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Air Quality and Greenhouse Gas Assessment

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Stone Ridge Quarry Project
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Air Quality and Greenhouse Gas Assessment

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Executive summary

Australian Resource Development Group Pty Limited (ARDG) is seeking to develop a new hard rock quarry, known as Stone Ridge Quarry (the Project), located within Wallaroo State Forest at Balickera, NSW. The Project proposes to produce up to 1.5 million tonnes per annum (Mtpa) of saleable quarry product with approval sought for an initial 30-year quarrying period.

This report provides an assessment of the potential air quality and greenhouse gas impacts of the Project. In summary, the air quality assessment involved identifying the key air quality issues, characterising the existing environment, quantifying emissions to air and modelling the potential impact of the Project on local air quality. The modelling was carried out in accordance with the assessment procedures prescribed by the NSW EPA. Greenhouse gas emissions were estimated in accordance with recognised methodologies.

The key air quality issue was identified as dust during operations. This was the focus of the assessment, along with impacts from diesel exhaust emissions, nitrogen dioxide (NO_2) emissions from blasting, impacts from associated road transport activities and the effects of dust containing quartz crystalline silica.

As part of the assessment, key features of the existing environment were identified including surrounding sensitive receptors, local meteorology, and background air quality. Aerial imagery was used to identify the location of surrounding receptors. Meteorological and ambient air quality data collected at monitors operated by the NSW Department of Planning and Environment (DPE) and Bureau of Meteorology (BoM) (meteorology only) were reviewed to characterise existing local conditions. The following conclusions were made in relation to the existing environment:

- Meteorological conditions do not vary significantly from year to year, and conditions in 2021 were identified as the most representative of the long term, local conditions.
- Air quality conditions are strongly correlated to the climatic conditions. For example, there was a deterioration in air quality conditions between 2017 and early 2020 that were heavily influenced by drought, dust storms and bushfires. These conditions are not unique to the Hunter region.

Air quality emission rates for key dust-generating activities associated with the proposed modification were estimated from local and international guidance. Modelling was then carried out with these emissions to predict potential changes to local air quality. The assessment determined that air quality impacts associated with the Project would meet the relevant requirements from the “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW” (Environment Protection Authority [EPA], 2022) as well as the ‘NSW Voluntary Land Acquisition and Mitigation Policy’, (NSW Government, 2018) (VLAMP). Specifically, it was predicted that:

- Construction and operational dust emissions are not expected to cause adverse air quality impacts at the nearby sensitive receptors based on the results of air dispersion modelling which showed compliance with the EPA assessment criteria. No VLAMP mitigation or acquisition triggers were exceeded.
- No exceedances of the EPA’s NO_2 criteria from diesel exhaust emissions or from blasting.
- Emissions from truck diesel exhausts travelling on public roads are not expected to result in any adverse air quality impacts based on the modelling which showed that maximum kerbside concentrations would not exceed EPA criteria.
- The Project is not expected to cause, adverse air quality impacts with respect to crystalline silica or odour.

An assessment of ‘combined cumulative impacts’ was also completed consistent with guidance presented in ‘Cumulative Impact Assessment Guidelines for State Significant Projects’ (DPIE, 2022). This assessment estimated that resulting air quality impacts from the Project, as well as from nearby existing and proposed developments (including background conditions) would not result in overall pollutant levels in excess of the relevant assessment criteria.

The Project is not expected to cause, adverse air quality impacts with respect to crystalline silica or odour. Regarding greenhouse gas emissions, an emissions inventory covering the life of operations was calculated in accordance with the principles of the GHG Protocol. This analysis estimated a maximum (0.017 Mt CO2-e)

and an average (0.0053 Mt CO_2-e) annual Scope 1 and 2 emissions from the Project which represent less than 0.0035% of Australia's 2020 emissions.

While this assessment has shown the Project is not expected to cause any adverse off-site air quality impacts or State or nationally significant quantities of greenhouse gas emissions, a range of mitigation and management measures are recommended with consideration also given to real-time air quality monitoring.

Operational controls may also be necessary to manage potential risks associated with employee exposure to particulate matter however these are outside the scope of this assessment and are managed under workplace health and safety legislation.

Contents

Appendices

Acronyms and abbreviations

Term	Definition
ABS	Australian Bureau of Statistics
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
BoM	Bureau of Meteorology
CALMET	Meteorological model for the CALPUFF air dispersion model
CALPUFF	Computer-based air dispersion model
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DPE	Department of Planning and Environment (formerly Department of Planning, Industry and Environment or DPIE)
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
HVAS	High volume air sampler
Jacobs	Jacobs Group (Australia) Pty Limited
NEPM	National Environment Protection Measure
NEPC	National Environment Protection Council of Australia
NPI	National Pollutant Inventory
OEH	Office of Environment and Heritage, now part of the Department of Planning, Industry and Environment as Environment, Energy and Science
OU	Odour unit
$PM_{2.5}$	Particulate matter with equivalent aerodynamic diameters less than 2.5 microns
PM_{10}	Particulate matter with equivalent aerodynamic diameters less than 10 microns
POEO Act	Protection of the Environment Operations (POEO) Act 1997
TAPM	The Air Pollution Model – a meteorological and air dispersion model developed by CSIRO
TEOM	Tapered Element Oscillating Microbalance
TSP	Total suspended particulate matter
VLAMP	Voluntary Land Acquisition and Mitigation Policy

1. Introduction

1.1 Background

Australian Resource Development Group Pty Limited (ARDG) is seeking to develop a new hard rock quarry, known as Stone Ridge Quarry (the Project), located within Wallaroo State Forest at Balickera, NSW, approximately 20 kilometres (km) north of Newcastle within the Port Stephens Local Government Area (LGA). This report provides an assessment of the potential air quality and greenhouse gas impacts of the Project.

1.2 Project Description

The Project is seeking to access a high quality, hard rock resource suitable for producing a wide range of quarry products for the Lower Hunter, Central Coast, and northern Sydney construction material markets. The Project proposes to produce up to 1.5 million tonnes per annum (Mtpa) of saleable quarry product with approval sought for an initial 30-year quarrying period.

The Project is located on land managed by Forestry Corporation of New South Wales (FCNSW) (Figure 1.1).

ARDG holds a Deed of Agreement (Deed) for a Forest Materials Licence (FML) with FCNSW under section 42 of the Forestry Act.

The construction phase of the Project consists of earthworks and clearing of vegetation for site preparation to enable access to target resources and development of the quarry extraction area. Construction of a weighbridge and associated administrative buildings combined with the installation of on-site processing plant and associated equipment are also required to facilitate the Project. A site access point off Italia Road will also need to be constructed. A summary of the of key project aspects is provided in Table 1.1.

The Project is a State Significant Development (SSD) under the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP) as proposed extraction rates will exceed 500,000 tonnes per year. A development application (DA) for the Project, supported by an environmental impact statement (EIS), is required to be submitted under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This air quality and greenhouse gas assessment (AQGHG Assessment) has been prepared as part of the EIS for the Project.

Table 1.1. Summary of key project aspects

Aspect	Proposed for the Project
Project life	30 years
Limits of production	Up to 1.5 Mtpa of quarry product/sales per year
Project Area	Approximately 139 ha (including extraction, processing and stockpiling area and buffers), with a disturbance area of approximately 94 ha
Extraction method	Drill, blast, and haul
Material processing	Processing on site using mobile crushing and screening plant, with provision for future modular / fixed processing plant
Overburden management	Overburden will be minimal, and any topsoil and overburden will be stockpiled on site for use in rehabilitation
Product	Concrete, asphalt and sealing aggregates, gabion, and crushed rock, armourstone and roadbase
Product transport	Road transport of up to 1.5 Mtpa of product via the Pacific Highway
Other operations	Use of a 100 tonne/hour road chip precoating plant
Site access	Single access point on Italia Road. No trucks will turn right out of the site onto Italia Road towards East Seaham
Employment	Construction:

Aspect	Proposed for the Project
	Operation: Up to 10 full time employees, 3 to 5 part-time employees
Hours of operation	Construction: - 7.00 am to 6.00 pm Monday to Friday - 8.00 am to 1.00 pm Saturday - No work on Sunday or public holidays Operation: - Quarrying and processing - 7.00 am to 6.00 pm Monday to Friday, and 7.00 am to 3.00 pm Saturdays - Truck loading, product transport and maintenance - 6.00 am to 10.00 pm Monday to Friday, and 7.00 am to 3.00 pm Saturdays - Blasting taking place between 10.00am and 3.00pm, Monday to Saturdays No operation on Sundays or Public Holidays apart from maintenance activities as required
Rehabilitation and final landform	Rehabilitation will be undertaken progressively where appropriate in the context of further resources remaining available in the Project Area at the end of the planned 30-year approval life. A conceptual final landform will be prepared for the Project.

