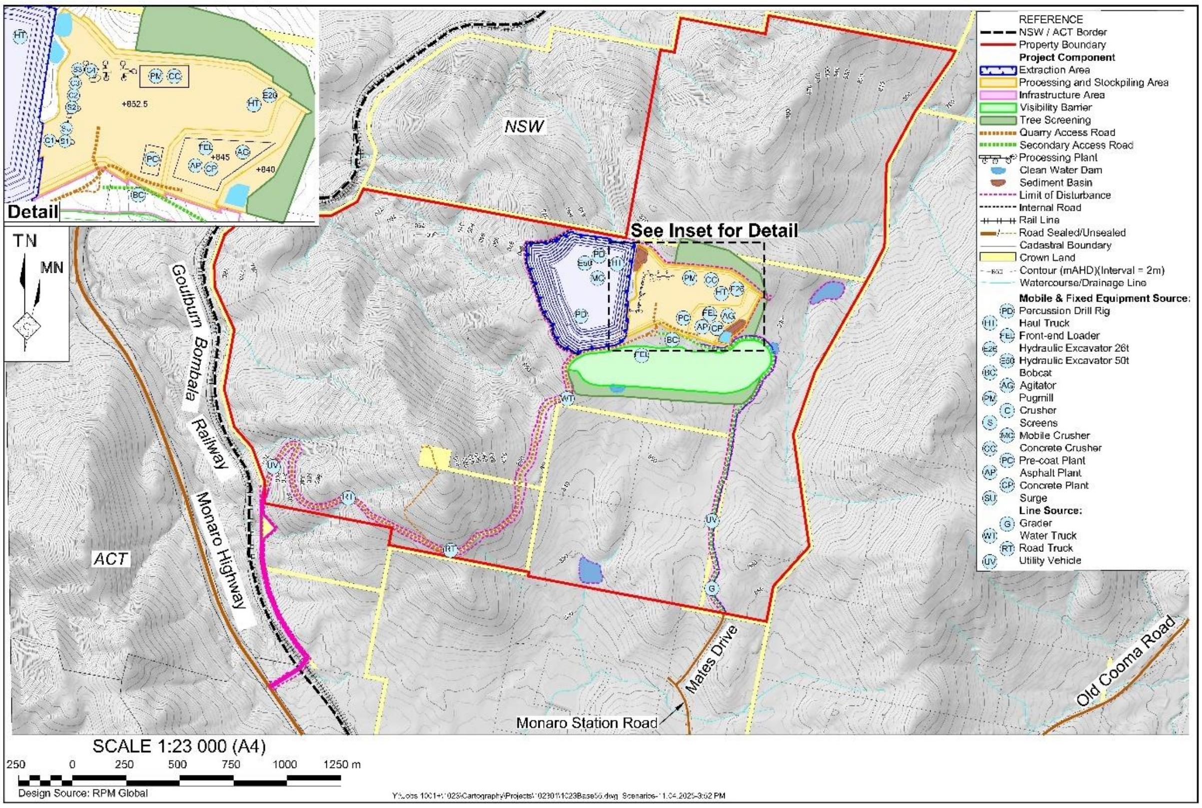
Although construction activities would occur at the commencement of the Project, the activity rates and emissions are anticipated to be greater during both operational scenarios than during construction, and impacts are therefore likely to be correspondingly greater. Impacts associated with construction activities have therefore not been quantitatively assessed.

Figure 13 Project operations under Scenario 1



Source: RWC

Figure 14 Project operations under Scenario 2



Source: RWC

5.1.3. Emissions Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. This assessment has adopted emission factors for drilling, blasting, materials handling processes, movement of trucks on paved and unpaved site roads, crushing and screening, and wind erosion contained within the US EPA AP-42 emission factor compendium (US EPA, 1995 and updates) to represent the emission of particulate matter resulting from the operations occurring at the Project Site as described in Section 2.11. These factors are appropriate for adoption in Australia and are routinely adopted in the assessment of operations of this nature.

Emissions associated with the Concrete Batching Plant have been calculated using emission factors outlined in the Australian Government National Pollutant Inventory Emission Estimation Technique Manual (EETM) for Concrete Batching Plants (NPI, 1999a). Potential emissions of particulate matter from the operation of the Asphalt Batching Plant have been estimated using the NPI EETM for hot mix asphalt plants (NPI, 1999b).

Emissions of odour, NO_X and VOCs from the asphalt batching plant have been estimated based on emissions testing data associated with an operational asphalt batching plant in Tomago, NSW, and data outlined in the NPI EETM for hot mix asphalt batching plants (NPI, 1999b). The emissions data for odour were associated with the production of asphalt using rubber crumb, which is considered to represent a potential worst-case scenario. Emissions associated with the dryer stack and load-out activities have been estimated and included in dispersion modelling.

Potential emissions of particulate matter during each scenario have been quantified, with an emissions inventory associated with the average operational characteristics, and peak characteristics during each stage calculated.

The estimation of annual emissions associated with the Project has assumed that operations are being performed at a steady rate across the year which is appropriate. In the assessment of maximum potential 24-hour impacts, it has been assumed that the day of <u>maximum activity occurs on every day of the year</u>. The assessment is required to be performed in this way to ensure that potential worst-case meteorological conditions are assumed at the same time as potential worst-case emissions, although the resulting impacts should be viewed with that conservatism in mind. Importantly, the AQIA is provided to confirm that the Project can be operated to be compliant with the air quality criteria in Section 3.

A full description of the emission sources included in the assessment, and the emission factors and assumptions adopted are presented in Appendix D.

5.1.4. Emissions Controls

As discussed in Section 2.10, emissions controls will be employed at the Project Site. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the Project operation.

A summary of the emissions reductions measures that would be adopted as part of the Project operation is presented in Table 19. These emission reductions are outlined in the NPI EETM for Mining (NPI, 2012), relevant AP-42 documentation (US EPA, 1995), or other industry guidance (Katestone, 2011).

Table 19 Summary of emission reduction methods adopted as part of Project operation

Emission control method	Control efficiency (%)
Fabric filters on drill rigs	99
Minimise drop height during material unloading/loading	30
Application of chemical suppressants on materials crushing operations	77.7
Application of chemical suppressants on materials screening operations	91.2
Use of chemical suppressants during material processing (carried over to transfer points and loading to temporary stockpiles)	70
Use of dust shroud during concrete blending	70
Enclosure around loading point of concrete agitator trucks	70
Reverse pulse dust filters of material storage silos	99.8
Application of water or chemical suppressants on unpaved haulage routes [(A)]	90
Application of water on paved haulage routes	30
Reduction in vehicle speeds on unpaved haulage routes	40
Reduction in vehicle speeds on paved haulage routes	44
Use of vegetation screen and colorbond fence along paved haulage route	75
Retention of particulate matter within the pit, for activities occurring in the pit	50 (TSP) 5 (PM_{10}, $PM_{2.5}$)
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified

Note: (A) Water or chemical suppressants would be used to achieve a minimum of 90 % dust control on unpaved haulage routes.

5.2. Greenhouse Gas Assessment

The purpose of the GHG assessment is to examine the potential impacts of the operation of the Project relating to emissions of GHG. A quantitative assessment of emissions is performed with direct emissions compared with total national and NSW GHG emissions for context (refer Section 4.6).

The scope of the GHG assessment is to provide a quantitative assessment of GHG emissions arising from the operation of the Project. This report does not provide a definitive quantification of GHG emissions arising from the Project operation but provides the general context of the likely quantum of emissions.

Opportunities for reduction of GHG emissions are discussed.

5.2.1. Emission Types

The Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) document, "National Greenhouse Accounts Factors" Workbook (NGA Factors) (DCCEEW, 2024c), defines two types of GHG emissions (see Table 20), namely 'direct' and 'indirect' emissions. This assessment considers both direct emissions and indirect emissions resulting from the operation of the Project.

Table 20 Greenhouse gas emission types

Emission Type	Definition
Direct	Produced from sources within the boundary of an organisation and as a result of that organisation's activities (e.g. consumption of fuel in on-site vehicles)
Indirect	Generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation (e.g. consumption of purchased electricity).

Note: Adapted from NGA Factors Workbook (DCCEEW, 2024c)

5.2.2. Emission Scopes

The NGA Factors (DCCEEW, 2024c) identifies two 'scopes' of emissions for GHG accounting and reporting purposes as shown in Table 21.

Table 21 Greenhouse gas emission scopes

Emission Scope	Definition
Scope 1	Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate Scope 1 emissions.
Scope 2	Indirect emission factors are used to calculate Scope 2 emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.

Note: Adapted from NGA Factors Workbook (DCCEEW, 2024c)

A third scope of emissions, Scope 3 Emissions, are also recognised in some GHG assessments. The Greenhouse Gas Protocol (GHG Protocol) (WRI, 2004) defines Scope 3 emissions as "other indirect GHG emissions":

> *"Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services."*

Scope 3 emissions related to the extraction and transport of fuels, and the use of fuels in employee transport have been considered. Emissions associated with the transport of materials from the Project are considered in this assessment as Scope 1 emissions as they are under the operational control of the Applicant.

5.2.3. Emission Source Identification

The geographical boundary set for this GHG assessment covers the Project Site and also includes the transport of materials from the Project Site to market. All Scope 1 and Scope 3 emissions within the defined boundary have been identified and reported as far as possible.

The GHG emission sources associated with the operation of the Project have been identified through the review of the proposed broad activities as described in Section 2.11. The activities/operations being performed as part of the Project, which have the potential to result in emissions of GHG, are presented in Table 22.

Table 22 Greenhouse gas emission sources

Project Component	Scope	Emission Source Description
Consumption of diesel fuel in mobile plant and equipment at the Project Site	1,3	Emissions from combustion of fuel (Scope 1) Emissions associated with the extraction and processing of fuel (Scope 3)
Consumption of electricity at the Project Site	2, 3	Emissions associated with the generation of electricity (Scope 2) Upstream and downstream emissions associated with electricity generation (Scope 3)
Consumption of diesel fuel / unleaded fuel for material transport purposes	1,3	Emissions from combustion of fuel (Scope 1) Emissions associated with the extraction and processing of fuel (Scope 3)
Consumption of diesel fuel / unleaded fuel for employee transport purposes	3	Emissions associated with the extraction and processing of fuel (Scope 3)

5.2.4. Emissions Estimation

Emissions of GHG from the source identified in Table 22 have been calculated using activity data for the source per annum (i.e. per kilowatt (kW) of electricity, per kilolitre (kL) of diesel) and the relevant emission factor for each source. The assumptions used in the calculation of activity data for the emission source and emission factors, are presented below.

Activity Data

The assumptions relating to activity data are outlined in Table 23.

Table 23 Calculated activity data

Component	Assumptions	Activity	Units
Consumption of diesel fuel in mobile plant and equipment at the Quarry	In the absence of specific information, a diesel fuel consumption rate of 1 L per t of rock processed has been applied, based on review of other quarrying operations. Diesel fuel use estimated to be 1 200 000 L per annum in mobile equipment and to provide power to the processing plant. Light vehicles and product transport trucks may also be refuelled on site, although the fuel use associated with trucks is considered separately below.	1 200	kL·annum^{-1}
Consumption of diesel fuel in asphalt batching plant	To produce 1 t of hot mix asphalt requires between 7.6 L to 11.4 L of diesel (Thives & Ghisi, 2017). To produce the required 50 000 t of asphalt per year would require 570 kL of diesel	570	kL·annum^{-1}
Consumption of diesel fuel / unleaded fuel for employee transport purposes	20 to 30 full-time equivalent positions to be generated by the Project (including 10 truck drivers). Assume employees reside in Canberra (45 km as a two-way journey) 300 days per year 10.6 L per 100km fuel efficiency (ABS, 2017)	42.9	kL·annum^{-1}
Consumption of diesel fuel / unleaded fuel for material transport purposes	Market for products would vary, although for the purposes of this assessment, laden trucks are assumed to travel to Goulburn (or equivalent distance, on average). 220 km return trip, to travel 26.2 km to Rankins Springs (20 % of loads) and 49.2 km to Goolgowi (80 % of loads) Up to 46 500 return trips each year (all materials and products – no backloading assumed) 56.3 L per 100 km fuel efficiency (ABS, 2017)	5 438	kL·annum^{-1}
Electricity	Electricity consumption across the Project site is not known, although electricity is likely to be used in administration buildings and in the concrete batching plant. Review of similar assessments for concrete batching plants (Lend Lease, Unknown) provides an electricity consumption rate of 4.375 kWh of electricity per 1 m^3 of concrete produced. Assuming 50 000 m^3 of concrete produced per year results in 218 750 kWh electricity consumption per year.	218 750	kWh annum^{-1}

Emission Factors

Emissions factors used for the assessment of GHG emissions associated with the operation of the Project have been sourced from the NGA Factors (DCCEEW, 2024c) (refer to Table 24). As outlined in Section 5.2, Scope 1 and Scope 3 emission factors relate to different emissions sources, or responsibilities. For example, some relate to combustion of fuel at the Project Site (Scope 1), whilst other emission factors relate to the extraction, processing, and transport of that fuel (Scope 3).

Table 24 Greenhouse gas emission factors

Emission Scope	Emission Source	Emission Factor	Energy Content Factor
Scope 1	Diesel fuel for mobile plant and equipment and material transport	70.2 kg CO_2-e·GJ^{-1}	38.6 GJ·kL^{-1}
	Diesel fuel for material transport	70.2 kg CO2-e·GJ^{-1}	38.6 GJ·kL^{-1}
Scope 2	Consumption of purchased electricity (NSW and ACT)	0.66 kg CO_2-e·kWh^{-1}	NA
Scope 3	Diesel fuel for mobile plant and equipment	17.3 kg CO_2-e·GJ^{-1}	38.6 GJ·kL^{-1}
	Unleaded fuel for employee transport	17.2 kg CO_2-e·GJ^{-1}	34.2 GJ·kL^{-1}
	Diesel fuel for material transport	17.3 kg CO_2-e·GJ^{-1}	38.6 GJ·kL^{-1}
	Consumption of purchased electricity (NSW and ACT)	0.04 kg CO_2-e·kWh^{-1}	NA

6. 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 Project in isolation.
- Cumulative impact – relates to the incremental concentrations predicted as a result of the operation of the Project PLUS the background air quality concentrations discussed in Section 4.3.

The results are presented in this manner to allow examination of the likely impact of the Project 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

Predicted impacts are presented at all receptors, with the Project related receptor (PR1) being greyed out. The statistics related to the contribution of the Project to incremental and cumulative impacts (% of criterion) are shown only for non-Project related receptors.

All results are presented for updated modelling which adopts the modelled meteorological data as described in Appendix B. For clarity, the meteorological file which resulted in 5 % calms has been adopted in preference to that adopted in the original AQIA, which included 0 % calm wind conditions, and was queried by NSW EPA.

6.1. Scenario 1

The following presents the results of the modelling assessment under the assumptions of Scenario 1 (refer Section 5.1.2).

6.1.1. Particulate Matter – Annual Average PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the operation of the Project under Scenario 1 are presented in Table 25.

The results indicate that incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at surrounding receptor locations are all predicted to be below the relevant criteria.

Table 25 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Scenario 1

Receptor	Annual average particulate matter 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	1.1	26.8	27.9	2.0	41.2	43.2	< 0.1	86.3	86.9
PR1	1.2	24.1	25.3	0.5	10.3	10.8	<0.1	6.9	7.0
R2	1.0	24.1	25.1	0.5	10.3	10.8	<0.1	6.9	7.0
R3	0.8	24.1	24.9	0.4	10.3	10.7	<0.1	6.9	7.0
R4	0.8	24.1	24.9	0.4	10.3	10.7	<0.1	6.9	7.0
R5	0.8	24.1	24.9	0.4	10.3	10.7	<0.1	6.9	7.0
R6	0.8	24.1	24.9	0.4	10.3	10.7	<0.1	6.9	7.0
R7	0.7	24.1	24.8	0.2	10.3	10.5	<0.1	6.9	7.0
R8	0.4	24.1	24.5	0.2	10.3	10.5	<0.1	6.9	7.0
R9	0.4	24.1	24.5	0.2	10.3	10.5	<0.1	6.9	7.0
R10	0.5	24.1	24.6	0.2	10.3	10.5	<0.1	6.9	7.0
R11	0.5	24.1	24.6	0.2	10.3	10.5	<0.1	6.9	7.0
R12	0.7	24.1	24.8	0.3	10.3	10.6	<0.1	6.9	7.0
R13	0.6	24.1	24.7	0.3	10.3	10.6	<0.1	6.9	7.0
R14	0.5	24.1	24.6	0.3	10.3	10.6	<0.1	6.9	7.0
R15	0.5	24.1	24.6	0.3	10.3	10.6	<0.1	6.9	7.0
R16	0.4	24.1	24.5	0.2	10.3	10.5	<0.1	6.9	7.0
R17	0.3	24.1	24.4	0.2	10.3	10.5	<0.1	6.9	7.0
R18	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R19	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R20	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R21	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R22	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R23	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R24	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R25	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R26	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R27	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R28	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R29	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R30	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R31	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R32	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R33	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R34	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R35	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0

Receptor	Annual average particulate matter concentration ($\mu g \cdot m^{-3}$)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R36	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R37	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R38	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R39	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R40	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R41	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R42	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R43	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R44	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R45	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R46	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R47	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0

Note: Incr = Incremental impact, Bkg = Background, Cumul = Cumulative Impact

6.1.2. Respirable Crystalline Silica – Annual Average

As outlined in Section 3.4.2, RCS concentrations have been taken to be 40 % of the annual average PM_{10} concentration. This is applied to the incremental impact only and assumes that the background air quality environment is not impacted by RCS, which is considered to be a reasonable assumption. The maximum predicted incremental annual average PM_{10} concentration at any non-Project related receptor under Scenario 1 operations is 0.5 $\mu g \cdot m^{-3}$ which results in a predicted impact of 0.2 $\mu g \cdot m^{-3}$ of RCS (0.5 $\mu g \cdot m^{-3}$ × 40 %). This is significantly below the adopted annual average RCS criterion of 3 $\mu g \cdot m^{-3}$.

Although the PM_{10} fraction has been adopted to allow assessment of the potential for RCS impacts (refer Section 3.4.2), $PM_{2.5}$ concentrations are also predicted to be < 0.1 $\mu g \cdot m^{-3}$ (annual average) at receptor locations, providing additional confidence that impacts associated with RCS would be negligible.

6.1.3. Particulate Matter – Annual Average Dust Deposition Rates

Table 26 presents the annual average dust deposition predicted as a result of the operation of the Project under Scenario 1.

The results indicate minor incremental impacts at all surrounding receptor locations, and compliance with the relevant criterion.

Table 26 Predicted annual average dust deposition – Scenario 1

Receptor	Annual average dust deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incr.	Bkg.	Cumul.
Criterion	2	-	4
Max. % of criterion	< 0.1	-	51.3
PR1	< 0.1	2.0	2.1
R2	< 0.1	2.0	2.1
R3	< 0.1	2.0	2.1
R4	< 0.1	2.0	2.1
R5	< 0.1	2.0	2.1
R6	< 0.1	2.0	2.1
R7	< 0.1	2.0	2.1
R8	< 0.1	2.0	2.1
R9	< 0.1	2.0	2.1
R10	< 0.1	2.0	2.1
R11	< 0.1	2.0	2.1
R12	< 0.1	2.0	2.1
R13	< 0.1	2.0	2.1
R14	< 0.1	2.0	2.1
R15	< 0.1	2.0	2.1
R16	< 0.1	2.0	2.1
R17	< 0.1	2.0	2.1
R18	< 0.1	2.0	2.1
R19	< 0.1	2.0	2.1
R20	< 0.1	2.0	2.1
R21	< 0.1	2.0	2.1
R22	< 0.1	2.0	2.1
R23	< 0.1	2.0	2.1
R24	< 0.1	2.0	2.1
R25	< 0.1	2.0	2.1
R26	< 0.1	2.0	2.1
R27	< 0.1	2.0	2.1
R28	< 0.1	2.0	2.1
R29	< 0.1	2.0	2.1
R30	< 0.1	2.0	2.1
R31	< 0.1	2.0	2.1
R32	< 0.1	2.0	2.1
R33	< 0.1	2.0	2.1
R34	< 0.1	2.0	2.1
R35	< 0.1	2.0	2.1
R36	< 0.1	2.0	2.1
R37	< 0.1	2.0	2.1

Receptor	Annual average dust deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incr.	Bkg.	Cumul.
R38	< 0.1	2.0	2.1
R39	< 0.1	2.0	2.1
R40	< 0.1	2.0	2.1
R41	< 0.1	2.0	2.1
R42	< 0.1	2.0	2.1
R43	< 0.1	2.0	2.1
R44	< 0.1	2.0	2.1
R45	< 0.1	2.0	2.1
R46	< 0.1	2.0	2.1
R47	< 0.1	2.0	2.1

Note: Incr = Incremental impact, Bkg = Background, Cumul = Cumulative Impact

6.1.4. Particulate Matter – Maximum 24-hour Average

Presented in Table 27 are the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest sensitive receptors as a result of the operation of the Project under Scenario 1. No background concentrations are included within this table. The highest incremental impacts are predicted at non-Project related receptor R2 for PM_{10} and $PM_{2.5}$.