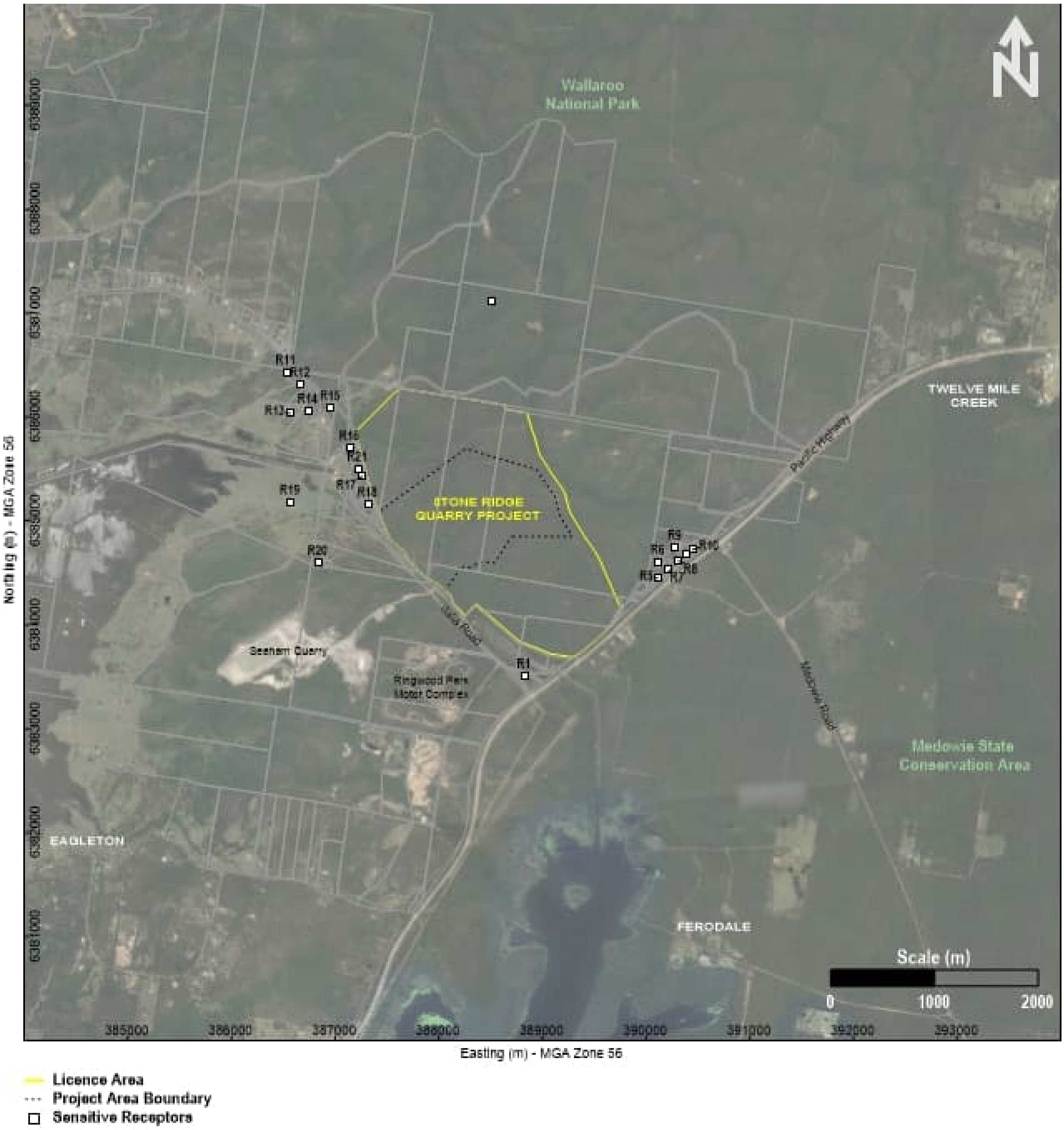


Figure 1.1. Project location and location of sensitive receptors

1.3 Secretary's Environmental Assessment Requirements

This AQGHG Assessment has been prepared following the appropriate guidelines, policies, and industry requirements, and in consultation with stakeholders including community members and relevant government agencies.

Guidelines and policies referenced in this assessment include:

- "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (EPA, 2022) (Approved Methods)
- "Approved Methods for the Sampling and Analysis of Air Pollutants in NSW" (DEC, 2007)

- "Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (TRC, 2011)
- "Australia's whole-of-economy Long-Term Emissions Reduction Plan" (DISER, 2020)
- "National Greenhouse Accounts Factors" (DCCEEW, 2022)
- "NSW Climate Change Policy Framework" (OEH, 2016)
- "Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments 2018" (DPIE, 2018)
- "Guideline for Assessing and Minimising Air Pollution in Victoria (for air pollution managers and specialists) Publication 1961" (EPA Victoria, 2022).

This assessment has also been prepared in accordance with requirements of the NSW Department of Planning and Environment (DPE). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the Project, issued on 1 June 2020. Table 1.2 outlines the SEARs relevant to this assessment along with references to where these are addressed.

Table 1.2. Relevant matters raised in the SEARs

Requirement	Section(s) where addressed
Air Quality – including: - a detailed assessment of potential construction and operational air quality impacts of the development including an assessment of cumulative impacts of any proposed, approved, and existing developments in the vicinity of the site, in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the *Voluntary Land Acquisition and Mitigation Policy*; - an assessment of potential dust and other emissions generated from processing, operational activities, and transportation of quarry products; - reasonable and feasible mitigation measures to minimise dust and emissions; and - monitoring and management measures, in particular, real-time air quality monitoring	This report, in particular: - **Section 2** (identification of issues) - **Section 6** (assessment of air quality impacts) - **Section 8** (reasonable and feasible mitigation measures) - **Section 8** (monitoring and management measures)

To inform the preparation of the SEARs, the DPE invited other government agencies to recommend matters to be addressed in the EIS. The NSW Environment Protection Authority (EPA) raised matters that are relevant to the air quality and greenhouse gas assessment. These matters raised are listed in Table 1.3 and have been considered in preparing this assessment, as indicated in the table.

Table 1.3. Agency assessment recommendations relevant to air quality and greenhouse gas

Requirement	Section(s) where addressed
Identify the existing air quality environment and identify applicable air quality goals (i.e., ground level concentrations for pollutants and odour assessment criteria) in line with relevant guidance/standards;	Applicable criteria are outlined in Section 3.1. The existing environment is discussed in Section 4.
Identify potential air quality and odour sources and impacts (including point source emissions from any site-based plant and equipment and/or fugitive dust or other emissions) during both construction and operational stages and identify best practice mitigation measures (pollution control) and strategies to minimise point and/or fugitive and/or odour emissions/impacts (with proposed timing), including monitoring, in line with relevant guidance/standards; and	Key air quality issues have been identified in Section 2. Sources and emissions have been identified in Section 5.

Requirement	Section(s) where addressed
	Potential impacts have been discussed in Section 6 and Section 7. Monitoring and management measures are outlined in Section 8.
Include an emission inventory of all sources of air emissions.	Included in Appendix C.

1.4 Report Structure

The report is structured as follows:

- Section 1 – Introduces the Project with a summary of the Project background, Project description and SEARs.
- Section 2 – Identifies the key air quality and greenhouse gas issues to be addressed.
- Section 3 – Outlines the key legislative and policy assessment requirements for air quality and greenhouse gas.
- Section 4 – Discusses key features of the existing environment including surrounding land uses, sensitive receptors, and local meteorological and air quality conditions.
- Section 5 – Provides an overview of the methods used to assess the potential for air quality and greenhouse gas impacts.
- Section 6 – Provides an assessment of the potential construction and operational air quality impacts including potential cumulative impacts.
- Section 7 – Provides an assessment of the potential greenhouse gas emissions.
- Section 8 – Outlines the measures to mitigate or otherwise effectively manage and monitor potential impacts.
- Section 9 – Provides the conclusions of the assessment.

2. Key Issues

Air quality issues can arise when emissions from an industry or activity lead to the deterioration of the ambient air quality. Potential air quality issues have been identified from a review of the Project and associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air from the Project could occur from a variety of activities including material handling, material transport, processing, and wind erosion from exposed areas. These emissions could occur in both the construction and operational phases of the Project.

The most common emission to air from quarry activities is dust, also referred to as particulate matter. Key classifications of particulate matter include:

- Total suspended particulates (TSP)
- Particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10})
- Particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$)
- Deposited dust.

Plant and equipment exhausts also have the potential to generate emissions that include carbon monoxide (CO), oxides of nitrogen (NO_x) and fine particulate matter, and to a lesser extent sulphur dioxide (SO_2). Post-blast fume has the potential to generate NO_x emissions which, in turn, can oxidise to the more nitrogen dioxide (NO_2). Rock crushing also has the potential to cause emissions of crystalline silica. Finally, limited odour may also be generated using the on-site road chip precoating plant.

The area around the Project site contains various emission sources that will influence the local air quality. Consequently, the potential cumulative impacts are an important issue to address in the assessment.

The key issues for construction will be:

- Emissions of particulate matter (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) including those from machinery exhausts
- Greenhouse gas emissions.

The key issues for operation will be:

- Emissions of particulate matter (TSP, PM_{10}, $PM_{2.5}$ and deposited dust)
- Post-blast fume (NO_2)
- Diesel exhaust (PM_{10}, $PM_{2.5}$ and NO_2)
- Crystalline silica dust particulates due to the breaking of rock
- Greenhouse gas emissions.

These issues are the focus of this assessment.

3. Policy Setting

3.1 Air Quality Criteria

Air quality is typically quantified by the concentrations of substances in the ambient air. Air pollution occurs when the concentration (or some other measure of intensity) of one or more substances known to cause health, nuisance and/or environmental effects, exceeds a certain level. Regarding human health and nuisance effects, the substances most relevant to the Project have been identified, from Section 2, as particulate matter in various forms.

The EPA has developed criteria for a range of air quality indicators that are used for the assessment of specific projects such as the Stone Ridge Quarry Project. These criteria are outlined in the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA, 2022), hereafter referred to as the Approved Methods. Except for the standards for crystalline silica and odour (which are considered further below), the EPA criteria referred to in this report have been drawn from national standards for air quality set by the National Environment Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPMs) (NEPC, 1998).

The Project has been assessed in terms of its ability to comply with the air quality criteria set by the EPA as part of the Approved Methods. These criteria are outlined in Table 3.1 and apply to existing and potentially sensitive receptors, where the Approved Methods defines a sensitive receptor as *"a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area"*. This definition has also been interpreted as places of near-continuous occupation.

Table 3.1. EPA air quality assessment criteria

Requirement	Averaging time	Assessment criterion
Particulate matter (PM_{10})	24-hour	50 µg/m^3
	Annual	25 µg/m^3
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3
	Annual	8 µg/m^3
Particulate matter (TSP)	Annual	90 µg/m^3
Deposited dust	Annual (maximum increase)	2 g/m^2/month
	Annual (maximum total)	4 g/m^2/month
Nitrogen dioxide (NO_2)	1-hour	164 µg/m^3
	Annual	31 µg/m^3

The EPA air quality assessment criteria relate to the total concentration of pollutants in the air (that is, cumulative) and not just the contribution from Project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess the potential impacts. In situations where background levels are elevated the proponent must "demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical" (EPA, 2022). Section 4 provides further discussion of background levels.

In December 2015 the Australian Government announced a National Clean Air Agreement (Agreement). This Agreement aims to reduce air pollution and improve air quality via the following main actions:

- The introduction of emission standards for new non-road spark ignition engines and equipment.
- Measures to reduce air pollution from wood heaters.

- Strengthened ambient air quality reporting standards for particle pollution.

The strengthening of ambient air quality reporting standards for particle pollution is relevant to the Project. Specifically, and at the time, the following (Meeting of Environment Ministers, 2015) was agreed:

> *"Taking into account the latest scientific evidence of health impacts, Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles. Ministers agreed to adopt reporting standards for annual average and 24-hour $PM_{2.5}$ particles of 8 µg/m^3 and 25 µg/m^3 respectively, aiming to move to 7 µg/m^3 and 20 µg/m^3 respectively by 2025. Ministers also agreed to establish an annual average standard for PM_{10} particles of 25 µg/m^3. Victoria and the Australian Capital Territory will set, and South Australia will consider setting, a more stringent annual average PM_{10} standard of 20 µg/m^3 in the state, while ensuring nationally consistent monitoring and reporting against the agreed National Environment Protection Measure standards. The decision was also taken to review $PM_{2.5}$ standards in 2018. The review will be co-led by the NSW and Victorian governments, in discussion with other jurisdictions."*

On 25 February 2016, an amendment to the Ambient Air Quality NEPM entered into force and introduced the new national air quality standards for PM_{10} and $PM_{2.5}$, as noted above. The EPA subsequently revised its PM_{10} and $PM_{2.5}$ assessment criteria as part of an update to the Approved Methods. These revised criteria are reflected in Table 3.1 and took effect from 20 January 2017 onwards. There is currently no State legislation regarding the aim to move to more stringent $PM_{2.5}$ criteria by 2025. Table 3.1 also reflects the April 2021 update to the NEPM, where the standards for ozone (O_3), sulfur dioxide (SO_2) and NO_2 were updated in-line with the latest scientific research around health impacts.

Accordingly, the Project is assessed against the current criteria detailed in the Approved Methods as these criteria would be applied by the consent authority in accordance with the provisions of Clause 12AB of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) (2018 amendment).

The 'NSW Voluntary Land Acquisition and Mitigation Policy', (NSW Government, 2018) (VLAMP) includes the NSW Government's policy for voluntary mitigation and land acquisition to address dust (particulate matter) impacts from State significant mining, petroleum, and extractive industry developments. The VLAMP brings the air quality criteria in line with the NEPM standards and EPA assessment criteria.

From the VLAMP, voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in Table 3.2 at any residence or workplace on privately owned land.

Table 3.2. VLAMP mitigation criteria for particulate matter

Air quality indicator	Averaging time	Mitigation criterion	Impact type
Particulate matter (PM_{10})	24-hour	50 µg/m^3 **	Human health
	Annual	25 µg/m^3 *	Human health
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3 **	Human health
	Annual	8 µg/m^3 *	Human health
Particulate matter (TSP)	Annual	90 µg/m^3 *	Amenity
Deposited dust	Annual (maximum increase)	2 g/m^2/month **	Amenity
	Annual (maximum total)	4 g/m^2/month *	Amenity

** Cumulative impact (i.e., increase in concentrations due to the development plus background concentrations due to all other sources).*
*** 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).*

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in Table 3.3 at any residence or workplace on privately owned land, or 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.

Table 3.3. VLAMP acquisition criteria for particulate matter

Air quality indicator	Averaging time	Mitigation criterion	Impact type
Particulate matter (PM_{10})	24-hour	50 µg/m^3 **	Human health
	Annual	25 µg/m^3 *	Human health
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3 **	Human health
	Annual	8 µg/m^3 *	Human health
Particulate matter (TSP)	Annual	90 µg/m^3 *	Amenity
Deposited dust	Annual (maximum increase)	2 g/m^2/month **	Amenity
	Annual (maximum total)	4 g/m^2/month *	Amenity

** Cumulative impact (i.e., increase in concentrations due to the development plus background concentrations due to all other sources).*
*** 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).*

The particulate matter levels for comparison with the criteria in Table 3.2 and Table 3.3 must be calculated in accordance with the Approved Methods.