It is noted that these predicted incremental impacts assume that the Project is operating at maximum capacity on each and every day of the year. That includes drilling, a blast, loading and hauling sufficient material from the extraction area to allow the mobile processing plant to process material over all hours of the operational day at the maximum possible rate, the pugmill, concrete and asphalt batching plants operating at their maximum possible rates, and vehicles bringing materials to and from the Project Site at peak levels. In reality, such a situation is not likely to eventuate, and the modelling results should be viewed with that in mind. The purpose of the AQIA is to ensure that, should the Applicant require that level of flexibility, the surrounding environment can accommodate the potential impact.

During operations, if the Applicant does require the level of flexibility defined above, it is not likely to be on each and every day of the year and would be for short campaigns. It would be highly unlikely for the peak requirements for rock, asphalt, road base, and concrete to occur on the same day, and even less likely that these peak activities would occur at the same time as worst-case meteorological conditions.

Table 27 Predicted maximum incremental 24-hour PM_{10} 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	20.5	6.4
PR1	7.4	1.2
R2	10.3	1.6
R3	8.9	1.4
R4	4.5	0.7
R5	5.9	0.8
R6	6.4	0.9
R7	3.9	0.6
R8	2.8	0.4
R9	2.8	0.4
R10	4.0	0.5
R11	5.2	0.8
R12	7.1	1.1
R13	6.7	1.0
R14	4.8	0.7
R15	3.8	0.6
R16	2.7	0.4
R17	2.3	0.4
R18	1.7	0.3
R19	1.4	0.2
R20	1.2	0.2
R21	1.2	0.2
R22	1.3	0.2
R23	1.2	0.2
R24	1.4	0.2
R25	1.3	0.2
R26	1.2	0.2
R27	1.3	0.2
R28	1.3	0.2
R29	1.3	0.2
R30	1.4	0.2
R31	1.7	0.3
R32	2.0	0.3
R33	1.8	0.3
R34	1.5	0.2

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
R35	1.7	0.3
R36	1.6	0.3
R37	1.9	0.4
R38	2.0	0.4
R39	2.2	0.4
R40	2.1	0.4
R41	1.9	0.4
R42	1.7	0.3
R43	1.7	0.3
R44	1.5	0.3
R45	1.1	0.2
R46	0.9	0.2
R47	0.9	0.2

Table 28 and Table 29 present the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Project under Scenario 1, with background included.

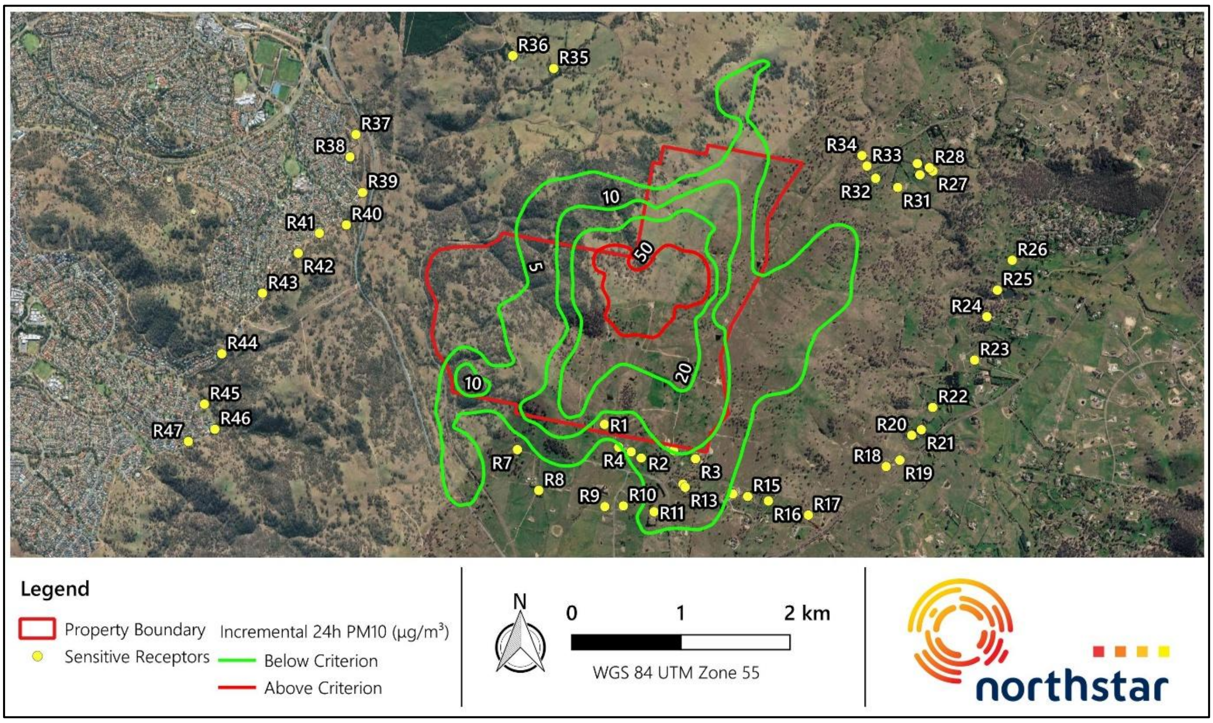
Results are presented for the non-Project related receptor at which the highest incremental PM_{10} and $PM_{2.5}$ impacts have been predicted, and also for the non-Project related receptors at which the highest cumulative impacts (increment plus background) have been predicted. These may be different receptors than those at which the highest incremental impacts are predicted.

The left side of the tables show the predicted concentration on days with the highest cumulative impact (principally driven by the highest background concentrations), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations with the contemporaneous background values to derive the respective cumulative predictions.

Analysis of the modelling results confirms that no additional exceedances of the 24-hour PM_{10} or $PM_{2.5}$ criteria are predicted at any modelled receptor, as a result of Project operations under Scenario 1.

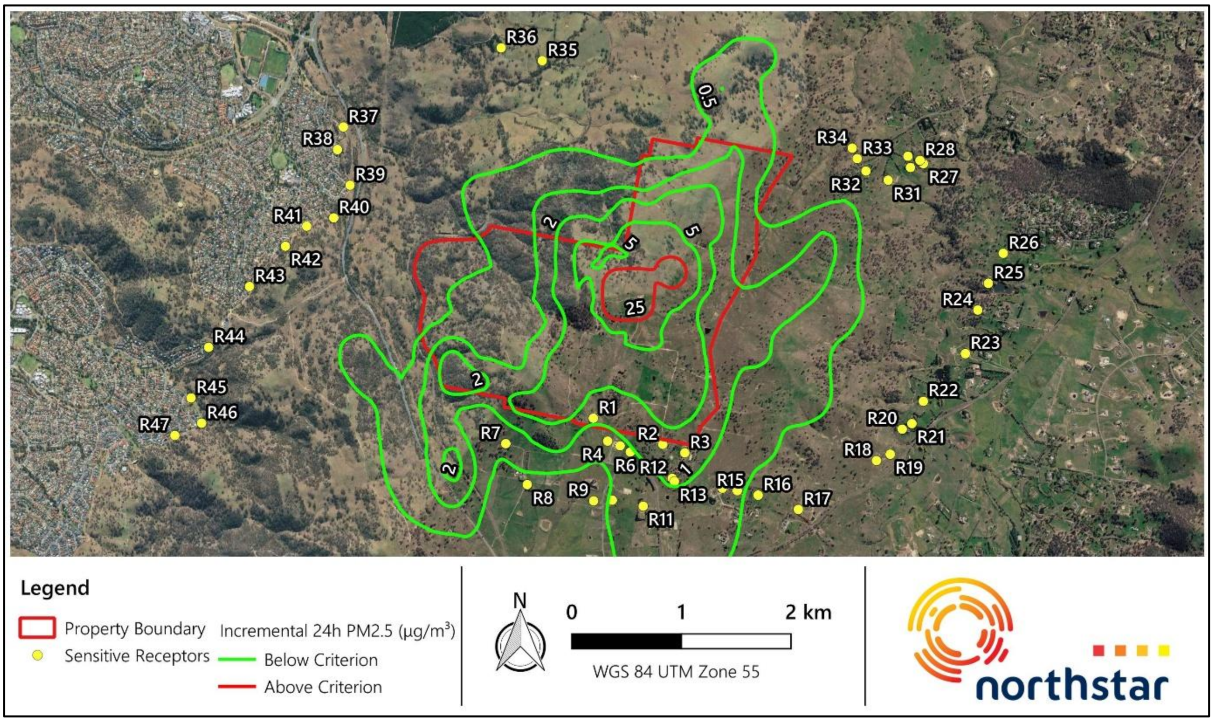
Contour plots of the incremental contribution of the proposed operation of the Project under Scenario 1 to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in Figure 15 and Figure 16, respectively.

Figure 15 Predicted maximum incremental 24-hour average PM_{10} concentrations – Scenario 1



Source: Northstar

Figure 16 Predicted maximum incremental 24-hour average $PM_{2.5}$ concentrations – Scenario 1



Source: Northstar

Table 28 Summary of contemporaneous impact and background – PM_{10} – Scenario 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R2			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R2		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
29/04/2021	3.0	37.3	40.3	23/07/2021	10.3	16.5	26.7
30/04/2021	1.3	37.1	38.3	1/07/2021	4.8	10.4	15.2
1/05/2021	3.5	30.7	34.2	15/06/2021	4.8	17.3	22.1
2/05/2021	3.3	26.8	30.1	16/06/2021	4.5	14.8	19.3
8/07/2021	1.4	28.5	29.9	2/09/2021	4.4	14.9	19.3
19/04/2021	1.0	28.7	29.7	23/06/2021	4.0	16.4	20.4
20/05/2021	0.4	29.0	29.4	2/06/2021	3.8	18.3	22.1
19/05/2021	1.4	27.9	29.4	29/08/2021	3.7	13.6	17.3
21/05/2021	0.8	28.0	28.8	31/07/2021	3.5	19.3	22.8
22/07/2021	3.2	25.3	28.5	1/05/2021	3.5	30.7	34.2
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) due to the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) due to the operation of the project.			

Note: Incr = Incremental impact, Bkg = Background, Cumul = Cumulative Impact

Table 29 Summary of contemporaneous impact and background – $PM_{2.5}$ – Scenario 1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R2			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R2		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
29/04/2021	0.4	27.9	28.3	23/07/2021	1.6	16.3	17.9
30/04/2021	0.2	25.8	26.0	1/07/2021	0.8	7.7	8.5
1/05/2021	0.5	25.4	25.9	15/06/2021	0.7	13.7	14.5
8/07/2021	0.2	25.6	25.9	16/06/2021	0.7	13.9	14.6
21/05/2021	0.1	25.2	25.3	2/09/2021	0.7	11.2	11.8
22/07/2021	0.4	24.1	24.5	2/06/2021	0.6	13.7	14.2
19/05/2021	0.2	24.0	24.2	29/08/2021	0.5	11.7	12.2
19/08/2021	0.4	23.0	23.4	1/05/2021	0.5	25.4	25.9
2/05/2021	0.5	22.8	23.3	23/06/2021	0.5	14.6	15.1
22/05/2021	0.3	22.5	22.8	25/05/2021	0.5	11.1	11.6
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) due to the operation of the project.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) due to the operation of the project.			

Note: Incr = Incremental impact, Bkg = Background, Cumul = Cumulative Impact

6.1.5. Voluntary Land Acquisition and Mitigation Policy

The previous sections confirm that the relevant criteria associated with the NSW Voluntary Land Acquisition and Mitigation Policy are not exceeded at any surrounding privately-owned residence.

The previous sections also confirm that the Voluntary Acquisition criteria are not exceeded at any surrounding sensitive receptor location, however the Voluntary Acquisition criteria are also to be applied across privately owned land (rather than just residences). Specifically, voluntary acquisition rights may be applied by the consent authority "*where the development is predicted to result in exceedances of the relevant criteria on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.*"

The relevant air quality criteria related to voluntary acquisition or mitigation are not predicted to be exceeded on any parts of private landholdings in Scenario 1.

6.2. Scenario 2

The following presents the results of the modelling assessment under the assumptions of Scenario 2 (refer Section 5.1.2).

6.2.1. Particulate Matter – Annual Average PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the operation of the Project under Scenario 2 are presented in Table 30.

The results indicate that incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at surrounding receptor locations are all predicted to be below the relevant criteria.

Table 30 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations – Scenario 2

Receptor	Annual average particulate matter 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	1.3	26.8	28.1	2.4	41.2	43.6	< 0.1	86.3	86.9
PR1	1.5	24.1	25.6	0.6	10.3	10.9	<0.1	6.9	7.0
R2	1.2	24.1	25.3	0.6	10.3	10.9	<0.1	6.9	7.0
R3	1.0	24.1	25.1	0.5	10.3	10.8	<0.1	6.9	7.0
R4	1.0	24.1	25.1	0.4	10.3	10.7	<0.1	6.9	7.0
R5	1.0	24.1	25.1	0.5	10.3	10.8	<0.1	6.9	7.0
R6	1.0	24.1	25.1	0.5	10.3	10.8	<0.1	6.9	7.0
R7	0.8	24.1	24.9	0.3	10.3	10.6	<0.1	6.9	7.0
R8	0.5	24.1	24.6	0.2	10.3	10.5	<0.1	6.9	7.0
R9	0.5	24.1	24.6	0.2	10.3	10.5	<0.1	6.9	7.0
R10	0.6	24.1	24.7	0.2	10.3	10.5	<0.1	6.9	7.0
R11	0.6	24.1	24.7	0.3	10.3	10.6	<0.1	6.9	7.0
R12	0.8	24.1	24.9	0.4	10.3	10.7	<0.1	6.9	7.0
R13	0.8	24.1	24.9	0.4	10.3	10.7	<0.1	6.9	7.0
R14	0.7	24.1	24.8	0.3	10.3	10.6	<0.1	6.9	7.0
R15	0.6	24.1	24.7	0.3	10.3	10.6	<0.1	6.9	7.0
R16	0.6	24.1	24.7	0.3	10.3	10.6	<0.1	6.9	7.0
R17	0.4	24.1	24.5	0.2	10.3	10.5	<0.1	6.9	7.0
R18	0.3	24.1	24.4	0.2	10.3	10.5	<0.1	6.9	7.0
R19	0.3	24.1	24.4	0.2	10.3	10.5	<0.1	6.9	7.0
R20	0.3	24.1	24.4	0.2	10.3	10.5	<0.1	6.9	7.0
R21	0.3	24.1	24.4	0.1	10.3	10.4	<0.1	6.9	7.0
R22	0.3	24.1	24.4	0.1	10.3	10.4	<0.1	6.9	7.0
R23	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R24	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R25	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R26	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R27	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R28	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R29	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R30	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R31	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R32	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R33	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R34	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R35	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0

Receptor	Annual average particulate matter concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R36	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R37	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R38	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R39	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R40	0.2	24.1	24.3	0.1	10.3	10.4	<0.1	6.9	7.0
R41	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R42	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R43	0.2	24.1	24.3	<0.1	10.3	10.4	<0.1	6.9	7.0
R44	0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R45	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R46	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0
R47	<0.1	24.1	24.2	<0.1	10.3	10.4	<0.1	6.9	7.0

Note: Incr = Incremental impact, Bkg = Background, Cumul = Cumulative Impact

6.2.2. Respirable Crystalline Silica – Annual Average

As outlined in Section 3.4.2, RCS concentrations have been taken to be 40 % of the annual average PM_{10} concentration. This is applied to the incremental impact only and assumes that the background air quality environment is not impacted by RCS, which is considered to be a reasonable assumption. The maximum predicted incremental annual average PM_{10} concentration at any non-Project related receptor under Scenario 2 operations is 0.6 µg·m^{-3} which results in a predicted impact of 0.24 µg·m^{-3} of RCS (0.6 µg·m^{-3} × 40 %). This is significantly below the adopted annual average RCS criterion of 3 µg·m^{-3}.

Although the PM_{10} fraction has been adopted to allow assessment of the potential for RCS impacts (refer Section 3.4.2), $PM_{2.5}$ concentrations are also predicted to be < 0.1 µg·m^{-3} (annual average) at receptor locations, providing additional confidence that impacts associated with RCS would be negligible.

6.2.3. Particulate Matter – Annual Average Dust Deposition Rates

Table 31 presents the annual average dust deposition predicted as a result of the operation of the Project under Scenario 2.

The results indicate minor incremental impacts at all surrounding receptor locations, and compliance with the relevant criterion.

Table 31 Predicted annual average dust deposition – Scenario 2

Receptor	Annual average dust deposition ($g{\cdot}m^{-2}{\cdot}month^{-1}$)		
	Incr.	Bkg.	Cumul.
Criterion	2	-	4
Max. % of criterion	< 0.1	-	51.3
PR1	< 0.1	2.0	2.1
R2	< 0.1	2.0	2.1
R3	< 0.1	2.0	2.1
R4	< 0.1	2.0	2.1
R5	< 0.1	2.0	2.1
R6	< 0.1	2.0	2.1
R7	< 0.1	2.0	2.1
R8	< 0.1	2.0	2.1
R9	< 0.1	2.0	2.1
R10	< 0.1	2.0	2.1
R11	< 0.1	2.0	2.1
R12	< 0.1	2.0	2.1
R13	< 0.1	2.0	2.1
R14	< 0.1	2.0	2.1
R15	< 0.1	2.0	2.1
R16	< 0.1	2.0	2.1
R17	< 0.1	2.0	2.1
R18	< 0.1	2.0	2.1
R19	< 0.1	2.0	2.1
R20	< 0.1	2.0	2.1
R21	< 0.1	2.0	2.1
R22	< 0.1	2.0	2.1
R23	< 0.1	2.0	2.1
R24	< 0.1	2.0	2.1
R25	< 0.1	2.0	2.1
R26	< 0.1	2.0	2.1
R27	< 0.1	2.0	2.1
R28	< 0.1	2.0	2.1
R29	< 0.1	2.0	2.1
R30	< 0.1	2.0	2.1
R31	< 0.1	2.0	2.1
R32	< 0.1	2.0	2.1
R33	< 0.1	2.0	2.1
R34	< 0.1	2.0	2.1
R35	< 0.1	2.0	2.1
R36	< 0.1	2.0	2.1
R37	< 0.1	2.0	2.1

Receptor	Annual average dust deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incr.	Bkg.	Cumul.
R38	< 0.1	2.0	2.1
R39	< 0.1	2.0	2.1
R40	< 0.1	2.0	2.1
R41	< 0.1	2.0	2.1
R42	< 0.1	2.0	2.1
R43	< 0.1	2.0	2.1
R44	< 0.1	2.0	2.1
R45	< 0.1	2.0	2.1
R46	< 0.1	2.0	2.1
R47	< 0.1	2.0	2.1

Note: Incr = Incremental impact, Bkg = Background, Cumul = Cumulative Impact

6.2.4. Particulate Matter – Maximum 24-hour Average

Presented in Table 27 are the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest sensitive receptors as a result of the operation of the Project under Scenario 2. No background concentrations are included within this table. The highest incremental impacts are predicted at non-project related receptor R2 for PM_{10} and $PM_{2.5}$.

Once again, it is noted that these predicted incremental impacts are based on the assumption that the Project is operating at maximum capacity on each and every day of the year. That includes drilling, a blast, loading and hauling sufficient material from the extraction area to allow the fixed processing plant to process material over all hours of the operational day at the maximum possible rate, the pugmill, concrete and asphalt batching plants operating at their maximum possible rates, and vehicles bringing materials to and from the Project Site at peak levels. In reality, such a situation is not likely to eventuate, and the modelling results should be viewed with that in mind. The purpose of the assessment is to ensure that, should the Applicant require that level of flexibility, the surrounding environment can accommodate the potential impact.

During operations, if the Applicant does require the level of flexibility defined above, it is not likely to be on each and every day of the year and would be for short campaigns. It would be highly unlikely for the peak requirements for rock, asphalt, road base, and concrete to occur on the same day and even less likely that these peak activities would occur at the same time as worst-case meteorological conditions.