As noted above, the Approved Methods do not contain an impact assessment criterion for airborne crystalline silica. However, suitable guidance is contained in “Guideline for Assessing and Minimising Air Pollution in Victoria (for air pollution managers and specialists) Publication 1961” (Publication 1961) (EPA Victoria, 2022). NSW EPA’s Approved Methods adopts impact assessment criteria for several other pollutants from the VIC EPA, and it is considered that the guidance contained for airborne crystalline silica is also suitable. The VIC EPA’s crystalline silica air pollution assessment criterion adopted for the assessment has been reproduced below in Table 3.4.

Table 3.4. VIC EPA health-based Air pollution assessment criterion for crystalline silica

Air quality indicator	Averaging time	Air pollution assessment criterion	Impact type
Respirable crystalline silica (defined as the $PM_{2.5}$ fraction)	Annual	3 µg/m^3	Human health

Section 7.5 of the Approved Methods provides impact assessment criteria for complex mixtures of odorous air pollutants. These have been reproduced below in Table 3.5. These criteria are expressed in the units, ‘odour units’ (OU). The Approved Methods describes the number of odour units as ‘the concentration of a sample divided by the odour threshold, or the number of dilutions required for the sample to reach the threshold’. The numerical value expressed is the threshold value equivalent to when 50% of a testing panel correctly detect an odour. A value of 1 OU represents the threshold of detection, and as such values less than 1 OU are below detection.

Table 3.5. EPA Impact assessment criteria for complex mixtures of odorous pollutants

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (greater than or equal to 2000 persons including schools and hospitals)	2.0
Approximately 500	3.0
Approximately 125	4.0
Approximately 30	5.0
Approximately 10	6.0
Single rural residence (less than or equal to 2 persons)	7.0

Section 7.5.2 of the Approved Methods describes how these criteria apply at ‘the nearest existing or likely future off-site sensitive receptor’. Where site-specific meteorological data is available, these criteria relate to the 99th percentile of peak concentrations.

As described in Section 6.6 of the Approved Methods, the evaluation of odour impacts requires the ‘estimation of short or peak concentrations on the time scale of less than one second’. Noting that the temporal resolution of dispersion modelling is generally one hour or more, an emission rate correction is applied in NSW to ‘accurately simulate atmospheric dispersion of odours and the instantaneous perception of odours by the human nose’. This correction is known as a peak-to-mean ratio. Values for the peak-to-mean ratio are dependent on the nature of the source, atmospheric stability, and the distance downwind. Applicable peak-to-mean ratios have been applied in this assessment.

3.2 Greenhouse Gas

Greenhouse gases (GHG) is a collective term for a range of trace gases that are known to absorb terrestrial infrared radiation in the atmosphere, where they cause a planetary greenhouse effect. Global warming is warming of the atmosphere caused by increasing quantities of GHGs. GHGs include:

- Carbon dioxide (CO_2); by far the most abundant GHG, primarily released during fuel combustion.
- Methane (CH_4); generated from the anaerobic decomposition of carbon-based material (including enteric fermentation and waste disposal in landfills).
- Nitrous oxide (N_2O); generated from industrial activity, fertiliser use and production.
- Hydrofluorocarbons (HFCs); commonly used as refrigerant gases in cooling systems.
- Perfluorocarbons (PFCs); used in a range of applications including solvents, medical treatments, and insulators.
- Sulphur hexafluoride (SF_6); used as a cover gas in magnesium smelting and as an insulator in heavy duty switch gear.

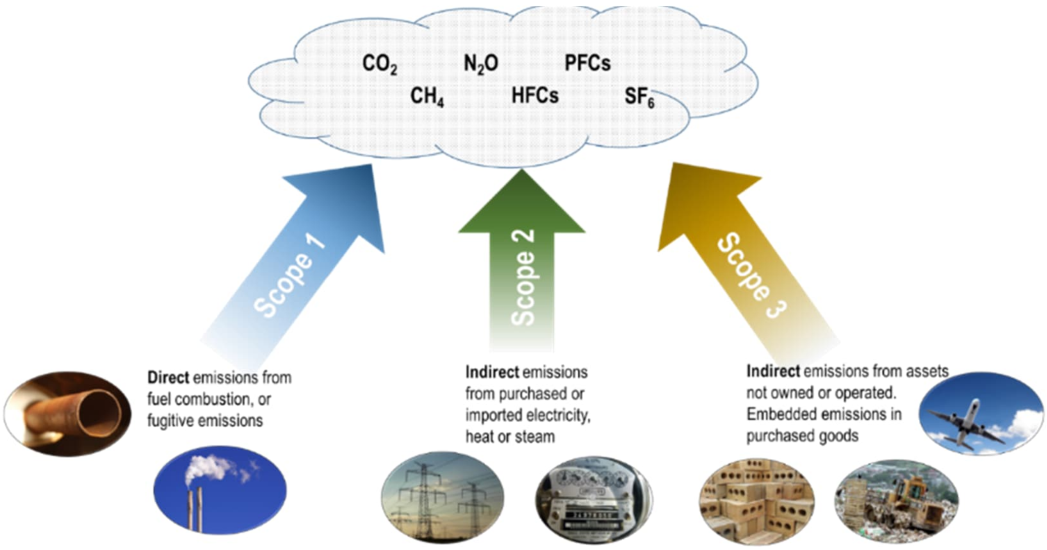
It is common practice to aggregate the emissions of these gases to the equivalent emission of carbon dioxide. This provides a simple figure for comparison of emissions against targets. Aggregation is based on the potential of each gas to contribute to global warming relative to carbon dioxide and is known as the global warming potential (GWP). The resulting number is expressed as carbon dioxide equivalent (or CO2-e).

GHG emissions that form an inventory can be split into three categories known as ‘Scopes’. Scopes 1, 2 and 3 are defined by the Greenhouse Gas Protocol (GHG Protocol)[1] and can be summarised as follows (refer to Figure 3.1):

- Scope 1 – Direct emissions from sources that are owned or operated by the organisation (examples include combustion of diesel in company owned vehicles or used in on-site generators).
- Scope 2 – Indirect emissions associated with the import of energy from another source (examples include importation of electricity or heat).
- Scope 3 – Other indirect emissions (other than Scope 2 energy imports) which are a direct result of the operations of the organisation but from sources not owned or operated by them (examples include business travel by air or rail and product usage).

The purpose of differentiating between the scopes of emissions is to avoid the potential for double counting, where two or more organisations assume responsibility for the same emissions.

[1] The Greenhouse Gas Protocol is a collaboration between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The Protocol provides guidance on the calculation and reporting of carbon footprints.



Adapted from – World Business Council for Sustainable Development – Greenhouse Gas Protocol

Figure 3.1. Sources of greenhouse gases

3.2.1 International Context

Following the United Nations Climate Change Conference (COP21), the Paris Agreement was established with long-term goals to address the negative impacts of climate change. These goals include:

- Keep global warming well below 2.0 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius
- Submit revised emission reduction targets every five years (from 2018), with the first being effective from 2020, and goals set to 2050
- Define a pathway to improve transparency and disclosure of emissions
- Make provisions for financing the commitments beyond 2020.

Australia signed the Paris Agreement and in 2022, updated its Nationally Determined Contribution (NDC) under Article 4 of the Paris Agreement, committing to reduce greenhouse gas emissions 43% below 2005 levels by 2030. Australia also reaffirmed its target to achieve net zero emissions by 2050.

3.2.2 Federal Greenhouse Gas Policy

Climate Change Act 2022The Commonwealth Government introduced the *Climate Change Act* (2022) to set out Australia's greenhouse gas emissions reduction targets and operates as an overarching piece of legislation to implement Australia's net-zero commitments.

The Act introduces legislated emissions reduction targets of:

- Reducing net GHG emissions to 43% below 2005 levels by 2030
- Reducing net GHG emissions to zero by 2050.

The 2030 GHG emissions reduction target is implemented as an emissions budget, as a linear decrease covering the period 2021 to 2030.