Table 32 Predicted maximum incremental 24-hour PM_{10} 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	23.5%	7.4%
PR1	7.9	1.3
R2	11.7	1.8
R3	10.6	1.7
R4	4.9	0.8
R5	6.5	0.9
R6	7.1	1.0
R7	4.1	0.7
R8	3.0	0.5
R9	3.0	0.5
R10	4.2	0.6
R11	5.7	0.8
R12	8.1	1.3
R13	7.8	1.2
R14	5.8	0.9
R15	4.6	0.7
R16	3.1	0.5
R17	2.8	0.4
R18	1.9	0.3
R19	1.6	0.3
R20	1.5	0.3
R21	1.5	0.3
R22	1.5	0.2
R23	1.3	0.2
R24	1.5	0.2
R25	1.5	0.2
R26	1.4	0.2
R27	1.4	0.2
R28	1.5	0.2
R29	1.6	0.3
R30	1.5	0.3
R31	1.9	0.3
R32	2.4	0.4
R33	2.2	0.3
R34	1.9	0.3

Receptor	Maximum 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
R35	2.1	0.3
R36	1.9	0.3
R37	2.2	0.4
R38	2.3	0.4
R39	2.5	0.4
R40	2.2	0.4
R41	2.0	0.4
R42	1.8	0.4
R43	2.2	0.3
R44	1.7	0.3
R45	1.1	0.2
R46	1.0	0.2
R47	0.9	0.2

Table 33 and Table 34 present the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Project under Scenario 2, with background included.

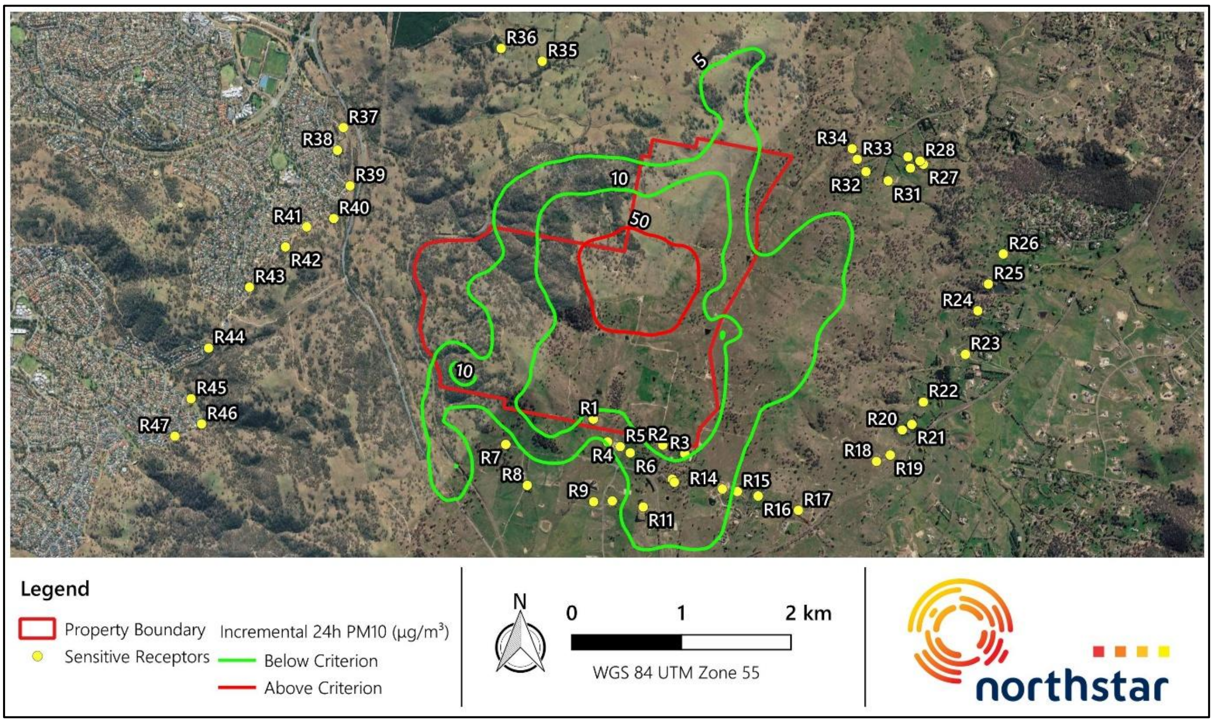
Results are presented for the non-Project related receptor at which the highest incremental PM_{10} and $PM_{2.5}$ impacts have been predicted, and also for the non-Project related receptors at which the highest cumulative impacts (increment plus background) have been predicted. These may be different receptors than those at which the highest incremental impacts are predicted.

The left side of the tables show the predicted concentration on days with the highest cumulative impact (principally driven by the highest background concentrations), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations with the contemporaneous background values to derive the respective cumulative predictions.

Analysis of the modelling results confirms that no additional exceedances of the 24-hour PM_{10} or $PM_{2.5}$ criteria are predicted at any modelled receptor, as a result of Project operations under Scenario 2.

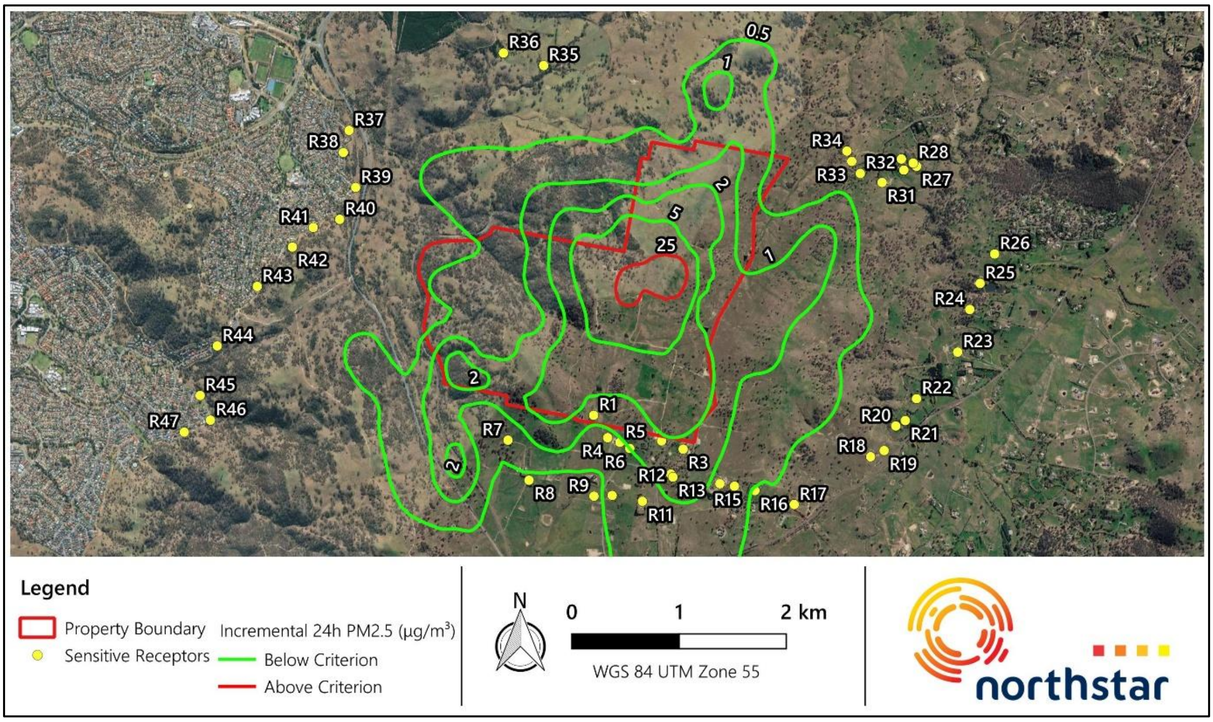
Contour plots of the incremental contribution of the proposed operation of the Project under Scenario 2 to the 24-hour average PM_{10} concentrations are presented in Figure 17 and Figure 18, respectively.

Figure 17 Predicted maximum incremental 24-hour average PM_{10} concentrations – Scenario 2



Source: Northstar

Figure 18 Predicted maximum incremental 24-hour average $PM_{2.5}$ concentrations – Scenario 2



Source: Northstar

Table 33 Summary of contemporaneous impact and background – PM_{10} – Scenario 2

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R2			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) - Receptor R2		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
29/04/2021	3.3	37.3	40.7	23/07/2021	11.7	16.5	28.2
30/04/2021	1.5	37.1	38.5	1/07/2021	5.6	10.4	16.0
1/05/2021	4.1	30.7	34.8	15/06/2021	5.3	17.3	22.6
2/05/2021	3.5	26.8	30.3	2/09/2021	4.6	14.9	19.5
8/07/2021	1.7	28.5	30.2	16/06/2021	4.5	14.8	19.3
19/04/2021	0.9	28.7	29.6	23/06/2021	4.3	16.4	20.7
20/05/2021	0.4	29.0	29.4	1/05/2021	4.1	30.7	34.8
19/05/2021	1.4	27.9	29.3	29/08/2021	4.0	13.6	17.6
21/05/2021	0.8	28.0	28.8	2/06/2021	4.0	18.3	22.3
22/07/2021	3.3	25.3	28.6	31/07/2021	3.9	19.3	23.1
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) due to the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

Table 34 Summary of contemporaneous impact and background – $PM_{2.5}$ – Scenario 2

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R2			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) - Receptor R2		
	Incr.	Bkg.	Cumul.		Incr.	Bkg.	Cumul.
29/04/2021	0.5	27.9	28.3	23/07/2021	1.8	16.3	18.1
1/05/2021	0.6	25.4	26.1	1/07/2021	0.9	7.7	8.6
30/04/2021	0.2	25.8	26.0	15/06/2021	0.8	13.7	14.5
8/07/2021	0.3	25.6	25.9	16/06/2021	0.7	13.9	14.6
21/05/2021	0.1	25.2	25.3	2/09/2021	0.7	11.2	11.8
22/07/2021	0.4	24.1	24.6	1/05/2021	0.6	25.4	26.1
19/05/2021	0.2	24.0	24.2	2/06/2021	0.6	13.7	14.3
19/08/2021	0.4	23.0	23.4	29/08/2021	0.6	11.7	12.3
2/05/2021	0.5	22.8	23.3	23/06/2021	0.6	14.6	15.2
22/05/2021	0.3	22.5	22.8	27/04/2021	0.5	13.2	13.7
These data represent the highest Cumulative Impact 24-hour $PM_{2.5}$ predictions (outlined in red) due to the operation of the project.				These data represent the highest Incremental Impact 24-hour $PM_{2.5}$ predictions (outlined in blue) due to the operation of the project.			

6.2.5. Voluntary Land Acquisition and Mitigation Policy

The previous sections confirm that the relevant criteria associated with the NSW Voluntary Land Acquisition and Mitigation Policy are not exceeded at any surrounding privately-owned residence.

The previous sections also confirm that the Voluntary Acquisition criteria are not exceeded at any surrounding sensitive receptor location, however the Voluntary Acquisition criteria are also to be applied across privately owned land (rather than just residences). Specifically, voluntary acquisition rights may be applied by the consent authority "*where the development is predicted to result in exceedances of the relevant criteria on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.*"

The relevant air quality criteria related to voluntary acquisition or mitigation are not predicted to be exceeded on any parts of private landholdings in Scenario 2.

6.3. Odour

The predicted 99th percentile 1-hour average odour concentrations resulting from the operation of the asphalt batching plant under Scenarios 1 and 2 are presented in Table 35. Note that these impacts include emissions from the dryer stack and load-out activities.

The results indicate that concentrations of odour at surrounding receptor locations are all predicted to be below the adopted criterion of 2 OU.

Table 35 Predicted 99th percentile 1-hour odour concentrations – Scenarios 1 and 2

Receptor	99th percentile 1-hour odour concentration (OU)	Receptor	99th percentile 1-hour odour concentration (OU)
	Incr.		Incr.
Criterion	2.0		
Max. % of criterion	66.3		
PR1	1.1	R25	0.3
R2	1.3	R26	0.3
R3	1.3	R27	0.3
R4	0.9	R28	0.3
R5	1.0	R29	0.3
R6	1.0	R30	0.3
R7	0.5	R31	0.4
R8	0.4	R32	0.4
R9	0.6	R33	0.4
R10	0.6	R34	0.4
R11	0.7	R35	0.4
R12	1.0	R36	0.4
R13	1.0	R37	0.3
R14	1.1	R38	0.3
R15	1.1	R39	0.3
R16	1.1	R40	0.3
R17	0.9	R41	0.3
R18	0.8	R42	0.3
R19	0.7	R43	0.2
R20	0.7	R44	0.2
R21	0.7	R45	0.2
R22	0.6	R46	0.2
R23	0.4	R47	0.1
R24	0.3		

Note: Incr = Incremental impact. Peak to mean (P/M60) factor of 2.3 applied as per section 6.6 of (NSW EPA, 2022a)

6.4. Nitrogen Dioxide

This section presents the predicted nitrogen dioxide (NO_2) concentrations resulting from the operation of the asphalt batching plant, and operation of the diesel generator under Scenarios 1 and 2 are presented in Table 36. The most conservative NO to NO_2 conversion method as outlined in the Approved Methods has been adopted, which assumes that all of the emitted NO_X is converted to NO_2 instantaneously. In addition, the maximum 1-hour NO_2 concentration measured at the Monash AQMS has been adopted as background conditions, which provides an additional level of conservatism.

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

Table 36 Predicted 1-hour and annual average NO_2 concentrations – Scenarios 1 and 2

Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g{\cdot}m^{-3}$)					
	1-hour average			Annual average		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
Criterion	164			31		
Max. % of criterion	5.8	45.0	49.8	<0.1	21.0	21.3
PR1	5.6	73.8	79.4	<0.1	6.5	6.6
R2	7.8	73.8	81.6	<0.1	6.5	6.6
R3	7.6	73.8	81.4	<0.1	6.5	6.6
R4	4.1	73.8	77.9	<0.1	6.5	6.6
R5	4.1	73.8	77.9	<0.1	6.5	6.6
R6	5.3	73.8	79.1	<0.1	6.5	6.6
R7	2.3	73.8	76.1	<0.1	6.5	6.6
R8	3.0	73.8	76.8	<0.1	6.5	6.6
R9	1.9	73.8	75.7	<0.1	6.5	6.6
R10	2.9	73.8	76.7	<0.1	6.5	6.6
R11	5.8	73.8	79.6	<0.1	6.5	6.6
R12	4.9	73.8	78.7	<0.1	6.5	6.6
R13	4.3	73.8	78.1	<0.1	6.5	6.6
R14	6.2	73.8	80.0	<0.1	6.5	6.6
R15	7.4	73.8	81.2	<0.1	6.5	6.6
R16	7.1	73.8	80.9	<0.1	6.5	6.6
R17	3.8	73.8	77.6	<0.1	6.5	6.6
R18	2.8	73.8	76.6	<0.1	6.5	6.6
R19	2.4	73.8	76.2	<0.1	6.5	6.6
R20	2.9	73.8	76.7	<0.1	6.5	6.6
R21	3.2	73.8	77.0	<0.1	6.5	6.6
R22	2.9	73.8	76.7	<0.1	6.5	6.6
R23	2.5	73.8	76.3	<0.1	6.5	6.6
R24	2.1	73.8	75.9	<0.1	6.5	6.6
R25	2.7	73.8	76.5	<0.1	6.5	6.6
R26	1.8	73.8	75.6	<0.1	6.5	6.6
R27	2.8	73.8	76.6	<0.1	6.5	6.6
R28	2.9	73.8	76.7	<0.1	6.5	6.6
R29	3.1	73.8	76.9	<0.1	6.5	6.6
R30	3.1	73.8	76.9	<0.1	6.5	6.6
R31	3.5	73.8	77.3	<0.1	6.5	6.6
R32	3.9	73.8	77.7	<0.1	6.5	6.6
R33	3.5	73.8	77.3	<0.1	6.5	6.6

Receptor	Nitrogen dioxide (NO_2) concentration ($\mu g \cdot m^{-3}$)					
	1-hour average			Annual average		
	Incr.	Bkg.	Cumul.	Incr.	Bkg.	Cumul.
R34	2.9	73.8	76.7	<0.1	6.5	6.6
R35	3.1	73.8	76.9	<0.1	6.5	6.6
R36	2.5	73.8	76.3	<0.1	6.5	6.6
R37	1.6	73.8	75.4	<0.1	6.5	6.6
R38	2.0	73.8	75.8	<0.1	6.5	6.6
R39	1.6	73.8	75.4	<0.1	6.5	6.6
R40	1.4	73.8	75.2	<0.1	6.5	6.6
R41	1.4	73.8	75.2	<0.1	6.5	6.6
R42	1.5	73.8	75.3	<0.1	6.5	6.6
R43	1.6	73.8	75.4	<0.1	6.5	6.6
R44	1.2	73.8	75.0	<0.1	6.5	6.6
R45	1.1	73.8	74.9	<0.1	6.5	6.6
R46	1.0	73.8	74.8	<0.1	6.5	6.6
R47	1.0	73.8	74.8	<0.1	6.5	6.6

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

6.5. Other Pollutants

The following presents the predicted concentrations associated with Scenarios 1 and 2 for all other pollutants assessed in this AQIA (refer Section 2.11).

Presented in Table 37 are the predicted 99.9th percentile incremental 1-hour concentrations of VOCs.

The predicted incremental concentrations for all VOCs are significantly below the relevant criteria at all receptors.

Table 37 Predicted incremental 1-hour benzene, toluene, xylene and ethylbenzene concentrations – Scenarios 1 and 2

Receptor	Predicted 1-hour (99.9th %ile) average concentration ($mg \cdot m^{-3}$)			
	Benzene	Toluene	Xylene	Ethylbenzene
Criterion	0.029	0.36	0.19	8
Max. % of criterion	0.1	<0.1	0.1	<0.1
PR1	1.71E-05	5.12E-05	1.11E-04	1.37E-04
R2	1.96E-05	5.88E-05	1.27E-04	1.57E-04
R3	2.18E-05	6.55E-05	1.42E-04	1.75E-04
R4	1.46E-05	4.37E-05	9.47E-05	1.17E-04
R5	1.56E-05	4.68E-05	1.01E-04	1.25E-04
R6	1.44E-05	4.33E-05	9.39E-05	1.16E-04
R7	9.82E-06	2.95E-05	6.39E-05	7.86E-05

Receptor	Predicted 1-hour (99.9th %ile) average concentration ($mg \cdot m^{-3}$)			
	Benzene	Toluene	Xylene	Ethylbenzene
R8	8.11E-06	2.43E-05	5.27E-05	6.49E-05
R9	9.38E-06	2.81E-05	6.10E-05	7.50E-05
R10	1.03E-05	3.09E-05	6.69E-05	8.23E-05
R11	9.99E-06	3.00E-05	6.49E-05	7.99E-05
R12	1.78E-05	5.33E-05	1.16E-04	1.42E-04
R13	1.73E-05	5.20E-05	1.13E-04	1.39E-04
R14	2.12E-05	6.35E-05	1.38E-04	1.69E-04
R15	2.41E-05	7.22E-05	1.57E-04	1.93E-04
R16	2.57E-05	7.70E-05	1.67E-04	2.05E-04
R17	1.67E-05	5.02E-05	1.09E-04	1.34E-04
R18	1.27E-05	3.81E-05	8.25E-05	1.02E-04
R19	1.14E-05	3.43E-05	7.43E-05	9.15E-05
R20	1.15E-05	3.44E-05	7.45E-05	9.17E-05
R21	1.31E-05	3.93E-05	8.51E-05	1.05E-04
R22	1.04E-05	3.13E-05	6.79E-05	8.36E-05
R23	1.25E-05	3.74E-05	8.10E-05	9.97E-05
R24	1.12E-05	3.35E-05	7.26E-05	8.94E-05
R25	9.98E-06	2.99E-05	6.49E-05	7.98E-05
R26	1.08E-05	3.25E-05	7.04E-05	8.67E-05
R27	1.22E-05	3.65E-05	7.91E-05	9.74E-05
R28	1.22E-05	3.67E-05	7.94E-05	9.78E-05
R29	1.30E-05	3.90E-05	8.46E-05	1.04E-04
R30	1.23E-05	3.69E-05	7.99E-05	9.83E-05
R31	1.22E-05	3.67E-05	7.94E-05	9.78E-05
R32	1.47E-05	4.41E-05	9.55E-05	1.17E-04
R33	1.29E-05	3.87E-05	8.38E-05	1.03E-04
R34	1.11E-05	3.34E-05	7.24E-05	8.91E-05
R35	7.63E-06	2.29E-05	4.96E-05	6.10E-05
R36	7.21E-06	2.16E-05	4.69E-05	5.77E-05
R37	7.18E-06	2.15E-05	4.67E-05	5.74E-05
R38	6.82E-06	2.05E-05	4.43E-05	5.46E-05
R39	6.85E-06	2.06E-05	4.46E-05	5.48E-05
R40	6.42E-06	1.93E-05	4.18E-05	5.14E-05
R41	5.71E-06	1.71E-05	3.71E-05	4.57E-05
R42	6.06E-06	1.82E-05	3.94E-05	4.85E-05
R43	5.56E-06	1.67E-05	3.62E-05	4.45E-05
R44	5.41E-06	1.62E-05	3.52E-05	4.33E-05
R45	4.75E-06	1.43E-05	3.09E-05	3.80E-05
R46	4.43E-06	1.33E-05	2.88E-05	3.55E-05
R47	4.51E-06	1.35E-05	2.93E-05	3.61E-05

6.6. Discussion

The performance of dispersion modelling indicates that the Project can be operated under both operational scenarios without giving rise to any additional exceedances of the air quality criteria at any receptor location.

The assessment does indicate that PM_{10} and $PM_{2.5}$ exceedances are predicted at surrounding receptors, but these would occur even without the operation of the Project. Importantly, no additional exceedances of the relevant air quality criteria are predicted as a result of the Project operation.

Review of the daily varying particulate matter concentrations measured at the Monash AQMS (refer Appendix C) shows that they tend to be elevated during the winter months, most likely due to domestic wood heater use. (Access Canberra, 2022) attributes an exceedance of the 24-hour $PM_{2.5}$ criterion at Monash AQMS on 8 July 2021 to be due to wood heater use. The ACT Government are actively encouraging the reduction in particulate pollution from domestic woodfired heating through several initiatives including education around domestic wood heater use and encouraging the replacement of wood heaters with electric systems[3]. Adoption of these initiatives would be likely to reduce concentrations of particulate matter, and especially $PM_{2.5}$ in the area over time.

Furthermore, higher concentrations of $PM_{2.5}$ due to domestic wood heater use would be expected in more urbanised areas, where woodsmoke emissions would tend to be higher. Therefore, concentrations of $PM_{2.5}$ due to woodsmoke at the receptors surrounding the Project would be expected to be lower than those measured at the Monash AQMS, based on the population density as presented in Figure 10.

Although the timing of emissions from woodsmoke (evening) and the Project (daytime) differ, the impact on the 24-hour $PM_{2.5}$ concentration can be affected by both.

It is considered that even though the minor incremental impacts resulting from Project operation have been conservatively predicted, and given the conservatism applied in the assumption that all activities would be operating at peak levels on every day of the year, and the likely conservatism in the background data adopted, no additional exceedances of the relevant air quality criteria are predicted to occur. However, to provide additional confidence that this would be the case, the Applicant proposes to install and operate a real-time air quality monitoring system at the Project Site and use the data to inform a Trigger Action Response Plan (TARP). These would be part of an over-arching Air Quality Management Plan (AQMP), which is discussed in detail in Section 8.

[3] https://www.accesscanberra.act.gov.au/city-services/reporting-pollution

7. GREENHOUSE GAS ASSESSMENT

This section presents the results of the GHG assessment, compares direct emissions totals with NSW and Australian totals, and provides a range of measures which might be considered to reduce GHG emissions.

7.1. Calculation of GHG Emissions

Based on the activity data for the operation of the Project and the emission factors outlined in Section 5.2, annual GHG emissions have been calculated and are presented in Table 38. The Project is calculated to result in direct (Scope 1) GHG emissions of 19 532 t CO_2-e per annum, with approximately 75 % of these resulting from material transport from the Project Site to market.

Table 38 Calculated Project GHG emissions

Scope		Activity Rate	Units	Energy Content	Units	Emission Factor		Emissions CO_2-e ($t{\cdot}yr^{-1}$)
1	Diesel fuel in plant and machinery on site	1 200	$kL{\cdot}yr^{-1}$	38.6	$GJ{\cdot}kL^{-1}$	70.2	kg CO_2-e$\cdot GJ^{-1}$	3 251.7
	Material transport	5 438						14 735.5
	Diesel fuel in plant and machinery at asphalt batching plant	570						1 544.5
Scope 1 (subtotal)								**19 531.7**
2	Electricity consumption	218 750	$kWh{\cdot}yr^{-1}$	-	-	0.66	kg CO_2-e$\cdot kWh^{-1}$	144.4
Scope 2 (subtotal)								**144.4**
3	Diesel fuel in plant and machinery on site	1 200	$kL{\cdot}yr^{-1}$	38.6	$GJ{\cdot}kL^{-1}$	17.3	kg CO_2-e$\cdot GJ^{-1}$	801.3
	Material transport	5 438						3 631.4
	Diesel fuel in plant and machinery at asphalt batching plant	570						380.6
	Employee travel	42.9		34.2		17.2		25.2
	Electricity consumption	218 750	$kWh{\cdot}yr^{-1}$	-	-	0.04	kg CO_2-e$\cdot kWh^{-1}$	8.8
Scope 3 (subtotal)								**4 847.3**

7.2. Greenhouse Gas Emissions in Context

A comparison of the calculated GHG emissions associated with the Project against Australian (DCCEEW, 2024a) and NSW (DCCEEW, 2024b) total emissions in 2022 is presented Table 39.

These data indicate that the operation of the Project, would contribute less than 0.002 % of NSW total GHG emissions and less than 0.005 % of Australian total GHG emissions in 2022.

Table 39 Project GHG emissions in context

Project Phase	Emissions (t CO_2-e per annum)		
	Project	NSW (2022)	Australia (2022)
		Total - 111 Mt	Total – 432.6 Mt
Maximum operation	19 531.7	0.018 %	0.005 %

7.3. Management of GHG Emissions

The above assessment indicates that GHG emissions resulting from the operation of the Project are anticipated to be small, although emissions could be further reduced through the application of a number of measures:

- All vehicles/plant and machinery should be turned off when not in use and regularly serviced to ensure efficient operation, including the optimisation of tyre pressures;
- Truck routes and loading capacity should be designed to reduce the distance and effort required by the vehicles;
- Maintenance of roads in good condition to avoid meandering of vehicles;
- Reducing gradients around site where feasible; and
- Where possible, B5 fuel should be used in plant and equipment.

8. MITIGATION AND MONITORING

8.1. Air Quality Mitigation

8.1.1. Air Quality Management Plan

Management of air quality would be performed at the Project Site with due reference to an Air Quality Management Plan (AQMP) which would clearly outline the management measures to be adopted as part of the ongoing operation of the Project.

The AQMP would include:

- Pre-emptive measures for dust control, including:
  - Inductions;
  - Weather condition monitoring;
  - Visible dust monitoring and management;
  - Water cart operations; and
  - Personnel Health Management.
- Area and activity specific controls for the Extraction Area, Processing and Stockpile Area, Asphalt Batching Plant, Concrete Batching Plant, Concrete Crushing activities, and haulage routes.
- Proactive/reactive dust controls actions based on visual, climatic, predicted weather and operational triggers.
- Details of the standard measures to be included to minimise VOC emissions from bitumen storage tanks (i.e. charcoal filters).

The AQMP would also include:

- Key Performance Indicators (KPI) to be adopted as part of Project construction and operation;
- A description of the air quality monitoring to be performed at the Project Site;
- A description of the triggers to be adopted to managed air quality impacts, and the actions to be implemented in response to those triggers (refer Section 8.1.2);
- Response to non-compliance with the KPI's and any limits imposed through the Approval conditions, and/or Environment Protection Licence (EPL); and
- The responsibilities for implementation of the AQMP, and a description of how the AQMP would be reviewed and continually improved over time.

8.1.2. Trigger Action Response Plan

The Project would implement a proactive dust management program, also termed a Trigger Action Response Plan (TARP), to manage particulate matter impacts at nearby sensitive receptors. That program would include real-time meteorological conditions and air quality observations at a minimum of two locations.

The goal of the AQMP and TARP is to ensure the 24-hour average PM_{10} and $PM_{2.5}$ concentrations remain below the assessment criterion at all surrounding sensitive receptor locations. Although this AQIA indicates that this is achievable, elevated concentrations may occur from time to time and the TARP would ensure that the contribution of the Project activities are minimised, in line with best practice particulate management.

The following provides a summary of the proposed TARP, which could operate as follows. Note that this describes one potential approach, with the final detail of the TARP being provided in the AQMP following Project Approval. The aim of the below is to demonstrate that a system such as this could be implemented to result in the achievement of air quality criteria:

- The continuous particulate matter monitors would relay data in near-real-time to a website.
- This website would be accessible to the relevant Project personnel on a continuous basis.
- An SMS alarm would be sent to relevant Project personnel when pre-determined particulate matter concentrations are breached, which would in turn indicate what action is required, on what timescale.
- It is suggested that a number of particulate matter concentration trigger levels could be applicable for the Project.
- Trigger Level 1 – Investigation Level
    - Current instantaneous particulate matter concentrations indicate that readings are elevated and activities from the Project may be contributing to these elevated levels. If Trigger Level 1 is exceeded, Project personnel may investigate prevailing winds, and determine what activities are occurring on site that may be contributing to elevated particulate matter concentrations. Project personnel would then be informed that particulate matter concentrations are increasing and action(s) may be required.
- Trigger Level 2 – Action Level
    - Particulate matter concentrations continue to be elevated and activities from the Project are identified as contributing to these levels. If Trigger Level 2 is breached, remedial action would be required, and additional dust control measures would be implemented.
    - It is proposed that trigger levels would be reviewed regularly to ensure they are working appropriately i.e. they are ensuring that particulate matter concentrations remain below ambient air quality goals.

In the event that air quality monitoring identifies an exceedance of the air quality criteria identified in the Project approval conditions, the exceedance would be investigated to determine the likely cause(s). All corrective and preventative actions would be recorded. An investigation would then follow to determine:

- what immediate action(s) need to be taken to fix the problem in the short term, if applicable;
- the root causes of the problem (e.g. management system, equipment design / performance, human factors/behaviour, work environment or training);
- corrective actions required to eliminate the root cause(s);
- action(s) taken to verify effectiveness of corrective action(s) (i.e. what measures and checks are taken to ensure the corrective actions that are in place are effective to prevent any further exceedance); and
- on completion of the investigation, an electronic copy would be forwarded to Project Manager for review/approval of corrective and preventative actions.

During dry conditions, and high wind speeds at the Project Site, especially when the wind is blowing toward the closest receptors to the south (that is when winds are blowing from the north/north west), the following additional particulate matter control measure would be implemented:

- Activities capable of generating dust would be curtailed in the exposed areas.
- Additional water would be applied to internal roads in use by haul trucks. Should chemical suppressant be the dust control method of choice, then its effectiveness would be reviewed and additional suppressant applied as required;
- Any other open areas capable of generating dust would be watered by the water truck.
- Activities capable of generating dust would be curtailed or ceased across the Project Site, if required.

Preparatory measures that can be put in place for adverse weather include:

- Aim to have surface moist before the on-set of windy conditions. The area of focus should be where significant site work will be taking place for that day.
- Prepare for water cart spraying or sprinkler system during high winds.
- Prepare to cease certain activities or reduce activity level.
- Schedule maintenance for plant and equipment to reduce dust generating activities.

Adverse weather, in terms of dust impacts, relates to hot, dry and gusty / windy conditions and specifically in relation to this Project is:

- Little or no rainfall forecast and little or no rainfall in past 48 hours; and
- High wind speeds (> 30 $km \cdot hr^{-1}$) from the north/north-west and towards nearest sensitive receptors.

The TARP would include two real-time particulate monitors, located

(i) One to the north west of the Project site, as a proxy for non-Project related air quality concentrations in north/north westerly winds; and

(ii) One close to receptor R2 or R3 (where highest incremental impacts are predicted to occur) to allow comparison of measured concentrations to ambient air quality criteria, and to allow the calculation of a Project contribution in north/north westerly winds.

Based on the findings of the operational phase air quality impact assessment, and taking into account the levels of conservatism adopted in relation to background air quality conditions, and the assumption of coincidental peak activity rates across all Project elements, it is considered that the particulate control measures proposed to be implemented will be more than sufficient to ensure that air quality impacts at surrounding receptor locations are adequately controlled.

8.2. Greenhouse Gas Mitigation

Emissions of GHG resulting from the Project operation would be minimised to the maximum extent practical by consideration of the following measures:

- All vehicles/plant and machinery should be turned off when not in use and regularly serviced to ensure efficient operation, including the optimisation of tyre pressures;
- Truck routes and loading capacity should be designed to reduce the distance and effort required by the vehicles;
- Maintenance of roads in good condition to avoid meandering of vehicles;
- Reducing gradients around site where feasible; and
- Where possible, B5 fuel should be used in plant and equipment.

9. CONCLUSION

RWC has engaged Northstar on behalf of the Applicant to perform an AQIA and GHGA for the proposed Project.

The AQIA forms part of the EIS prepared to accompany the development application for the Project under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The AQIA has been performed in accordance with the requirements of the NSW Approved Methods document and meets the requirements of the SEARs. The AQIA provides a detailed description of:

- the activities proposed to be performed by the Applicant as part of the Project, under two separate operational scenarios;
- the legislative requirements which are required to achieved, including those prescribed through NSW EPA air quality criteria, POEO Act, and POEO (Clean Air) Regulations, and any policies and guidelines as they relate to air quality and greenhouse gas impacts of the Project;
- the existing conditions surrounding the Project Site, including the definition of sensitive receptor locations, prevailing meteorology and air quality, topography, and emissions of GHG in Australia and NSW in the year 2022;
- the approach to assessment, including justification for the approach adopted;
- emissions controls proposed to be employed as part of the Project construction and operation;
- predicted air quality impacts during each of the two scenarios modelled;
- additional air quality management and mitigation measures which may need to be employed to ensure that the environmental objectives associated with the Project are achieved;
- how those measures would be triggered and implemented;
- predicted emissions of GHG during a year of operations representative of high activity;
- air quality mitigation measures which would be employed as part of the Project construction and operation, including air quality monitoring methods; and
- greenhouse gas mitigation and monitoring measures which would be employed as part of Project construction and operation, with the aim of minimising those emissions.

The AQIA predicts that the Project can be operated to achieve annual average air quality criteria for TSP, PM_{10}, $PM_{2.5}$, dust deposition, RCS, and NO_2. It can also be operated to achieve short term air quality criteria associated with odour, PM_{10}, $PM_{2.5}$, NO_2, and VOCs.

Whilst the AQIA presents a conservative assessment of potential impacts, the Applicant proposes to implement an air quality monitoring program which would inform, in real-time, management measures to be adopted to minimise particulate emissions at the Project Site to ensure that any additional exceedances would be avoided.

An Air Quality Management Plan (AQMP) and a Trigger Action Response Plan (TARP) would be adopted as part of the construction and operational phases of the Project. The TARP would include two real-time particulate monitors, located to allow the determination of ambient particulate concentrations, and the contribution from the Project. The detailed assessment presented in this report indicates that a range of management measures can be employed to ensure that additional exceedances do not occur at surrounding receptor locations.

In relation to greenhouse gas, the assessment indicates that direct emissions associated with the Project are likely to be of the order of approximately 19 531 t CO_2-e per annum. The Applicant is committed to continue to investigate ways to minimise the emission of GHG, and to reviewing any schemes which may provide opportunity to modernise plant and increase productivity, under the NSW Government Net Zero Plan Stage 1: 2020-2030.

In conclusion, the Project can be constructed and operated in accordance with best management practice, to minimise the concentrations of air pollutants on the surrounding environment.

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APPENDIX A

Commonly used units and abbreviations

Units Used in the Report

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

Commonly used SI units

The following units are commonly used in Northstar reports.

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

Multiples of SI and non-SI units

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

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

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

In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol.

For example:

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

Commonly used SI-derived and non-SI units

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

Commonly used abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
ACT	Australian Commonwealth Territory
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

Abbreviation	Term
CEMP	construction environment management plan
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	digital elevation model
EETM	emission estimation technique manual
EPA VIC	Environmental Protection Authority Victoria
EPBC	Environment Protection and Biodiversity Conservation Act
FIBC	flexible intermediate bulk container
GIS	geographical information system
IAQM	UK Institute of Air Quality Management
IBC	intermediate bulk container
ID	internal diameter
LLV	low level waste
LoM	life of mine
MSDS	Material Safety Data Sheet
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NH_3	ammonia
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
NORM	naturally occurring radioactive material
NSW	New South Wales
NSW DCCEEW	New South Wales Department of Climate Change, Energy, the Environment and Water
NSW EPA	New South Wales Environment Protection Authority
NT	Northern Territory
OEMP	operational environmental management plan
O_3	ozone
OU	odour unit
$OU{\cdot}m^3{\cdot}s^{-1}$	odour units times metres cubed per second
$OU{\cdot}s^{-1}$	odour units per second
Pb	lead
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
ROM	run of mine
SA	South Australia
SEPP	State Environmental Protection Policy
SO_X	oxides of sulphur

Abbreviation	Term
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

Meteorology

Meteorological Stations

As discussed in Section 4.2, a meteorological modelling exercise has been performed to characterise the meteorology of the Project Site in the absence of site-specific measurements. The meteorological modelling has been based on measurements taken at a number of surrounding automatic weather stations (AWS) operated by the Australian Government Bureau of Meteorology (BoM).

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

Table B1 Details of the meteorological monitoring surround the Quarry site

Site Name	Station #	Source	Approximate location (UTM)		Approximate distance (km)
			mE	mS	
Tuggeranong (Isabella Plains) AWS	070339	BoM	690 089	6 078 543	6.4
Canberra Airport	070351	BoM	700 049	6 090 490	16.6
Mount Ginni AWS	070349	BoM	660 667	6 066 812	34.9

As outlined in Section 4.2, meteorological conditions at Tuggeranong (Isabella Plains) AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2019 to 2023) are presented in Figure B1.

The correlation coefficient between each year and the five-year period for the distribution of wind speed, wind direction, PM_{10} and $PM_{2.5}$ are summarised in Table B2. The correlation coefficients were ranked and aggregated to select the representative year for the meteorological modelling. The rankings are also presented in Table B2.

The wind roses indicate that from 2019 to 2023, winds at Tuggeranong (Isabella Plains) AWS show similar wind distribution patterns across the years assessed, with a predominant north-westerly wind direction. An easterly wind direction component is also observable.

The majority of wind speeds experienced at Tuggeranong (Isabella Plains) AWS between 2019 and 2023 are generally in the range 0.5 meters per second ($m \cdot s^{-1}$) to 5.5 $m \cdot s^{-1}$ with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from mostly north-westerly directions. Winds of this speed are rare and occur during 0.3 % of the observed hours during the years. Calm winds (< 0.5 $m \cdot s^{-1}$) are more common and occur during 22.6 % of hours on average across the years 2019-2023.