National Greenhouse and Energy Reporting Act 2007

The Commonwealth Government uses the *National Greenhouse Gas and Energy Reporting Act 2007* (NGER Act) for the measurement, reporting and verification of Australian greenhouse gas emissions. Corporations in Australia which exceed the thresholds for reporting under NGER scheme must register and report their GHG emissions.

There are two types of thresholds that determine which companies have reporting obligation under the NGER Act;

- A 'facility' is obligated to report greenhouse gas emissions if it produces 25,000 tonnes of CO2-e (t CO2-e) per year and consumes 100 TJ or more of energy
- A 'corporate group' is obligated to report greenhouse gas emissions if it produces 50,000 t CO2-e per year and consumes 200 TJ or more of energy.

The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* identifies several methodologies to account for greenhouse gases from specific sources relevant to the Project. This includes emissions of greenhouse gases from direct fuel combustion (e.g., diesel generators and plant/equipment used during construction), and from consumption of electricity from the grid.

Climate Solutions Fund

The "Direct Action Plan" was introduced on 1 July 2014 and aims to focus on sourcing low-cost emission reductions (Energetics, 2017). The Direct Action Plan includes the Climate Solutions Fund, previously known as the Emissions Reduction Fund (ERF). Legislation to implement the ERF came into effect on 13 December 2014 and is considered to be the centrepiece of the Australian Government's policy suite to reduce GHG emissions (Australian Government Clean Energy Regulator, 2020).

The implementation of a 'safeguard mechanism' came into effect on 1 July 2016 aimed at requiring Australia's largest emitters of more than 100,000 $_{t}CO_2$-e a year to keep net emissions at or below baseline emissions levels (Australian Government Clean Energy Regulator, 2020). The Australian government is now reforming the Safeguard Mechanism to reduce baseline emissions limits based on a target consistent with achieving net-zero by 2050. This reform is currently in consultation phase with the new Safeguard Mechanism to commence on 1st July 2023.

3.2.3 State Greenhouse Gas Policy

In response to national GHG reduction commitments, the NSW government developed the NSW Climate Change Policy Statement which sets the objective of achieving net-zero emissions by 2050. It intends to achieve this through a combination of policy development, leading by example and advocacy.

4. Existing Environment

4.1 Local Setting

The Project area is located approximately 30 km north of Newcastle, within the Wallaroo State Forest. The Wallaroo State Forest extends to the north, east and south of the project area, while Italia Road lies to the west. On the western side of Italia Road is Boral's Seaham Quarry and several commercial land uses including a car racing circuit, car club and paintball facility. The closest residential premises are located approximately 1 km to the northwest along Italia Road and to the south along Nine Mile Creek Road.

Land uses within approximately 2 km of the project area include:

- Several privately-owned residences along Italia Road to the west and northwest. The closest of these is located approximately 1.2 km from the centre of the of project area
- Boral's Seaham Quarry is located to the southwest of the project area and accessed off Italia Road
- Seven privately-owned residences located along Nine Mile Creek Road at Ferodale to the southeast, approximately 1.7 to 2 km from the project area
- A single residence located approximately 1.6 km to the south on the corner of Italia Road and the Pacific Highway
- Three residences located on the south side of the Pacific Highway between Balickera Channel and Medowie Road
- An approved motor sports facility (Circuit Italia) located approximately 1.5 to 2 km to the southwest on Italia Road

Stone Ridge is the main topographic feature within the Project area and is approximately 1200 m long. Stone Ridge comprises two rocky hills separated by a low saddle. The hill at the southwest end of the ridge has a maximum elevation of 108 m Australian Height Datum (AHD), whereas the hill to the northeast has a maximum elevation of 83 m AHD.

More gently undulating topography to the northwest and southeast of the Project area typically ranges in elevation from 20 to 60 m AHD. A prominent broad low ridge extends from the central south-eastern flank of Stone Ridge, approximately 1600 m southeast to the Pacific Highway. Figure 4.1 shows a pseudo three-dimensional representation of the local terrain.

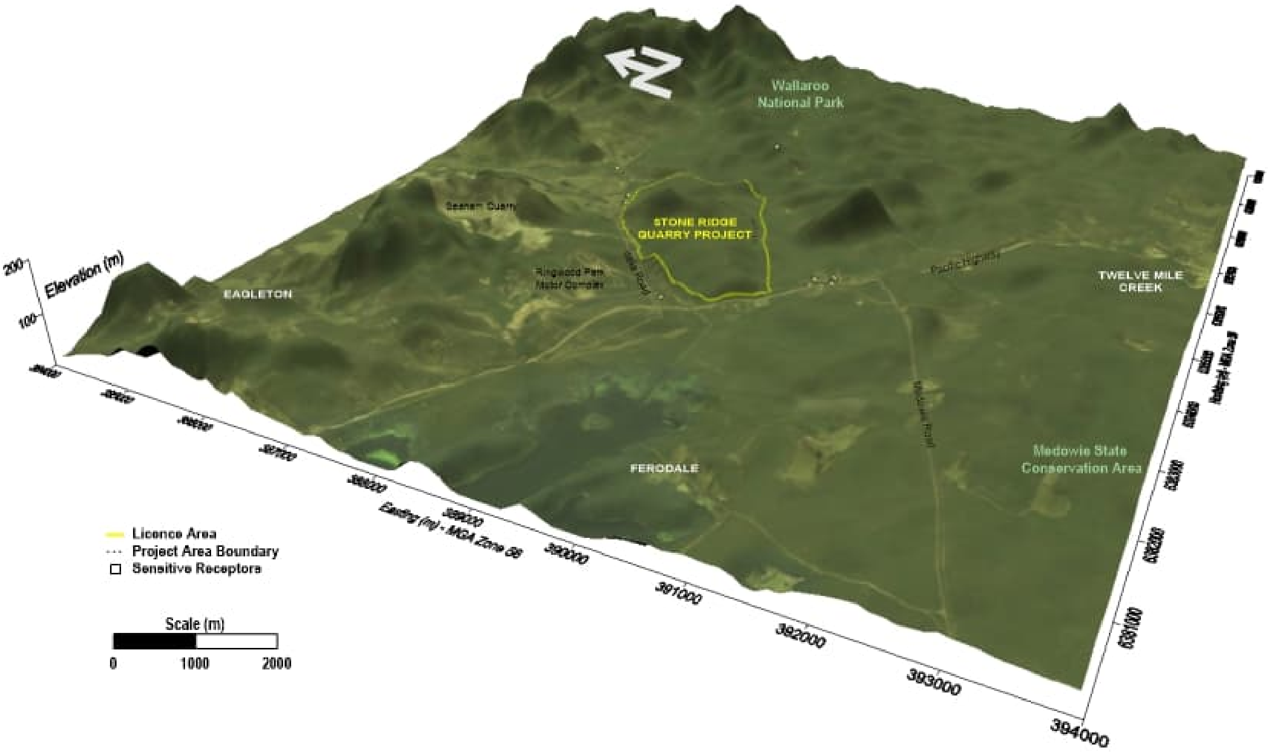


Figure 4.1. Pseudo three-dimensional representation of the local terrain

4.2 Meteorology

Meteorological conditions are important for determining the transport of emissions, and the potential influences on air quality. In addition, meteorological data are often used with concurrent air quality data to determine potential contributions from sources of interest. This section provides an analysis of meteorological data collected near the Project and identifies the datasets that may be representative of the long term, local conditions.

There are no meteorological stations near Project site however the Bureau of Meteorology (BoM) and DPE both operate networks of meteorological monitoring stations across NSW including several stations in the Hunter region. Figure 4.2 shows the nearest stations to the Project. The closest stations are located at Beresfield, operated by the DPE, and Williamtown, operated by the BoM. Meteorological modelling using the data from these two stations has been used to derive meteorological conditions near the Project.