Figure B1 Annual wind roses – Tuggeranong (Isabella Plains) AWS (2019 – 2023)

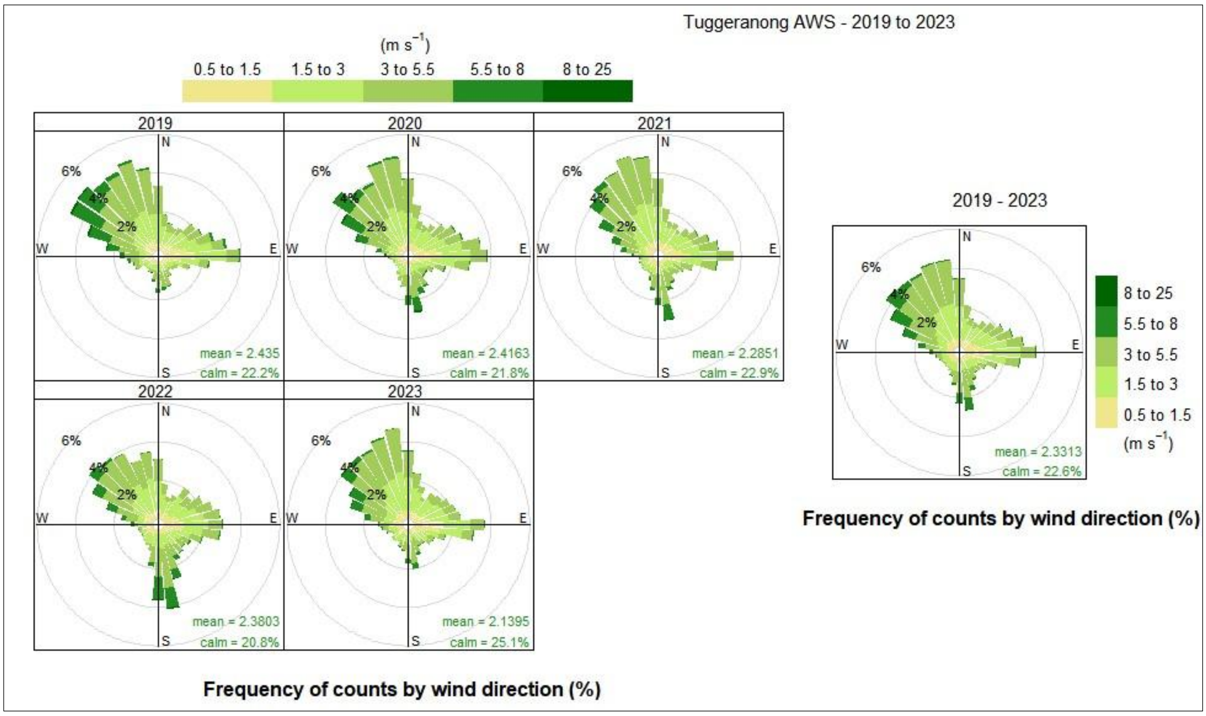


Figure B2 Annual wind speed and direction distributions – Tuggeranong (Isabella Plains) AWS (2019 – 2023)

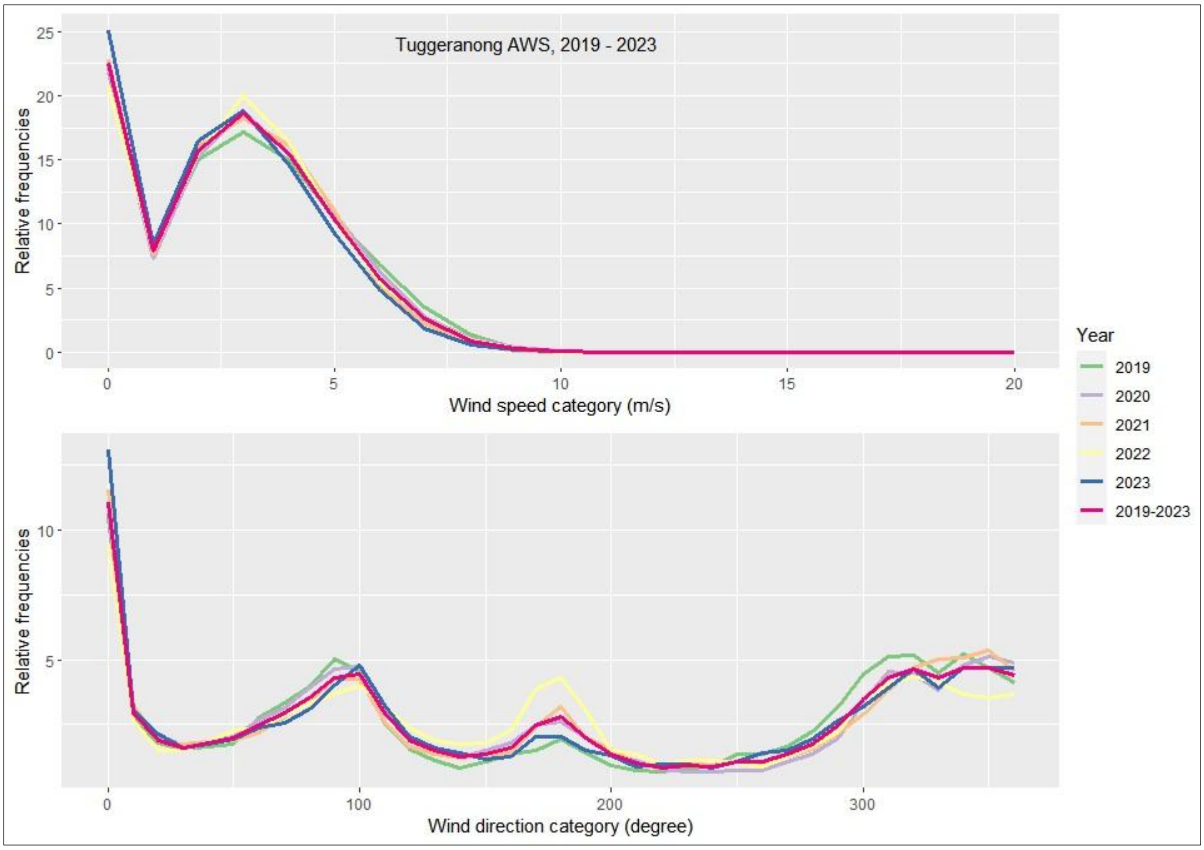


Table B2 Correlation coefficient analysis – Tuggeranong (Isabella Plains) AWS and Monash AQMS (2019 – 2023)

Parameter	Wind speed		Wind direction		PM_{10}		$PM_{2.5}$		Aggregated rank
	Corr.	Rank	Corr.	Rank	Corr.	Rank	Corr.	Rank	
2019	0.9981	3	0.9731	4	0.9660	4	0.9564	5	4
2020	0.9993	2	0.9916	1	0.9906	2	0.9804	4	2
2021	0.9993	1	0.9912	2	0.9969	1	0.9967	1	1
2022	0.9972	4	0.9556	5	0.9573	5	0.9848	3	5
2023	0.9961	5	0.9851	3	0.9794	3	0.9893	2	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 well correlated against the wind direction over the five-year period, with each year having a correlation coefficient greater than of 0.95. The year 2020 is the highest ranked for correlation against the wind direction over the five-year period.

Particulate matter concentrations for each year are also well correlated against particulate matter concentrations over the five-year period. Each year resulted in having a correlation coefficient greater than 0.95. The year 2021 holds the highest rank for PM_{10} and the year 2021 holds the highest rank for $PM_{2.5}$.

The correlation coefficient analysis indicates that 2021 is the most appropriate 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 Project Site. To address these uncertainties, a multi-phased assessment of the meteorological data has been performed.

In absence of any measured onsite meteorological data, site representative meteorological data for the Project was generated using the CALMET meteorological model in a format suitable for using in the CALPUFF dispersion model (refer Section 5.1.1).

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.

As outlined in Table 2, to address EPA comments regarding the lack of calm winds in dispersion modelling, two additional methods of meteorological modelling have been performed.

- Inclusion of Tuggeranong AWS data in TAPM modelling.
- Inclusion of Tuggeranong AWS data in the CALMET modelling.

The following sections outline the updated approach and compare with the original assessment.

In this AQIA, CALMET has been run in 'hybrid' 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), and using surface observations from Tuggeranong AWS.

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.

The TAPM meteorological modelling run was also run using observations at Tuggeranong AWS to 'nudge' model predictions towards those observations.

The parameters used in original and updated TAPM and CALMET modelling are presented in Table B3. Further, as per (Barclay & Scire, 2011), the seven critical parameters used in the CALMET modelling are presented in Table B4.

Table B3 CALMET and TAPM meteorological parameters

TAPM v 4.0.5		
	Original AQIA	**Updated Modelling**
Modelling period	1 January 2021 to 31 December 2021	1 January 2021 to 1 January 2022
Centre of analysis	695106 mE, 6 074 003 mN (UTM Coordinates)	No change
Number of grid points	41 x 41 x 25	No change
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)	No change
Terrain	AUSLIG 9 second DEM	No change
Data assimilation	-	Tuggeranong AWS
CALMET		
Modelling period	1 January 2021 to 31 December 2021	1 January 2021 to 1 January 2022

South-West corner of analysis	688 500 mE, 6 066 900 mN (UTM Coordinates)	No change
Meteorological grid domain (resolution)	14 km x 14 km (0.2 km)	No change
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)	No change
Data assimilation	No-obs approach using TAPM – 3D.DAT file	Hybrid approach using TAPM – 3D.DAT file and Tuggeranong AWS

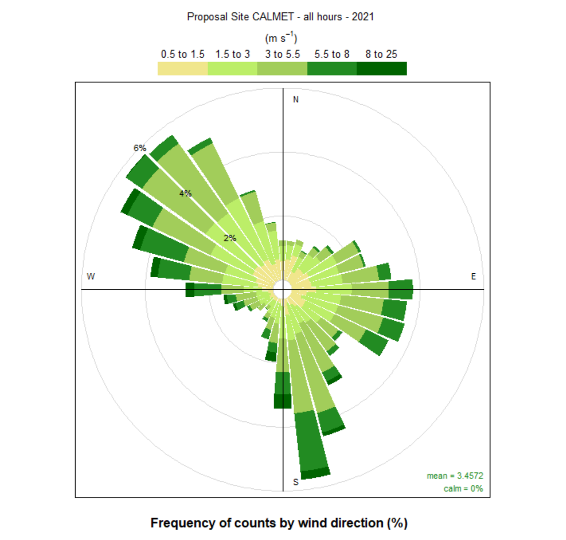
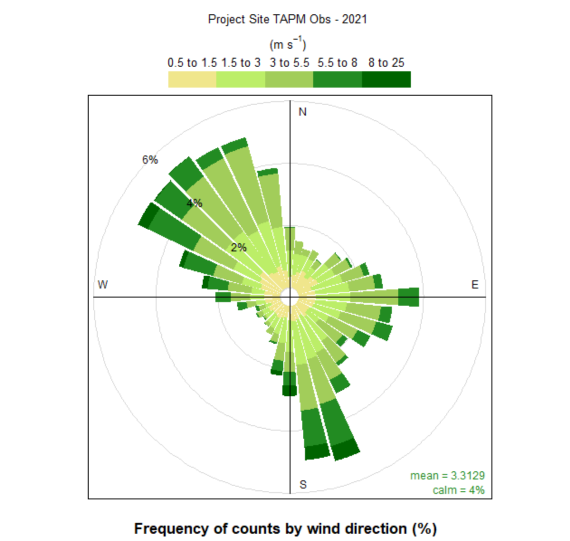
Table B4 Seven critical meteorological parameters used in CALMET

Parameter	Value
TERRAD	5.0
IEXTRP	-4
BIAS (NZ)	-1.0, -0.5, -0.25, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0
R1 and R2	5, 5
RMAX1 and RMAX2	5, 5

It is noted that in the original AQIA, a comparison of the CALMET generated meteorological data and that observed at Tuggeranong (Isabella Plains) AWS was presented. This comparison hasn't been presented in this updated AQIA given that observations from Tuggeranong (Isabella Plains) AWS data were used in the CALMET modelling. However, it is noted that in the original AQIA the data generally compared well which provided confidence that the general pattern of wind conditions modelled as part of the original AQIA were appropriate.

Additionally, presented in Figure B4, are the wind roses at the Project Site from the original AQIA CALMET, and the updated modelling TAPM wind rose. The updated CALMET wind rose is presented in Figure B6. The inclusion of Tuggeranong AWS observations in the TAPM modelling is noted to increase the percentage of calms to 3.1 % and in the CALMET modelling to 5.3 %.

Figure B4 Predicted wind speed and direction from various models – Project Site (2021)

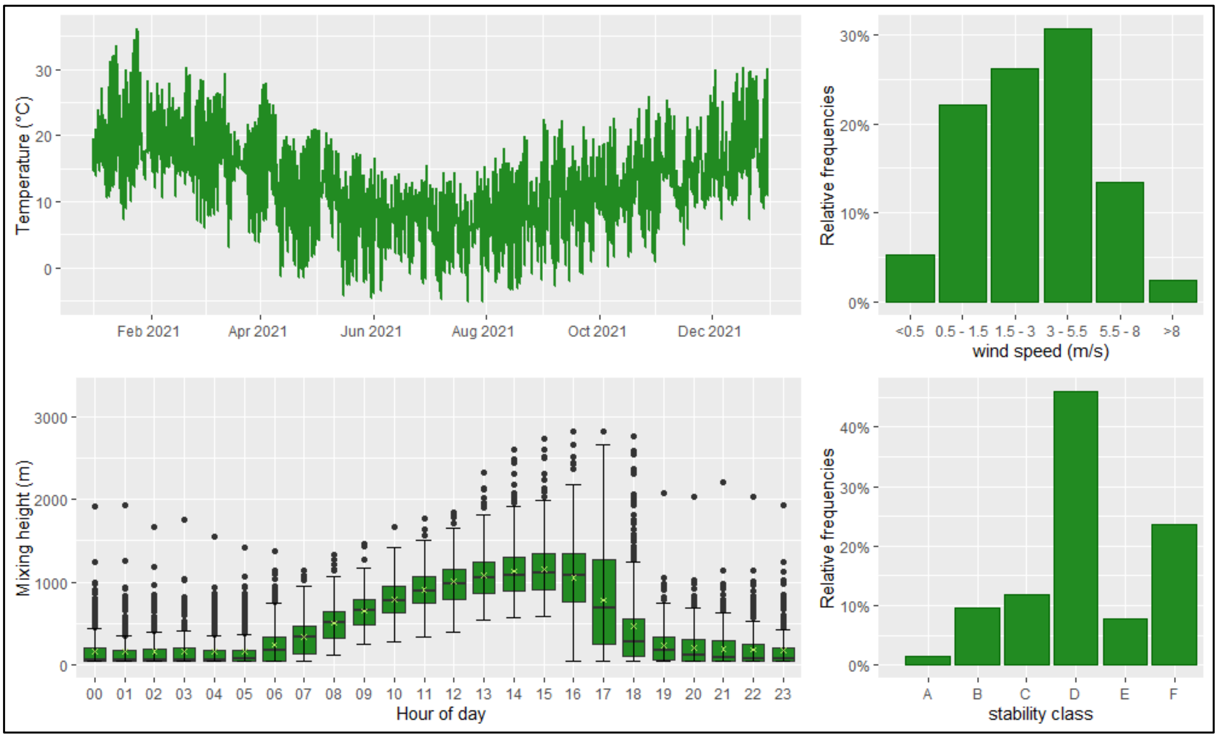
Original AQIA CALMET generated windrose	This AQIA TAPM obs generated windrose
	

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

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Project Site during the 2021 period are illustrated in Figure B5.

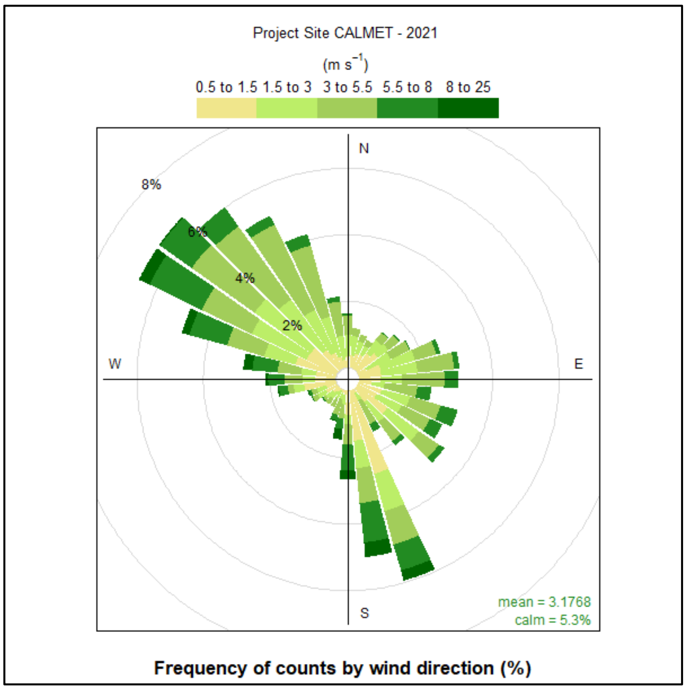
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and growth of the convective mixing layer.

Figure B5 Predicted temperature, mixing height and wind speed frequency – Project Site (2021)



The modelled wind speed and direction at the Project Site during 2021 are presented in Figure B6. As previously mentioned, the Project site wind rose in the original assessment presented 0 % calms, however with the updated approach of using Tuggeranong AWS observations in the TAPM and CALMET modelling, the percentage of calms has increased to 5.3 %.

Figure B6 Predicted wind speed and direction – Project Site (2021)



APPENDIX C

Background Air Quality

Air Quality Monitoring Stations

Air quality is not monitored at the Project 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 Project Site and during a representative year can be complicated by factors which include:

- The sources of air pollutant emissions around the Project Site and representative air quality monitoring station(s); and,
- The variability of particulate matter concentrations (often impacted by natural climate variability).

Air quality monitoring in NSW is performed by the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW). However, there are no NSW DCCEEW air quality monitoring stations (AQMS) proximate to the Project Site, the closest being Wagga Wagga, 165 km from the Project.

Monitoring is also performed by ACT Health at three AQMS located within a 30 km radius of the Project Site. Details of the monitoring performed at these AQMS is presented in Table C1. As discussed in Section 4.2 and Section 4.3, the year 2021 was selected for assessment based upon an analysis of meteorological and background air quality data.

Table C1 Details of proximate AQMS surrounding the Project Site

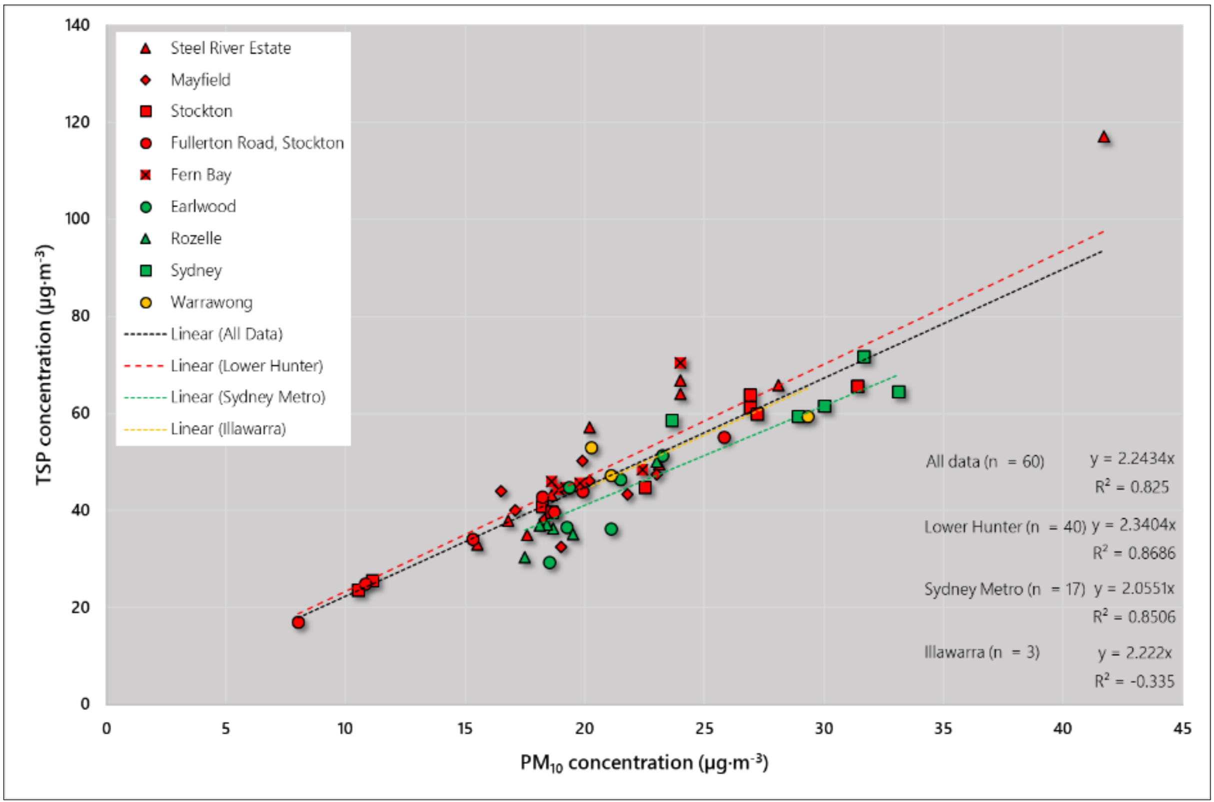
AQMS location	Approximate distance to Project Site (km)	Screening Parameters				
		2021 data	Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Monash	6.4	✓	✓	✓	×	✓
Civic	18.6	✓	✓	✓	×	×
Florey	27.5	✓	✓	✓	×	✓

Based on the sources of AQMS data available and their proximity to the Project Site, Monash was selected as the source of AQMS data for use in this assessment.

Concentrations of TSP are not measured at any AQMS surrounding the Project Site. An analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in Figure C1. The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.3404 : 1 (i.e. PM_{10} represents ~43% of TSP) from the Lower Hunter is appropriate, and the most conservative of all the relationships assessed. 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 24.1 $\mu g \cdot m^{-3}$ being adopted.

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

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



Similarly, no dust deposition data is available for the area surrounding the Project Site. The incremental impact criterion of 2 g m^{-2} month^{-1} as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of 2 g m^{-2} month^{-1} (the total allowable deposition being 4 g m^{-2}·month^{-1}).

Graphs presenting the daily varying PM_{10}, $PM_{2.5}$ and hourly varying NO_2 data recorded at Monash AQMS in 2021 are presented in Figure C2 to Figure C4, respectively.

Table C2 Background air quality statistics – Monash AQMS (2021)

Pollutant	TSP	PM_{10}	$PM_{2.5}$	NO_2
Units	$\mu g\ m^{-3}$	$\mu g \cdot m^{-3}$	$\mu g \cdot m^{-3}$	$\mu g \cdot m^{-3}$
Averaging Period	Annual	24-Hour	24-Hour	1-Hour
Statistics				
Data Points (number)	365	365	365	8 383
Mean	24.1	10.3	6.9	6.5
Standard Deviation	-	6.5	5.6	10.1
Skew[1]	-	*1.1*	*1.6*	*2.1*
Kurtosis[2]	-	*1.4*	*2.3*	*4.5*
Minimum	-	-0.1	-0.8	0
Percentiles				
25^{th}	-	5.6	3.3	0
50^{th}	-	9.0	5.2	2.1
75^{th}	-	13.6	8.1	8.2
90^{th}	-	19.2	15.2	20.5
95^{th}	-	23.5	19.6	28.7
97^{th}	-	24.8	22.2	34.9
98^{th}	-	27.3	23.5	39.0
99^{th}	-	29.2	25.0	45.1
Maximum	**24.1**	**37.6**	**27.9**	**73.8**
Data Capture (%)	**99.7**	**99.7**	**99.7**	**95.4**

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 kurtosis represents a more peaked distribution, and negative kurtosis represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure C2 Daily varying PM_{10} Measurements – Monash AQMS (2021)

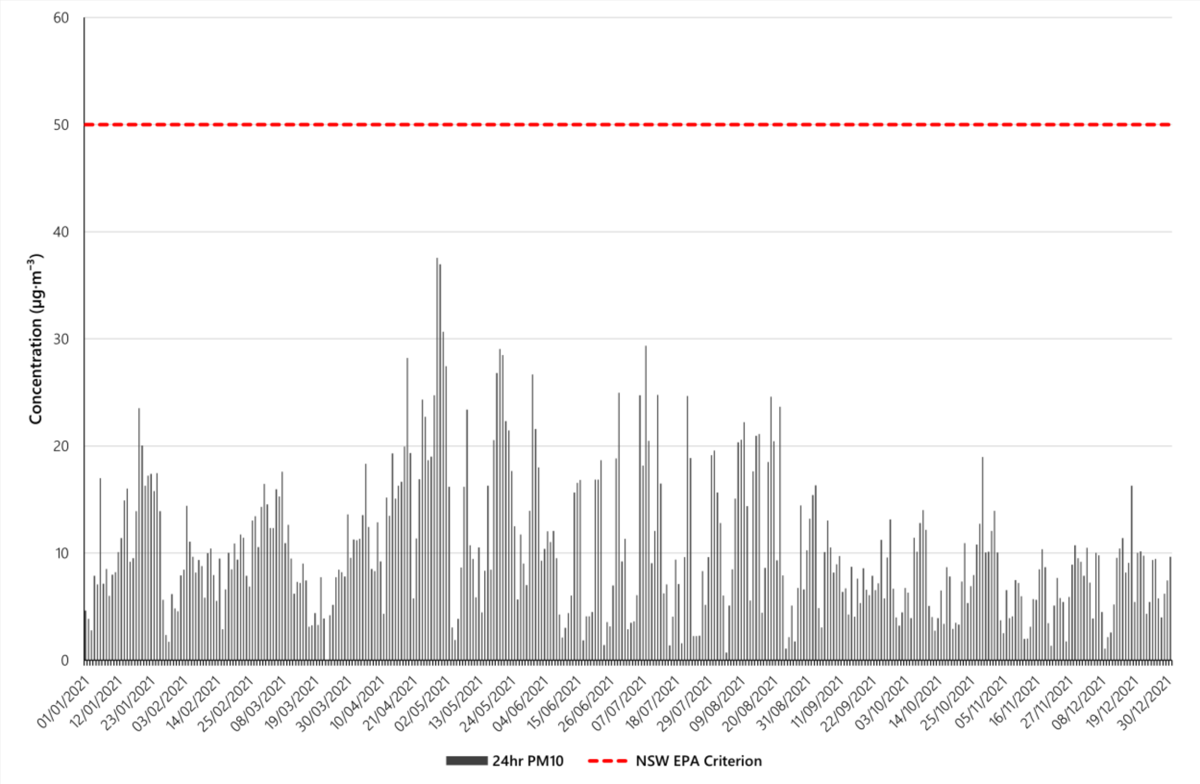


Figure C3 Daily varying $PM_{2.5}$ Measurements – Monash AQMS (2021)

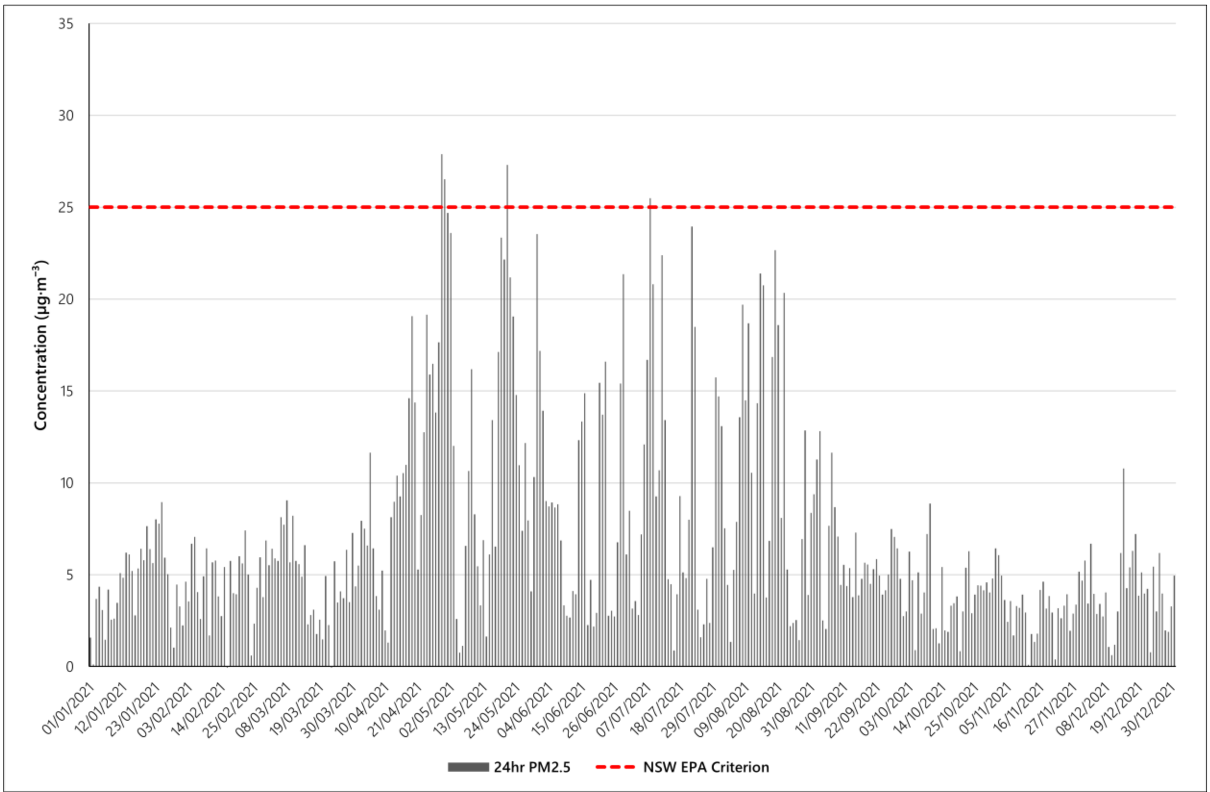
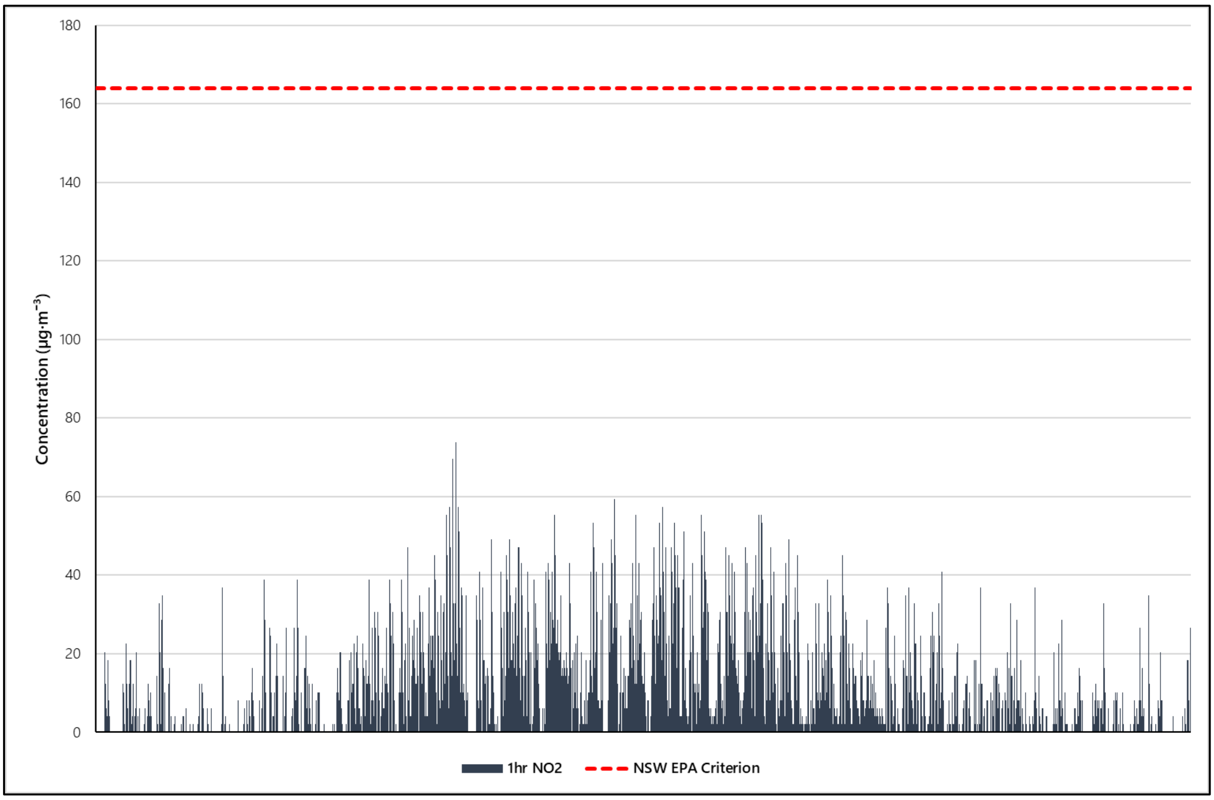


Figure C4 Hourly varying NO_2 Measurements – Monash AQMS (2021)



There were no exceedances of the NSW EPA maximum 24-hour average PM_{10} criterion, and five (5) exceedances of the maximum 24-hour average $PM_{2.5}$ criterion measured at the Monash AQMS in 2021. The ACT Annual Air Quality Report for 2021 (Access Canberra, 2022) provides commentary on the likely source of particulate exceedances, reproduced in Table C2.

Table C2 Calendar days in 2021 when 24-hour PM_{10} and $PM_{2.5}$ criterion was exceeded

Date	PM_{10} concentration (µg m^{-3})	$PM_{2.5}$ concentration (µg m^{-3})	Comments on $PM_{2.5}$ exceedance (from (Access Canberra, 2022))
29/04/2021	37.6	27.9	Hazard reduction burns in NSW
30/04/2021	37.0	26.5	Hazard reduction burns in NSW
1/05/2021	30.7	25.0	Combination of hazard reduction burns in NSW & domestic wood fire heater emissions
21/05/2021	28.5	27.3	Domestic wood fire heater emissions
8/07/2021	29.4	25.5	Domestic wood fire heater emissions

PM_{10} concentrations do not show a seasonal trend at Monash AQMS, with concentrations fluctuating consistently throughout 2021. $PM_{2.5}$ concentrations at Monash AQMS in 2021 show higher concentrations in winter relative to all other seasons. All exceedances in $PM_{2.5}$ occurred between April and July.

Given the likely source of particulates which influence measurements of particulate matter at Monash AQMS, it is likely that these sources may be similar in the area surrounding the Project Site (i.e. wood-fired heaters). The use of air quality data from Monash to characterise the air quality in the area surrounding Royalla and the Project Site is considered to be appropriate.

The AQIA considers all measured particulate concentrations within the background dataset (including exceedances) and provides discussion as to the potential impact of the Project on air quality. Impacts are discussed in terms of 'incremental' and 'cumulative' impact, and in relation to the number of 'additional exceedances' which may eventuate with the operation of the Project.

APPENDIX D

Emissions Inventory

As outlined in Section 2, a number of operations to be performed as part of the Project operation have the potential to result in emissions of particulate matter. A detailed outline of the emission estimation techniques adopted to derive total emissions from the sources identified are presented below.

The silt and moisture content of the various materials that has been adopted for the AQIA is provided in Table D1.

Table D1 Adopted silt and moisture contents

Source material	Silt content (%	Moisture content (%)	Comments
Overburden	2	2	Assumed
Rock	2	2	Assumed
Product	2	2	Assumed
Road base (post pugmill)	2	5	Assumed
Asphalt	2	5	Assumed

Blasting

The emissions of particulate matter from blasting operations have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mine) (USEPA, 1998). The emission factors are:

$$EF_{TSP}\ (kg.blast^{-1}) = 0.00022 \times (A)^{1.5}$$

$$EF_{PM_{10}}\ (kg.blast^{-1}) = 0.52 \times (EF_{TSP})$$

$$EF_{PM_{2.5}}\ (kg.blast^{-1}) = 0.03 \times (EF_{TSP})$$

where:

$EF_{\ (kg \cdot blast^{-1})}$ = emission factor for particulate matter.

A = horizontal area (m^2), with blasting depth ≤ 21 m.

The quality rating for this emission factor is rated is rated C for TSP, D for PM_{15}, and D for $PM_{2.5}$.

Bulldozing (Overburden)

The emissions of particulate matter from the bulldozing (overburden [or material other than coal in the NPI]) process have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mining) (USEPA, 1998). The emission factor is:

$$EF_{TSP}\ (kg.hr^{-1}) = \frac{2.6 \times (s)^{1.2}}{(M)^{1.3}}$$

$$EF_{PM_{15}}\ (kg.hr^{-1}) = \frac{0.45 \times (s)^{1.5}}{(M)^{1.4}}$$

$$EF_{PM_{10}}(kg.hr^{-1}) = 0.75 \times EF_{PM_{15}}$$

$$EF_{PM_{2.5}}\,(kg.hr^{-1}) = 0.105 \times EF_{TSP}$$

where:

$EF_{(kg \cdot hr^{-1})}$ = emission factor for particulate matter.

$s_{(\%)}$ = silt content in %, by weight.

$M_{(\%)}$ = moisture content of overburden in %, by weight.

The quality rating for this emission factor is rated B for TSP, C for PM_{15}, D for PM_{10}, D for $PM_{2.5}$.

Crushing (Primary, Secondary and Tertiary)

Emissions of particulate matter resulting from the processing of materials (primary, secondary and tertiary crushing) have been estimated using the emission factors presented in Section 11.19.2 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for the operations outlined above. No emission factors associated with primary or secondary crushing are available within AP-42 although emission factors for tertiary crushers can be used as an upper limit for primary or secondary crushing (US EPA, 2004). The control efficiency used for controlled crushing is 77.7 % as calculated in AP-42 (USEPA, 2006c).

$PM_{2.5}$ emission factors are not available for uncontrolled crushing sources in AP-42 although have been taken to be 18 % of PM_{10} as per controlled tertiary crushing in table 11.19.2-1 (USEPA, 2006c).

For uncontrolled tertiary crushing (and uncontrolled primary and secondary crushing):

$$EF_{TSP}\,(kg.tonne^{-1}) = 0.0027$$

$$EF_{PM_{10}}\,(kg.tonne^{-1}) = 0.0012$$

$$EF_{PM_{2.5}}\,(kg.tonne^{-1}) = 0.00012$$

For controlled tertiary crushing (and controlled primary and secondary crushing):

$$EF_{TSP}\,(kg.tonne^{-1}) = 0.0006$$

$$EF_{PM_{10}}\,(kg.tonne^{-1}) = 0.00027$$

$$EF_{PM_{2.5}}\,(kg.tonne^{-1}) = 0.00005$$

The quality rating for these emission factors is: Tertiary Crushing (uncontrolled) = E & C (TSP & PM_{10} respectively), and Tertiary Crushing (controlled) = E, C & E (TSP, PM_{10} & $PM_{2.5}$ respectively). All other crushing emission factors calculated have a quality rating of U (no rating).

Drilling

Emissions of particulate matter resulting from drilling (overburden) operations have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (USEPA, 1998).

The emission factors within table 11.9-4 have been adopted for the operations outlined above. The emission factor is:

$$EF_{TSP}\ (kg.hole^{-1}) = 0.59$$

where:

EF_{TSP} = emission factor for total suspended particulate matter (kg per hole)

PM_{10} & $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 52% of TSP for PM_{10} and, 3 % of TSP for $PM_{2.5}$ as per AP-42 blasting (Table 11.9-2) (USEPA, 1998).

The quality rating for this emission factor is C.

Materials Handling, Loading and Unloading Processes

Emissions associated with all loading and unloading operations have been characterised using the factor outlined in AP-42 for Batch Drop processes (Section 13.2.4.3) (USEPA, 2006a). This equation is consistent with that associated with the use of excavators, shovels and front-end loaders outlined in the NPI EETM for Mining (NPI, 2012):

$$EF\ (kg \cdot tonne^{-1}) = k(0.0016)\,\frac{\left(\frac{U\ (m \cdot s^{-1})}{2.2}\right)^{1.3}}{\left(\frac{M\ (\%)}{2}\right)^{1.4}}$$

where:

$EF_{TSP\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

$EF_{PM_{10}\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

k_{TSP} = 0.74 for particles less than 30 micrometres aerodynamic diameter

$k_{PM_{10}}$ = 0.35 for particles less than 10 micrometres aerodynamic diameter

$k_{PM_{2.5}}$ = 0.053 for particles less than 2.5 micrometres aerodynamic diameter

U = mean wind speed ($m \cdot s^{-1}$)

M = material moisture content (% by weight)

The quality rating for this application is rated U (no rating).

Screening

Emissions of particulate matter resulting from the screening of material have been estimated using the emission factors presented in Section 11.19.2 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for screening operations. $PM_{2.5}$ emission factors are not available for uncontrolled screening sources in AP-42 although have been taken to be 7 % of PM_{10} as per controlled screening activities in table 11.19.2-1 (US EPA, 2004). The control efficiency used for screening is 91.2 % as calculated in AP-42 (USEPA, 2006c).

For uncontrolled screening:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0125$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.0043$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.00030$$

For controlled screening:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0011$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.00037$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.000025$$

The quality rating for these emission factors is: screening (uncontrolled) = E & C (TSP & PM_{10} respectively), and screening (controlled) = E, C & E (TSP, PM_{10} & $PM_{2.5}$ respectively). All other screening emission factors calculated have a quality rating of U (no rating).

Conveyor Transfer Points

The emissions of particulate matter from the conveyor transfer point process have been estimated using emission factors presented in Section 11.19.2-1 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for conveyor transfer points. $PM_{2.5}$ emission factors are not available for conveyor transfer point sources in AP-42 although have been taken to be 10 % of PM_{10} as per aggregate handling sources (MRI, 2006).

For uncontrolled conveyor transfers:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0015$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.00055$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.000055$$

The quality rating for this application is rated ED.

Paved Roads

Emissions of particulate matter resulting from the movement of materials on paved roads have been estimated using the emission factors presented in section 13.2.1 (Paved Roads) of AP-42, (US EPA, 2011).