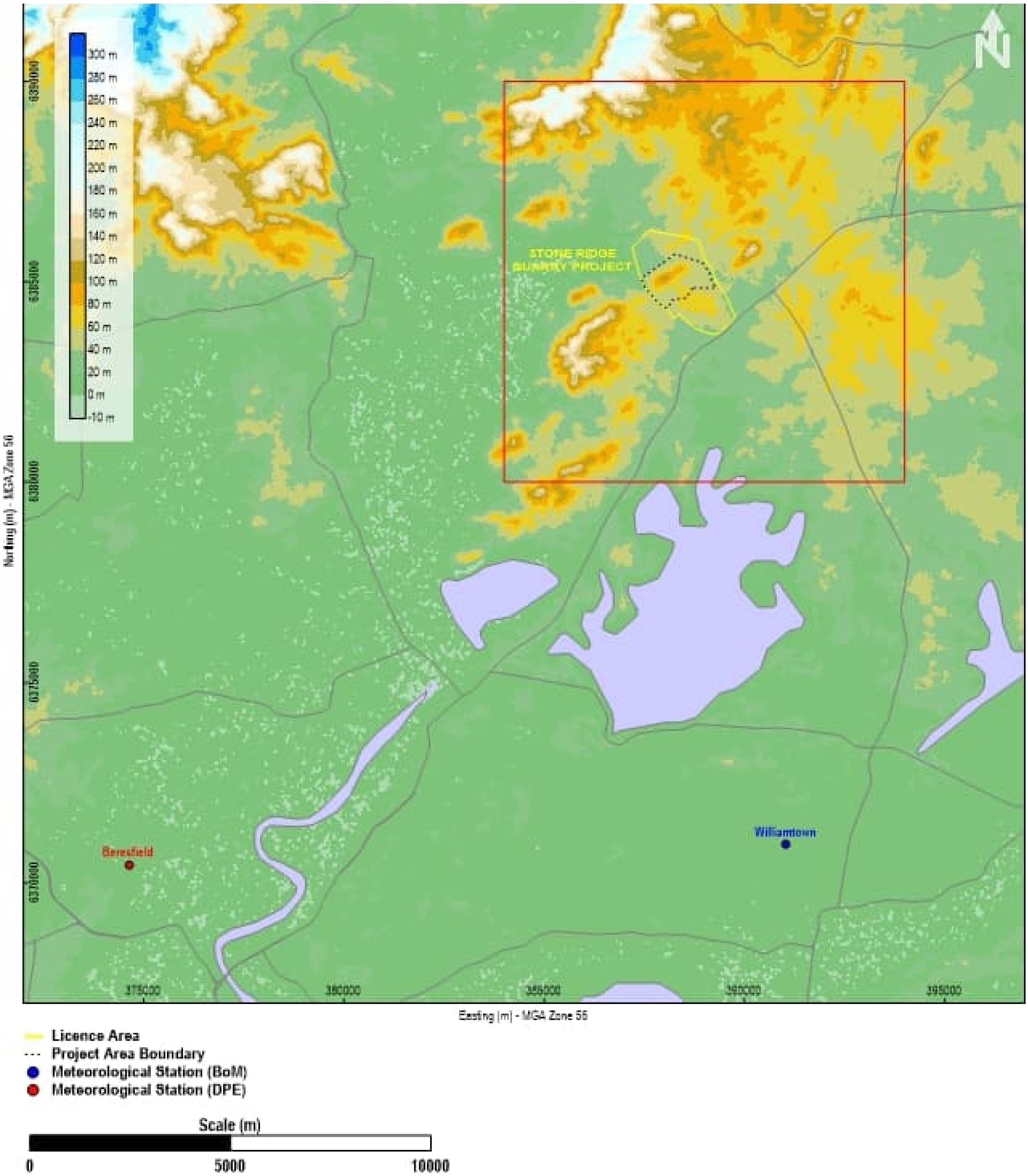


Figure 4.2. Locations of the nearest meteorological stations

The EPA prescribes the minimum requirements for meteorological data that are to be used for air quality assessments. These requirements are outlined in the Approved Methods and include minimum data capture rates, siting and operation, and data preparation. Two types of meteorological stations are described by the EPA; “Site specific” and “Site representative”. Data from site-specific meteorological stations are preferred for air quality assessments however site representative data are also acceptable provided that the analysis indicates that the data adequately describes the expected meteorological conditions at the site of interest.

Meteorological data from five recent years (2017 to 2021 inclusive) have been analysed to identify a representative year for the modelling. Figure 4.3 and Figure 4.4 show the annual wind patterns for each year from 2017 to 2021 based on hourly wind speed and wind direction records from Beresfield and Williamtown meteorological stations. The most common winds are from the northwest and south to southeast; a wind pattern that is evident in all five years of data presented and at both locations. The similarities suggest that wind patterns in this region do not change significantly from year-to-year.

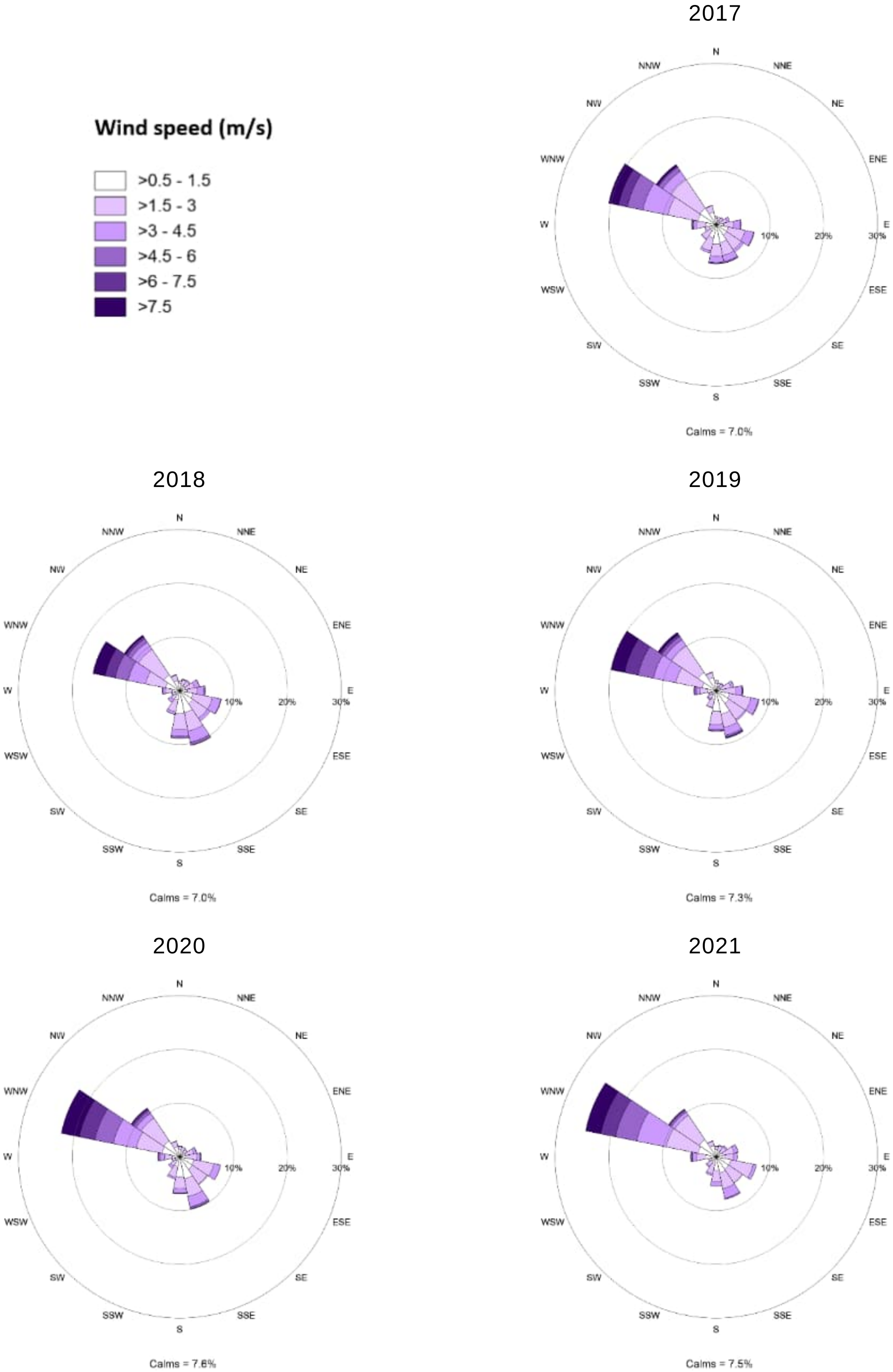


Figure 4.3. Annual wind-roses from data collected at the DPE Beresfield meteorological station from 2017 to 2021