The emission factor on page 13.2.1.3 of (US EPA, 2011) has been adopted for the operations of vehicles on paved roads:

$$EF_{(g.VKT^{-1})} = k(sL)^{0.91}(W \times 0.907185)^{1.02}$$

where:

$EF_{(g.VKT^{-1})}$= emission factor (g per vehicle kilometre travelled)

k = particle size multiplier (dimensionless)

sL = road surface silt loading ($g{\cdot}m^{-2}$)

W = average weight (tons) of vehicles travelling the road multiplied by 0.907185 to convert to metric tonnes

The particle size multipliers for TSP, PM_{10} and $PM_{2.5}$ (*k*) are provided in (US EPA, 2011) as 3.23, 0.62 and 0.15, respectively.

The quality rating for this emission factors are A for TSP, A for PM_{10}, D for $PM_{2.5}$.

The silt content of paved haul roads at the Quarry Site has been taken to be 8.2 % which is consistent with haul roads at stone quarrying and processing sites (Table 13.2.1-3 of (US EPA, 2011).

The mean weight of road vehicles that utilise paved road components has been calculated based on a mix of Truck & Dog (32.5 t to 37.5 t loads), semi-trailers (27.5 t to 30 t loads) and rigid (12.5 t to 18 t loads) vehicles. The average vehicle weight has therefore been calculated to be 36.25 t (metric).

Unpaved Roads

Emissions of particulate matter resulting from the movement of materials on unpaved roads have been estimated using the emission factors presented in Section 13.2.2 (Unpaved Roads) of AP-42 (USEPA, 2006c).

The emission factor in section 13.2.2 of (USEPA, 2006c) has been adopted for the operations of vehicles on unpaved roads:

$$EF_{(kg.VKT^{-1})} = 0.2819 \times k \times (\frac{s}{12})^{a} \times (\frac{W \times 0.907185}{3})^{b}$$

where:

$EF_{(kg.VKT^{-1})}$ = emission factor (kg per vehicle kilometre travelled) multiplied by 0.2819 to convert from lb per vehicle mile travelled

k = particle size multiplier (dimensionless)

s = surface material silt content (%)

W = mean vehicle weight (tons) multiplied by 0.907185 to convert from metric tonnes

The particle size multipliers for TSP, PM_{10} and $PM_{2.5}$ (*k*) are provided in (US EPA, 2006a) as 4.9, 1.5 and 0.15, respectively.

The quality rating for this application is rated B for TSP, B for PM_{10} and B for $PM_{2.5}$.

The silt content of unpaved haul roads at the Quarry Site has been taken to be 8.3 % which is consistent with haul roads at stone quarrying and processing sites (Table 13.2.2-1 of (US EPA, 2006a)).

The mean weight of road vehicles used on unpaved road components has been calculated based on a mix of Truck & Dog (32.5 t to 37.5 t loads), semi-trailers (27.5 t to 30 t loads) and rigid (12.5 t to 18 t loads) vehicles. The average vehicle weight has therefore been calculated to be 36.25 t (metric).

The mean weight of vehicles used on site has been calculated based on the use of a CAT 730 Articulated Truck which has a payload of 28 t, tare weight of 22.8 t and a loaded weight of 36.8 t (ritchiespecs.com). The average vehicle weight has therefore been calculated to be 36.8 t (metric).

Wind Erosion (Exposed Areas)

Emissions of particulate matter resulting from the wind erosion of exposed areas have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (USEPA, 1998).

The emission factor is:

$$EF_{TSP}\ (tonne.(hectare.year)^{-1}) = 0.85$$

where:

$EF_{TSP}\ (tonne.(hectare.year)^{-1})$= emission factor for total suspended particulate matter.

PM_{10} and $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 50 % of TSP for PM_{10} and, 7.5 % of TSP for $PM_{2.5}$ as per AP-42 section (13.2.5) for industrial wind erosion (USEPA, 1998).

The quality rating for this emission factors is C.

Concrete Batching

Emissions of particulate matter resulting from concrete batching processes have been estimated using the emission factors presented in Table 11.12-1 of (USEPA, 2006b).

Asphalt Batching

Emissions of TSP, PM_{10} and $PM_{2.5}$ associated with the operation of the asphalt batching plant have been taken from emission factors outlined in (NPI, 1999b), for materials handling activities, and from emissions testing data for particulate matter and odour from the dryer stack.

Emissions from stack testing reports for the Tomago Asphalt Batching Plant have been used, along with emissions velocity, temperature, and stack height and diameter, as presented in Table D2. Note that the emissions testing data was associated with an hourly maximum production rate of 80 $t{\cdot}hr^{-1}$, which has been scaled to 90 $t{\cdot}hr^{-1}$ (1 000 $t{\cdot}day^{-1}$) to reflect the proposed operations at the Project Site.

Table D2 Adopted emissions data for the asphalt plant dryer stack – Scenarios 1 and 2

Parameter	Adopted value
Stack height (m)	14.75
Stack diameter (m)	1.5
Stack exhaust temperature (K)	349
Stack exhaust velocity ($m{\cdot}s^{-1}$)	7.7
TSP emission rate ($g{\cdot}s^{-1}$)	0.26
PM_{10} emission rate ($g{\cdot}s^{-1}$)	0.1
$PM_{2.5}$ emission rate ($g{\cdot}s^{-1}$)	0.006
NO_X emission rate ($g{\cdot}s^{-1}$)^A	0.14
Benzene emission rate ($g{\cdot}s^{-1}$)^A	0.002
Toluene emission rate ($g{\cdot}s^{-1}$)^A	0.006
Ethylbenzene emission rate ($g{\cdot}s^{-1}$)^A	0.013
Xylene emission rate ($g{\cdot}s^{-1}$)^A	0.016
Odour emission rate ($OU{\cdot}s^{-1}$)	92 272

Note: A: based on (NPI, 1999b) emission factors (kg pollutant$\cdot t^{-1}$ asphalt)

Odour emissions associated with the asphalt load out process were measured at the Tomago Asphalt Plant in 2022, which indicated an odour concentration of 490 $OU{\cdot}m^{-3}$ (associated with an 80 $t{\cdot}hr^{-1}$ production rate, and an asphalt mix of 2 % rubber crumb). Assuming a load out volume of 35 t, an asphalt bulk density of 2.4 $t{\cdot}m^{-3}$, and a load out time of two minutes, and assuming that all air in the truck bed is displaced, the displaced air would be 14.58 m^3 in total, or 0.1215 $m^3{\cdot}s^{-1}$. The odour emission rate would therefore be

59.5 $OU \cdot s^{-1}$ (490 $OU \cdot m^{-3}$ × 0.1215 $m^3 \cdot s^{-1}$). However, this emission rate accounts for air displacement only, and the impact of entrainment effects, the effect of wind, and turbulence are not accounted for using that approach.

To provide an estimate of those effects, the effective opening of the truck tray is assumed to be 9 m × 2.5 m (22.5 m^2) with the average wind speed at the Project Site 3.5 $m \cdot s^{-1}$. The entrained flow would therefore be 78.75 $m^3 \cdot s^{-1}$ and the emission rate 38 588 $OU \cdot s^{-1}$ (78.75 $m^3 \cdot s^{-1}$ × 49 $OU \cdot m^{-3}$). When compared with other similar studies associated with asphalt load-out (ranging from 1 600 $OU \cdot s^{-1}$ (Rich River, Ektimo, 2017) to 4 333 $OU \cdot s^{-1}$ (Orange Grove, Air Assessments, 2013), the calculated value is highly conservative.

Although the calculated values above associated with asphalt load out are highly conservative, they have been adopted to provide assurance that the asphalt plant could be operated without giving rise to adverse odour impacts at nearby sensitive receptor locations.

The emissions of NO_X associated with the proposed 500 kW diesel generator at the asphalt plant have been estimated assuming a CAT DE500S GC diesel generator (500 eKw) which is certified for USEPA Tier 2 or Tier 3 emissions standards for NO_X (6.4 $g \cdot kWh^{-1}$ [Tier 2], 4 $g \cdot kWh^{-1}$ [Tier 3]) and particulate matter (0.2 $g \cdot kWh^{-1}$ [Tier 2 and 3]). The emission parameters of relevance to this AQIA outlined in the specification sheet are presented in

Table D3 Adopted emission parameters for diesel generator

Parameter	Value	Notes
Exhaust gas temperature	490.1 °C	
Exhaust gas flow rate	102.8 $m^3 \cdot min^{-1}$ (1.7 $m^3 \cdot s^{-1}$)	
Stack height	3 m	Assumed
Stack diameter	0.3 m	Assumed
Stack exhaust velocity	24.1 $m \cdot s^{-1}$	Calculated
NO_X emission rate	0.56 $g \cdot s^{-1}$	Calculated (Tier 3)
NO_X emission concentration	326.8 $mg \cdot m^{-3}$	
PM emission rate[A]	0.03 $g \cdot s^{-1}$	Calculated (Tier 3)
PM emission concentration	1.2 $mg \cdot m^{-3}$	

Note: A: Taken to be $PM_{2.5}$

Emissions Estimates

Table D3 to Table D5 show emissions from volume sources in Scenario 1, while Table D6 to Table D8 cover emissions from road sources in Scenario 1. Tables D9 to Table D11 present emissions from wind erosion (stockpile) areas in Scenario 1. For Scenario 2, Table D12 to Table D14 detail emissions from volume sources, Table D15 to Table D17 address emissions from road sources, and Table D18 to Table D20 focus on emissions from wind erosion (stockpile) areas.

These tables cover both peak 24-hour and annual emissions, which were assessed in the AQIA.

Table D3 Emissions estimates – volume sources – peak daily and annual activity rates – Scenario 1

Source ID	Description	Emission factor	Activity rate	
			$t \cdot day^{-1}$ (A)	$t \cdot yr^{-1}$ (A)
VOL1	Drill	AP-42 - Drilling (Overburden) - Table 11.9-4	12.0 $hole \cdot day^{-1}$	3 120.0 $hole \cdot yr^{-1}$
VOL2	Blast	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	1.0 $blast \cdot day^{-1}$	46.0 $blast \cdot yr^{-1}$
VOL3	Excavator/FEL loading haul trucks	AP-42 - Batch drop - Section 13.2.4.3	6 101.4	953 350.4
VOL4	Unloading at processing plant	AP-42 - Batch drop - Section 13.2.4.3	5 520.0	862 500.0
VOL5	Excavator/FEL loading processing plant hopper	AP-42 - Batch drop - Section 13.2.4.3	5 520.0	862 500.0
VOL6	Scalp pre-primary (15%)	AP-42 - Screening - Table 11.19.2.1	720.0	112 500.0
VOL7	Primary jaw crusher	AP-42 - Primary crushing - Table 11.19.2.1	4 800.0	750 000.0
VOL8	Conveyor to Secondary Cone Crusher	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 800.0	750 000.0
VOL9	Secondary Cone Crusher	AP-42 - Secondary crushing - Table 11.19.2.1	4 800.0	750 000.0
VOL10	Conveyor to scalps stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	480.0	75 000.0
VOL11	Unloading at scalps stockpile	AP-42 - Batch drop - Section 13.2.4.3	480.0	75 000.0
VOL12	Conveyor to screening deck 1	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 320.0	675 000.0
VOL13	Screening deck 1	AP-42 - Screening - Table 11.19.2.1	4 320.0	675 000.0
VOL14	Conveyor to 20mm stockpiles	AP-42 - Conveyor transfer point - Table 11.19.2.1	960.0	150 000.0
VOL15	Conveyor to 14mm stockpiles	AP-42 - Conveyor transfer point - Table 11.19.2.1	672.0	105 000.0
VOL16	Loading 20mm aggregate stockpile	AP-42 - Batch drop - Section 13.2.4.3	960.0	150 000.0
VOL17	Loading 14mm aggregate stockpile	AP-42 - Batch drop - Section 13.2.4.3	672.0	105 000.0
VOL18	Conveyor to tertiary cone crusher	AP-42 - Conveyor transfer point - Table 11.19.2.1	2 688.0	420 000.0
VOL19	Tertiary Cone Crusher	AP-42 - Tertiary crushing - Table 11.19.2.1	2 688.0	420 000.0
VOL20	Conveyor to road base stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	-	300 000.0
VOL21	Loading road base stockpile	AP-42 - Batch drop - Section 13.2.4.3	-	300 000.0
VOL22	Conveyor to manufactured sand stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	1 056.0	165 000.0
VOL23	Loading manufactured sand stockpile	AP-42 - Batch drop - Section 13.2.4.3	1 056.0	165 000.0
VOL24	Conveyor to screening deck 2	AP-42 - Conveyor transfer point - Table 11.19.2.1	1 632.0	255 000.0

Source ID	Description	Emission factor	Activity rate	
			t·day^{-1} (A)	t·yr^{-1} (A)
VOL25	Screening deck 2	AP-42 - Screening - Table 11.19.2.1	1 632.0	255 000.0
VOL26	Conveyor to 10mm/7mm/5mm aggregate stockpiles	AP-42 - Conveyor transfer point - Table 11.19.2.1	1 632.0	255 000.0
VOL27	Loading 10mm aggregate stockpile	AP-42 - Batch drop - Section 13.2.4.3	1 152.0	180 000.0
VOL28	Loading 7mm aggregate stockpile	AP-42 - Batch drop - Section 13.2.4.3	288.0	45 000.0
VOL29	Loading 5mm aggregate stockpile	AP-42 - Batch drop - Section 13.2.4.3	192.0	30 000.0
VOL30	Excavator/FEL loading road trucks from bins/stockpiles	AP-42 - Batch drop - Section 13.2.4.3	4 800.0	450 000.0

Note: (A) unless otherwise stated

Table D4 Emission estimates – volume sources – peak daily emission rates – Scenario 1

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·day^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL1	5.90E-01	3.07E-01	1.77E-02	kg·hole^{-1}	Fabric filters (99%)	7.08E-02	3.68E-02	2.12E-03
VOL2	2.75E+01	1.43E+01	8.25E-01	kg·blast^{-1}	-	2.75E+01	1.43E+01	8.25E-01
VOL3	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%), Pit retention	4.62E+00	4.16E+00	6.29E-01
VOL4	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	8.37E+00	3.96E+00	5.99E-01
VOL5	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	8.37E+00	3.96E+00	5.99E-01
VOL6	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Minimise drop height (30%)	6.30E+00	2.17E+00	1.52E-01
VOL7	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	2.89E+00	1.28E+00	2.31E-01
VOL8	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	2.16E+00	7.92E-01	2.22E-01
VOL9	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	2.89E+00	1.28E+00	2.31E-01
VOL10	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	2.16E-01	7.92E-02	2.22E-02
VOL11	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	1.04E+00	4.92E-01	7.44E-02
VOL12	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.94E+00	7.13E-01	2.00E-01
VOL13	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	4.75E+00	1.63E+00	1.14E-01
VOL14	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	4.32E-01	1.58E-01	4.44E-02

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·day^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL15	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	3.02E-01	1.11E-01	3.10E-02
VOL16	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	2.08E+00	9.83E-01	1.49E-01
VOL17	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	1.45E+00	6.88E-01	1.04E-01
VOL18	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.21E+00	4.44E-01	1.24E-01
VOL19	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	1.62E+00	7.19E-01	1.29E-01
VOL20	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	0.00E+00	0.00E+00	0.00E+00
VOL21	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	0.00E+00	0.00E+00	0.00E+00
VOL22	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	4.75E-01	1.74E-01	4.88E-02
VOL23	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	2.29E+00	1.08E+00	1.64E-01
VOL24	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	7.34E-01	2.69E-01	7.54E-02
VOL25	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	1.80E+00	6.18E-01	4.32E-02
VOL26	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	7.34E-01	2.69E-01	7.54E-02
VOL27	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	2.49E+00	1.18E+00	1.79E-01
VOL28	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	6.24E-01	2.95E-01	4.47E-02
VOL29	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	4.16E-01	1.97E-01	2.98E-02
VOL30	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	7.27E+00	3.44E+00	5.21E-01

Table D5 Emission estimates – volume sources – annual emission rates – Scenario 1

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL1	5.90E-01	3.07E-01	1.77E-02	kg·hole^{-1}	Fabric filters (99%)	1.84E+01	9.57E+00	5.52E-01
VOL2	2.75E+01	1.43E+01	8.25E-01	kg·blast^{-1}	-	1.27E+03	6.58E+02	3.80E+01
VOL3	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%), Pit retention	7.22E+02	6.49E+02	9.83E+01
VOL4	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	1.31E+03	6.18E+02	9.36E+01
VOL5	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	1.31E+03	6.18E+02	9.36E+01

Source ID	Emission factor				Emissions control(s)	Controlled emissions ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL6	1.25E-02	4.30E-03	3.01E-04	$kg \cdot t^{-1}$	Minimise drop height (30%)	9.84E+02	3.39E+02	2.37E+01
VOL7	2.70E-03	1.20E-03	2.16E-04	$kg \cdot t^{-1}$	Controlled crushing (77.7%)	4.52E+02	2.01E+02	3.61E+01
VOL8	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	3.38E+02	1.24E+02	3.47E+01
VOL9	2.70E-03	1.20E-03	2.16E-04	$kg \cdot t^{-1}$	Controlled crushing (77.7%)	4.52E+02	2.01E+02	3.61E+01
VOL10	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	3.38E+01	1.24E+01	3.47E+00
VOL11	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	1.62E+02	7.68E+01	1.16E+01
VOL12	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	3.04E+02	1.11E+02	3.12E+01
VOL13	1.25E-02	4.30E-03	3.01E-04	$kg \cdot t^{-1}$	Controlled screening (91.2%)	7.43E+02	2.55E+02	1.79E+01
VOL14	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	6.75E+01	2.48E+01	6.93E+00
VOL15	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	4.73E+01	1.73E+01	4.85E+00
VOL16	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	3.25E+02	1.54E+02	2.33E+01
VOL17	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	2.27E+02	1.08E+02	1.63E+01
VOL18	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	1.89E+02	6.93E+01	1.94E+01
VOL19	2.70E-03	1.20E-03	2.16E-04	$kg \cdot t^{-1}$	Controlled crushing (77.7%)	2.53E+02	1.12E+02	2.02E+01
VOL20	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	1.35E+02	4.95E+01	1.39E+01
VOL21	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	6.50E+02	3.07E+02	4.65E+01
VOL22	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	7.43E+01	2.72E+01	7.62E+00
VOL23	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	3.57E+02	1.69E+02	2.56E+01
VOL24	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	1.15E+02	4.21E+01	1.18E+01
VOL25	1.25E-02	4.30E-03	3.01E-04	$kg \cdot t^{-1}$	Controlled screening (91.2%)	2.81E+02	9.65E+01	6.75E+00
VOL26	1.50E-03	5.50E-04	1.54E-04	$kg \cdot t^{-1}$	Chemical suppressant at transfer points (70%)	1.15E+02	4.21E+01	1.18E+01
VOL27	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	3.90E+02	1.84E+02	2.79E+01
VOL28	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	9.74E+01	4.61E+01	6.98E+00
VOL29	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	-	6.50E+01	3.07E+01	4.65E+00
VOL30	2.17E-03	1.02E-03	1.55E-04	$kg \cdot t^{-1}$	Minimise drop height (30%)	6.82E+02	3.23E+02	4.88E+01

Table D6 Emissions estimates – road sources – peak daily and annual activity rates – Scenario 1

Source ID	Description	Emission factor	Activity rate	
			$VKT \cdot day^{-1}$	$VKT \cdot yr^{-1}$
ROAD1	Haul trucks to processing area	AP-42 Unpaved roads - Section 13.2.2	175.5	27 415.2
ROAD2	Haul trucks to visibility barrier	AP-42 Unpaved roads - Section 13.2.2	39.4	6 151.9
ROAD3	Road trucks on QAR (unpaved)	AP-42 Unpaved roads - Section 13.2.2	728.5	103 288.8
ROAD4	Road trucks on QAR (paved)	AP-42 Paved roads - Section 13.2.1	1 381.0	195 802.0

Table D7 Emission estimates – road sources – peak daily emission rates – Scenario 1

Source ID	Emission factor				Emissions control(s)	Controlled emissions ($kg \cdot day^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
ROAD1	3.44E+00	9.80E-01	9.80E-02	$kg \cdot VKT^{-1}$	Speed limits (40%), Watering (90%), Pit retention	3.63E+01	1.03E+01	1.03E+00
ROAD2	3.44E+00	9.80E-01	9.80E-02	$kg \cdot VKT^{-1}$	Speed limits (40%), Watering (90%)	8.14E+00	2.31E+00	2.31E-01
ROAD3	3.42E+00	9.73E-01	9.73E-02	$kg \cdot VKT^{-1}$	Speed limits (40%), Watering (90%)	1.50E+02	4.25E+01	4.25E+00
ROAD4	8.54E-01	1.64E-01	3.96E-02	$kg \cdot VKT^{-1}$	Speed limits (44%), Watering (30%), Fence (75%)	1.16E+02	2.22E+01	5.37E+00