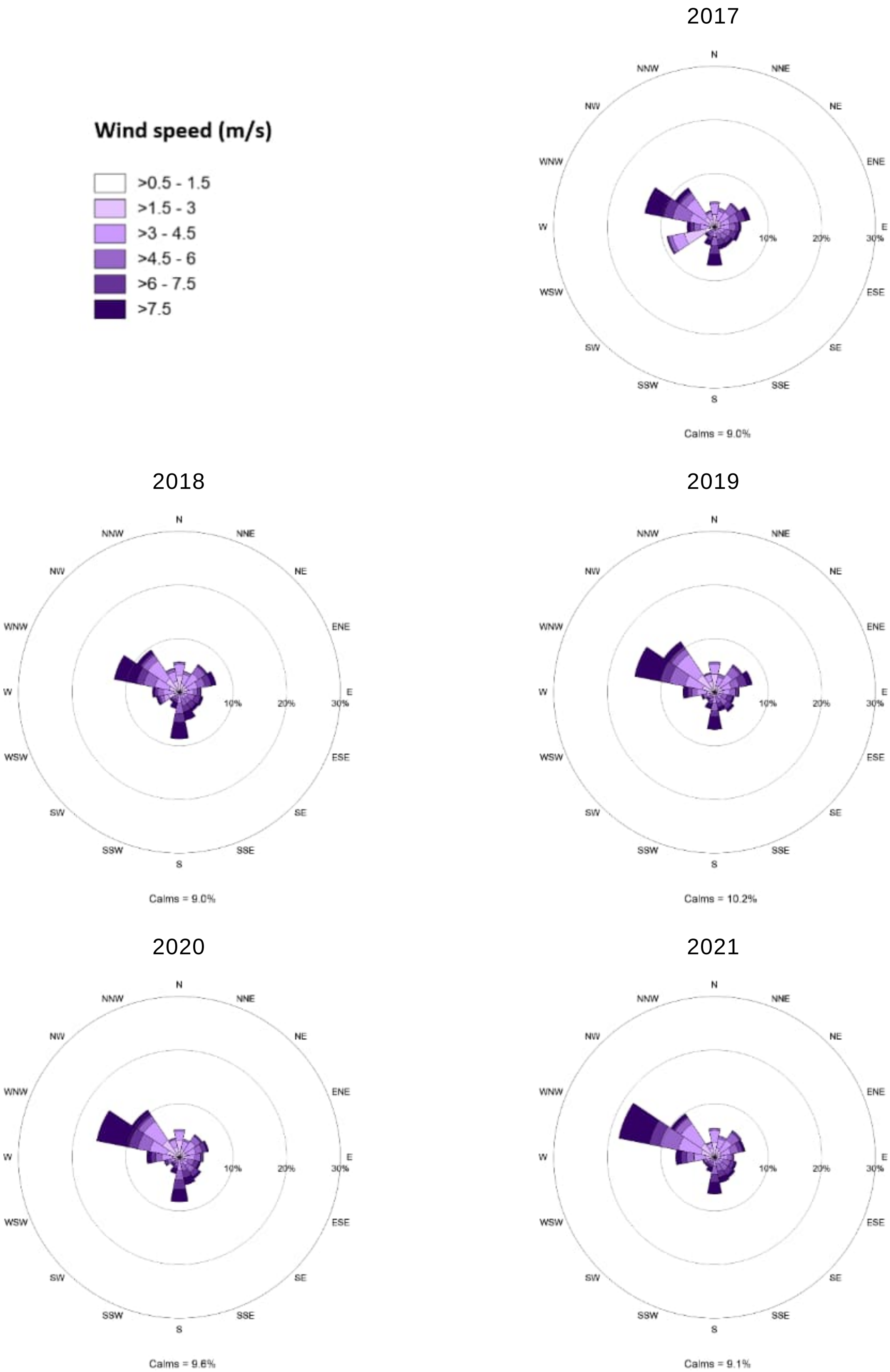


Figure 4.4. Annual wind-roses from data collected at the BoM Williamtown meteorological station from 2017 to 2021

Figure 4.5 shows the wind speed data from Beresfield and Williamtown meteorological stations. These data show that the average and maximum wind speeds exhibited similar ranges across all five years. Maximum wind speeds reached around 15-20 metres per second (m/s) as an hourly average and these winds were not isolated to any particular time of year.

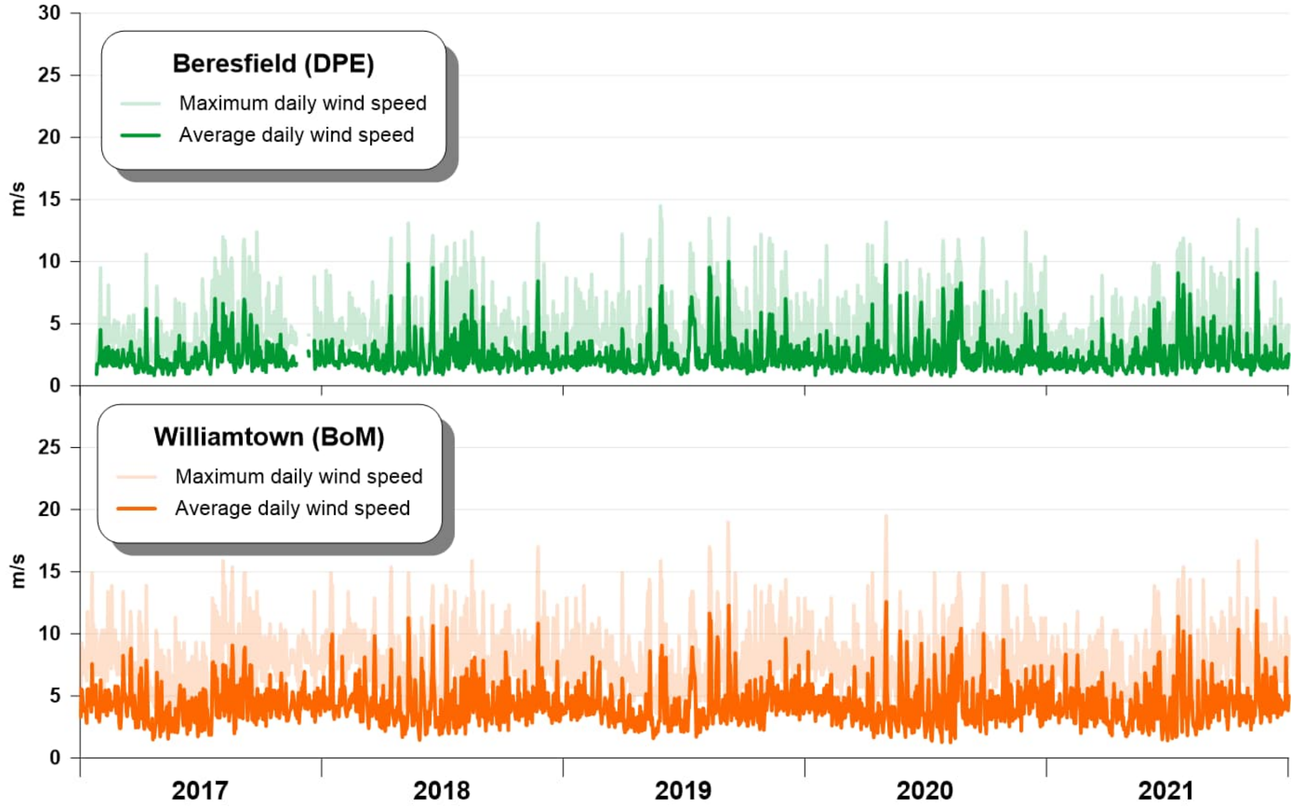


Figure 4.5. Wind speed data from Beresfield and Williamtown Meteorological Stations between 2017 and 2021

The annual data statistics for the 2017 to 2021 years have been examined to assist with identifying a representative meteorological year. Table 4.1 shows the statistics.