Table D8 Emission estimates – road sources – annual emission rates – Scenario 1

Source ID	Emission factor				Emissions control(s)	Controlled emissions ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
ROAD1	3.44E+00	9.80E-01	9.80E-02	$kg \cdot VKT^{-1}$	Speed limits (40%), Watering (90%), Pit retention	5.67E+03	1.61E+03	1.61E+02
ROAD2	3.44E+00	9.80E-01	9.80E-02	$kg \cdot VKT^{-1}$	Speed limits (40%), Watering (90%)	1.27E+03	3.62E+02	3.62E+01
ROAD3	3.42E+00	9.73E-01	9.73E-02	$kg \cdot VKT^{-1}$	Speed limits (40%), Watering (90%)	2.12E+04	6.03E+03	6.03E+02
ROAD4	8.54E-01	1.64E-01	3.96E-02	$kg \cdot VKT^{-1}$	Speed limits (44%), Watering (30%), Fence (75%)	1.64E+04	3.14E+03	7.61E+02

Table D9 Emissions estimates – open area wind erosion sources – peak activity rates – Scenario 1

Source ID	Description	Emission factor	Peak activity rate	
			Area (ha)	$hr \cdot day^{-1}$
WE1	Exposed area (extraction)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	19.5	2.40E+01
WE2	Exposed area (visibility barrier)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	12.0	2.40E+01
WE3	Exposed area (processing area)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	18.2	2.40E+01

Table D10 Emission estimates – open area wind erosion sources – peak daily emission rates – Scenario 1

Source ID	Emission factor				Emissions control(s)	Controlled emissions ($kg \cdot day^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
WE1	8.50E+02	4.25E+02	6.38E+01	$kg \cdot ha^{-1} \cdot yr^{-1}$	Assume 25% 'actively disturbed' (75% control), Pit retention	5.68E+00	5.39E+00	8.09E-01
WE2	8.50E+02	4.25E+02	6.38E+01	$kg \cdot ha^{-1} \cdot yr^{-1}$	Assume 50% revegetated (50% control)	1.40E+01	6.99E+00	1.05E+00
WE3	8.50E+02	4.25E+02	6.38E+01	$kg \cdot ha^{-1} \cdot yr^{-1}$	Assumed 50% 'actively disturbed' (50% control)	2.12E+01	1.06E+01	1.59E+00

Table D11 Emission estimates – open area wind erosion sources – annual emission rates – Scenario 1

Source ID	Emission factor				Emissions control(s)	Controlled emissions ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
WE1	8.50E+02	4.25E+02	6.38E+01	$kg \cdot ha^{-1} \cdot yr^{-1}$	Assume 25% 'actively disturbed' (75% control), Pit retention	2.07E+03	1.97E+03	2.95E+02
WE2	8.50E+02	4.25E+02	6.38E+01	$kg \cdot ha^{-1} \cdot yr^{-1}$	Assume 50% revegetated (50% control)	5.10E+03	2.55E+03	3.83E+02
WE3	8.50E+02	4.25E+02	6.38E+01	$kg \cdot ha^{-1} \cdot yr^{-1}$	Assumed 50% 'actively disturbed' (50% control)	7.74E+03	3.87E+03	5.80E+02

Table D12 Emissions estimates – volume sources – peak daily and annual activity rates – Scenario 2

Source ID	Description	Emission factor	Activity rate	
			$t{\cdot}day^{-1}$ (A)	$t{\cdot}yr^{-1}$ (A)
VOL1	Drill	AP-42 - Drilling (Overburden) - Table 11.9-4	12.0 $hole{\cdot}day^{-1}$	3 120.0 $hole{\cdot}yr^{-1}$
VOL2	Blast	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	1.0 $blast{\cdot}day^{-1}$	46.0 $blast{\cdot}yr^{-1}$
VOL3	Excavator/FEL loading haul trucks	AP-42 - Batch drop - Section 13.2.4.3	5 574.8	1 161 425.0
VOL4	Unloading at processing plant	AP-42 - Batch drop - Section 13.2.4.3	5 520.0	1 150 000.0
VOL5	Excavator/FEL loading processing plant hopper	AP-42 - Batch drop - Section 13.2.4.3	5 520.0	1 150 000.0
VOL6	Scalp pre-primary (15%)	AP-42 - Primary crushing - Table 11.19.2.1	720.0	150 000.0
VOL7	Primary jaw crusher	AP-42 - Primary crushing - Table 11.19.2.1	4 800.0	1 000 000.0
VOL8	Conveyor to scalps screen	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 800.0	1 000 000.0
VOL9	Conveyor to scalps stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	-	-
VOL10	Unloading at scalps stockpile	AP-42 - Batch drop - Section 13.2.4.3	-	-
VOL11	Conveyor to surge stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 800.0	1 000 000.0
VOL12	Unloading at surge stockpile	AP-42 - Batch drop - Section 13.2.4.3	4 800.0	1 000 000.0
VOL13	Loading surge bin	AP-42 - Batch drop - Section 13.2.4.3	4 800.0	1 000 000.0
VOL14	Screening deck 2	AP-42 - Screening - Table 11.19.2.1	4 800.0	1 000 000.0
VOL15	Conveyor to gabion stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	384.0	-
VOL16	Unloading at gabion stockpile	AP-42 - Batch drop - Section 13.2.4.3	384.0	-
VOL17	Conveyor to secondary crusher	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 416.0	1 000 000.0
VOL18	Secondary crusher	AP-42 - Secondary crushing - Table 11.19.2.1	4 416.0	1 000 000.0
VOL19	Conveyor to tertiary crusher	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 416.0	1 000 000.0
VOL20	Tertiary crusher	AP-42 - Tertiary crushing - Table 11.19.2.1	4 416.0	1 000 000.0
VOL21	Conveyor to screen 3	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 416.0	1 000 000.0
VOL22	Screen 3	AP-42 - Screening - Table 11.19.2.1	4 416.0	1 000 000.0

Source ID	Description	Emission factor	Activity rate	
			t·day^{-1} (A)	t·yr^{-1} (A)
VOL23	Conveyor to VSI	AP-42 - Conveyor transfer point - Table 11.19.2.1	4 416.0	1 000 000.0
VOL24	Vertical Shaft Impactor	AP-42 - Tertiary crushing - Table 11.19.2.1	4 416.0	1 000 000.0
VOL25	Conveyor to road base stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	-	400 000.0
VOL26	Loading road base stockpile	AP-42 - Batch drop - Section 13.2.4.3	-	400 000.0
VOL27	Conveyor to manufactured sand stockpile	AP-42 - Conveyor transfer point - Table 11.19.2.1	1 536.0	192 000.0
VOL28	Loading manufactured sand stockpile	AP-42 - Batch drop - Section 13.2.4.3	1 536.0	192 000.0
VOL29	Conveyor to screen 4	AP-42 - Conveyor transfer point - Table 11.19.2.1	2 880.0	192 000.0
VOL30	Screen 4	AP-42 - Screening - Table 11.19.2.1	2 880.0	192 000.0

Note: (A): Unless otherwise stated

Table D13 Emission estimates – volume sources – peak daily emission rates – Scenario 2

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·day^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL1	5.90E-01	3.07E-01	1.77E-02	kg·hole^{-1}	Fabric filters (99%)	7.08E-02	3.68E-02	2.12E-03
VOL2	2.75E+01	1.43E+01	8.25E-01	kg·blast^{-1}	-	2.75E+01	1.43E+01	8.25E-01
VOL3	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%), Pit retention	4.22E+00	3.80E+00	5.75E-01
VOL4	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	8.37E+00	3.96E+00	5.99E-01
VOL5	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	8.37E+00	3.96E+00	5.99E-01
VOL6	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	-	1.94E+00	8.64E-01	1.56E-01
VOL7	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	2.89E+00	1.28E+00	2.31E-01
VOL8	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	2.16E+00	7.92E-01	2.22E-01
VOL9	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	0.00E+00	0.00E+00	0.00E+00
VOL10	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	0.00E+00	0.00E+00	0.00E+00
VOL11	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	2.16E+00	7.92E-01	2.22E-01
VOL12	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	1.04E+01	4.92E+00	7.44E-01

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·day^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL13	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	7.27E+00	3.44E+00	5.21E-01
VOL14	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	5.28E+00	1.82E+00	1.27E-01
VOL15	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.73E-01	6.34E-02	1.77E-02
VOL16	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	8.31E-01	3.93E-01	5.95E-02
VOL17	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.99E+00	7.29E-01	2.04E-01
VOL18	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	2.66E+00	1.18E+00	2.13E-01
VOL19	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.99E+00	7.29E-01	2.04E-01
VOL20	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	2.66E+00	1.18E+00	2.13E-01
VOL21	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.99E+00	7.29E-01	2.04E-01
VOL22	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	4.86E+00	1.67E+00	1.17E-01
VOL23	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.99E+00	7.29E-01	2.04E-01
VOL24	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	2.66E+00	1.18E+00	2.13E-01
VOL25	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	0.00E+00	0.00E+00	0.00E+00
VOL26	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	0.00E+00	0.00E+00	0.00E+00
VOL27	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	6.91E-01	2.53E-01	7.10E-02
VOL28	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	3.33E+00	1.57E+00	2.38E-01
VOL29	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.30E+00	4.75E-01	1.33E-01
VOL30	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	3.17E+00	1.09E+00	7.63E-02

Table D14 Emission estimates – volume sources – annual emission rates – Scenario 2

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL1	5.90E-01	3.07E-01	1.77E-02	kg·hole^{-1}	Fabric filters (99%)	1.84E+01	9.57E+00	5.52E-01
VOL2	2.75E+01	1.43E+01	8.25E-01	kg·blast^{-1}	-	1.27E+03	6.58E+02	3.80E+01
VOL3	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%), Pit retention	8.80E+02	7.91E+02	1.20E+02

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
-	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	1.74E+03	8.24E+02	1.25E+02
VOL5	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	1.74E+03	8.24E+02	1.25E+02
VOL6	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Minimise drop height (30%)	4.05E+02	1.80E+02	3.24E+01
VOL7	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	6.02E+02	2.68E+02	4.82E+01
VOL8	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	4.50E+02	1.65E+02	4.62E+01
VOL9	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	0.00E+00	0.00E+00	0.00E+00
VOL10	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	0.00E+00	0.00E+00	0.00E+00
VOL11	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	4.50E+02	1.65E+02	4.62E+01
VOL12	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	2.17E+03	1.02E+03	1.55E+02
VOL13	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	1.52E+03	7.17E+02	1.09E+02
VOL14	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.10E+03	3.78E+02	2.65E+01
VOL15	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	0.00E+00	0.00E+00	0.00E+00
VOL16	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	0.00E+00	0.00E+00	0.00E+00
VOL17	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	4.50E+02	1.65E+02	4.62E+01
VOL18	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	6.02E+02	2.68E+02	4.82E+01
VOL19	2.70E-03	1.20E-03	2.16E-04	kg·t^{-1}	Controlled crushing (77.7%)	4.50E+02	1.65E+02	4.62E+01
VOL20	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	6.02E+02	2.68E+02	4.82E+01
VOL21	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	4.50E+02	1.65E+02	4.62E+01
VOL22	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	1.10E+03	3.78E+02	2.65E+01
VOL23	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	4.50E+02	1.65E+02	4.62E+01
VOL24	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	6.02E+02	2.68E+02	4.82E+01
VOL25	1.25E-02	4.30E-03	3.01E-04	kg·t^{-1}	Controlled screening (91.2%)	1.80E+02	6.60E+01	1.85E+01
VOL26	1.50E-03	5.50E-04	1.54E-04	kg·t^{-1}	Chemical suppressant at transfer points (70%)	8.66E+02	4.10E+02	6.20E+01
VOL27	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	8.64E+01	3.17E+01	8.87E+00
VOL28	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	4.16E+02	1.97E+02	2.98E+01

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
VOL29	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	-	8.64E+01	3.17E+01	8.87E+00
VOL30	2.17E-03	1.02E-03	1.55E-04	kg·t^{-1}	Minimise drop height (30%)	2.11E+02	7.27E+01	5.09E+00

Table D15 Emissions estimates – road sources – peak daily and annual activity rates – Scenario 2

Source ID	Description	Emission factor	Activity rate	
			VKT·day^{-1}	VKT·yr^{-1}
ROAD1	Haul trucks to processing area	AP-42 Unpaved roads - Section 13.2.2	372.2	77 542.9
ROAD2	Haul trucks to visibility barrier	AP-42 Unpaved roads - Section 13.2.2	5.5	1 137.6
ROAD3	Road trucks on QAR (unpaved)	AP-42 Unpaved roads - Section 13.2.2	728.5	124 103.1
ROAD4	Road trucks on QAR (paved)	AP-42 Paved roads - Section 13.2.1	1 381.0	235 259.2

Table D16 Emission estimates – road sources – peak daily emission rates – Scenario 2

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·day^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
ROAD1	3.44E+00	9.80E-01	9.80E-02	kg·VKT^{-1}	Speed limits (40%), Watering (90%), Pit retention	7.69E+01	2.19E+01	2.19E+00
ROAD2	3.44E+00	9.80E-01	9.80E-02	kg·VKT^{-1}	Speed limits (40%), Watering (90%)	1.13E+00	3.21E-01	3.21E-02
ROAD3	3.42E+00	9.73E-01	9.73E-02	kg·VKT^{-1}	Speed limits (40%), Watering (90%)	1.50E+02	4.25E+01	4.25E+00
ROAD4	8.54E-01	1.64E-01	3.96E-02	kg·VKT^{-1}	Speed limits (44%), Watering (30%), Fence (75%)	1.16E+02	2.22E+01	5.37E+00

Table D17 Emission estimates – road sources – annual emission rates – Scenario 2

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
ROAD1	3.44E+00	9.80E-01	9.80E-02	kg·VKT^{-1}	Speed limits (40%), Watering (90%), Pit retention	1.60E+04	4.56E+03	4.56E+02
ROAD2	3.44E+00	9.80E-01	9.80E-02	kg·VKT^{-1}	Speed limits (40%), Watering (90%)	2.35E+02	6.69E+01	6.69E+00
ROAD3	3.42E+00	9.73E-01	9.73E-02	kg·VKT^{-1}	Speed limits (40%), Watering (90%)	2.55E+04	7.25E+03	7.25E+02

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
ROAD4	8.54E-01	1.64E-01	3.96E-02	kg·VKT^{-1}	Speed limits (44%), Watering (30%), Fence (75%)	1.97E+04	3.78E+03	9.14E+02

Table D18 Emissions estimates – open area wind erosion sources – peak activity rates – Scenario 2

Source ID	Description	Emission factor	Peak activity rate	
			Area (ha)	hr·day^{-1}
WE1	Exposed area (extraction)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	22.6	2.40E+01
WE2	Exposed area (visibility barrier)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	12.0	2.40E+01
WE3	Exposed area (processing area)	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	18.2	2.40E+01

Table D19 Emission estimates – open area wind erosion sources – peak daily emission rates – Scenario 2

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·day^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
WE1	8.50E+02	4.25E+02	6.38E+01	kg·ha^{-1}·yr^{-1}	Assume 25% 'actively disturbed' (75% control), Pit retention	6.58E+00	6.25E+00	9.37E-01
WE2	8.50E+02	4.25E+02	6.38E+01	kg·ha^{-1}·yr^{-1}	Assume 50% revegetated (50% control)	1.40E+01	6.99E+00	1.05E+00
WE3	8.50E+02	4.25E+02	6.38E+01	kg·ha^{-1}·yr^{-1}	Assumed 50% 'actively disturbed' (50% control)	2.12E+01	1.06E+01	1.59E+00

Table D20 Emission estimates – open area wind erosion sources – annual emission rates – Scenario 2

Source ID	Emission factor				Emissions control(s)	Controlled emissions (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Units		TSP	PM_{10}	$PM_{2.5}$
WE1	8.50E+02	4.25E+02	6.38E+01	kg·ha^{-1}·yr^{-1}	Assume 25% 'actively disturbed' (75% control), Pit retention	2.40E+03	2.28E+03	3.42E+02
WE2	8.50E+02	4.25E+02	6.38E+01	kg·ha^{-1}·yr^{-1}	Assume 50% revegetated (50% control)	5.10E+03	2.55E+03	3.83E+02
WE3	8.50E+02	4.25E+02	6.38E+01	kg·ha^{-1}·yr^{-1}	Assumed 50% 'actively disturbed' (50% control)	7.74E+03	3.87E+03	5.80E+02

APPENDIX E

Meteorological Sensitivity Analysis

A sensitivity analysis has been performed to assess the impact of adopting the meteorological file used in the original AQIA (0 % calm winds), and that generated as outlined in Appendix B (5.3 % calm winds). A summary of the sensitivity analysis is provided as:

- Incremental maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations; and
- Number of additional exceedances of the cumulative maximum 24-hour average criteria.

Results are provided for Scenario 2 only, given that this scenario resulted in the highest incremental concentrations. Note that emissions sources included in this assessment are consistent with the original AQIA, and any updates (i.e. addition of diesel generator) are not included here, but are included in the main assessment.

The results indicate that whilst the inclusion of additional calm wind conditions results in a marginal increase in the maximum predicted particulate matter impacts (Table E1), it also results in a change in the distribution of impacts, which results in the previously predicted exceedances now not being predicted (refer Table E2).

Table E1 Comparison of 24-hour PM_{10} and $PM_{2.5}$ concentrations – modelled meteorology

Receptor	Maximum 24-hour average PM_{10} concentration		Maximum 24-hour average $PM_{2.5}$ concentration	
	Original AQIA	Updated meteorology	Original AQIA	Updated meteorology
Criterion	50		25	
Max. % of criterion	22.6 %	23.4 %	7.3 %	7.3 %
PR1	6.6	8.0	0.9	1.3
R2	11.2	11.7	1.8	1.8
R2	9.8	10.6	1.6	1.7
R4	4.4	4.8	0.6	0.8
R5	5.4	6.3	0.8	0.9
R6	5.8	6.9	0.9	1.0
R7	3.7	4.1	0.6	0.7
R8	2.6	3.0	0.4	0.5
R9	2.3	3.0	0.3	0.5
R10	3.2	4.2	0.4	0.6
R11	4.4	5.7	0.6	0.8
R12	6.5	8.1	1.0	1.3
R13	6.0	7.8	1.0	1.2
R14	7.0	5.8	1.2	0.9
R15	8.8	4.6	1.3	0.7
R16	11.3	3.1	1.7	0.4
R17	5.8	2.7	0.9	0.4
R18	2.8	1.9	0.5	0.3

Receptor	Maximum 24-hour average PM_{10} concentration		Maximum 24-hour average $PM_{2.5}$ concentration	
	Original AQIA	Updated meteorology	Original AQIA	Updated meteorology
R19	2.6	1.7	0.4	0.3
R20	2.6	1.6	0.4	0.3
R21	2.7	1.5	0.4	0.3
R22	2.7	1.5	0.4	0.2
R23	1.9	1.3	0.3	0.2
R24	2.4	1.5	0.4	0.2
R25	2.8	1.5	0.4	0.2
R26	2.5	1.4	0.4	0.2
R27	1.5	1.4	0.2	0.2
R28	1.5	1.5	0.2	0.2
R29	1.6	1.6	0.2	0.3
R30	1.6	1.5	0.2	0.2
R31	2.0	1.9	0.3	0.3
R32	2.5	2.4	0.4	0.4
R33	1.8	2.2	0.3	0.3
R34	1.4	1.9	0.2	0.3
R35	2.3	2.1	0.3	0.3
R36	1.8	1.9	0.3	0.3
R37	1.7	2.2	0.2	0.4
R38	2.0	2.3	0.3	0.4
R39	1.9	2.5	0.3	0.4
R40	1.2	2.2	0.2	0.4
R41	1.2	2.0	0.2	0.4
R42	1.0	1.8	0.1	0.4
R43	0.8	2.1	0.1	0.3
R44	0.7	1.6	0.1	0.3
R45	0.6	1.1	<0.1	0.2
R46	0.8	1.0	0.1	0.2
R47	0.7	0.9	0.1	0.2

Table E2 Predicted exceedances of the 24-hour PM_{10} and $PM_{2.5}$ criteria – modelled meteorology

Receptor	Additional exceedances – 24-hour PM_{10} criterion		Additional exceedances – 24-hour $PM_{2.5}$ criterion	
	Original AQIA	Updated meteorology	Original AQIA	Updated meteorology
R2	0	0	1	0
R3	0	0	1	0
All others	0	0	0	0

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