Table 4.1. Meteorological data statistics

Year	Beresfield	Williamtown
Percentage complete (%)		
2017	85	99
2018	100	100
2019	99	99
2020	99	100
2021	100	100
Mean wind speed (m/s)		
2017	2.3	4.2
2018	2.4	4.3
2019	2.4	4.3

Year	Beresfield	Williamtown
2020	2.4	4.3
2021	2.4	4.3
Percentage of calms (<=0.5 m/s) (%)		
2017	6.0	8.9
2018	7.0	9.0
2019	7.2	10.1
2020	7.6	9.6
2021	7.4	9.1

Over these five years the mean wind speeds were lower at Beresfield than at Williamtown. The differences reflect the more exposed nature of the BoM stations. However, the trends and statistics are similar for each year, from each location, suggest that data from any of the years reviewed may be considered as representative for the purposes of modelling.

For this air quality assessment, the 2021 calendar year has been selected as the meteorological modelling year, based on high data capture rate, meeting the EPA's requirement for a 90% complete dataset, and similar wind patterns to other years. The average wind speeds in 2021 were also closest to the long-term average from all years.

Methods used for incorporating the 2021 data into the meteorological model (CALMET) and air dispersion model (CALPUFF) are discussed in detail in Section 5. Annual and seasonal wind-roses from all 2021 data are provided in Appendix A.

4.3 Air Quality

The DPE conducts air quality monitoring as part of their Lower Hunter Air Quality Monitoring Network. This section examines the recent and historical air quality conditions measured in the Lower Hunter region and establishes the appropriate background levels to be considered for assessment of the Project.

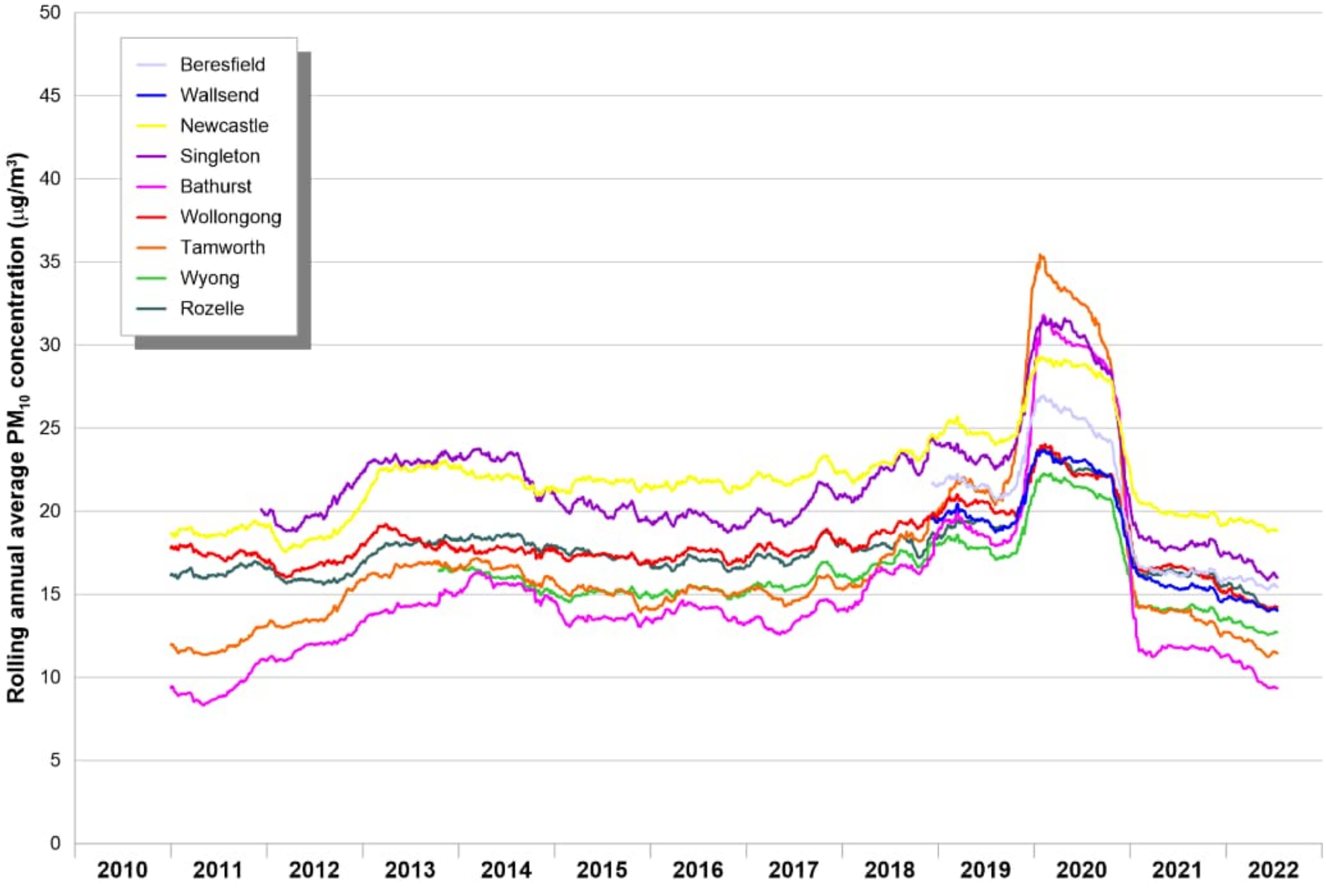
It should be noted that air quality monitoring data represents the contributions from all sources that have at some stage been upwind of each monitor. In the case of particulate matter (as PM_{10}) for example, a measurement may contain contributions from many sources such as from construction works, bushfires and 'burning off', agricultural activities, industry, vehicles, roads, wind-blown dust from nearby and remote areas, fragments of pollens, moulds, and so on.

4.3.1 Extraordinary Events

Air quality in many parts of NSW, including the Lower Hunter, was adversely influenced by drought conditions between 2017 and early 2020 with lower-than-average rainfall. A deterioration in air quality conditions in recent years was not unique to the Hunter Valley and extraordinary events, beyond normal conditions, have been identified as part of annual reviews of monitoring data.

In their "Annual Air Quality Statement 2018" the DPE concluded that particle levels increased across NSW due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH, 2019). The DPE subsequently concluded, from their "Annual Air Quality Statement 2019", that air quality in NSW was greatly affected by the continuing intense drought conditions and unprecedented extensive bushfires during 2019. In addition, the continued "intense drought has led to an increase in widespread dust events throughout the year" (DPIE, 2020).

The influence of drought conditions on air quality is evident in the DPE's monitoring data. Figure 4.6 shows the rolling annual average PM_{10} concentrations from data collected at various rural and urban air quality monitoring sites since 2011. These data clearly show an increase in PM_{10} concentrations at all rural and urban locations from 2017 onwards, reflecting the onset of drought conditions, and increased bushfire activity in 2019 and into early 2020.



Source: https://www.dpie.nsw.gov.au/air-quality/air-quality-data-services/data-download-facility

Figure 4.6. Annual average PM_{10} concentrations from various NSW air quality monitoring sites

The use of years with elevated air quality levels, largely driven by extraordinary events or extreme climatic conditions (or both) are avoided in modelling studies primarily because they do not address the definition of being representative. In addition, extraordinary events cannot be reliably simulated in air dispersion models as it is not possible to identify all possible factors that led to these events, for example, the factors that influence the time, location, and intensity of bushfires. This context has been considered in the analysis below.

4.3.2 Particulate Matter (as PM_{10})

Air quality criteria for PM_{10} are usually set to protect against adverse health impacts. The closest DPE monitoring station is located at Beresfield, approximately 15 km to the southwest of the Project. Data from Beresfield and two other stations (Newcastle and Wallsend) have been reviewed. Figure 4.7 shows the measured 24-hour average PM_{10} concentrations from each monitoring site for data collected between 2017 and 2021.

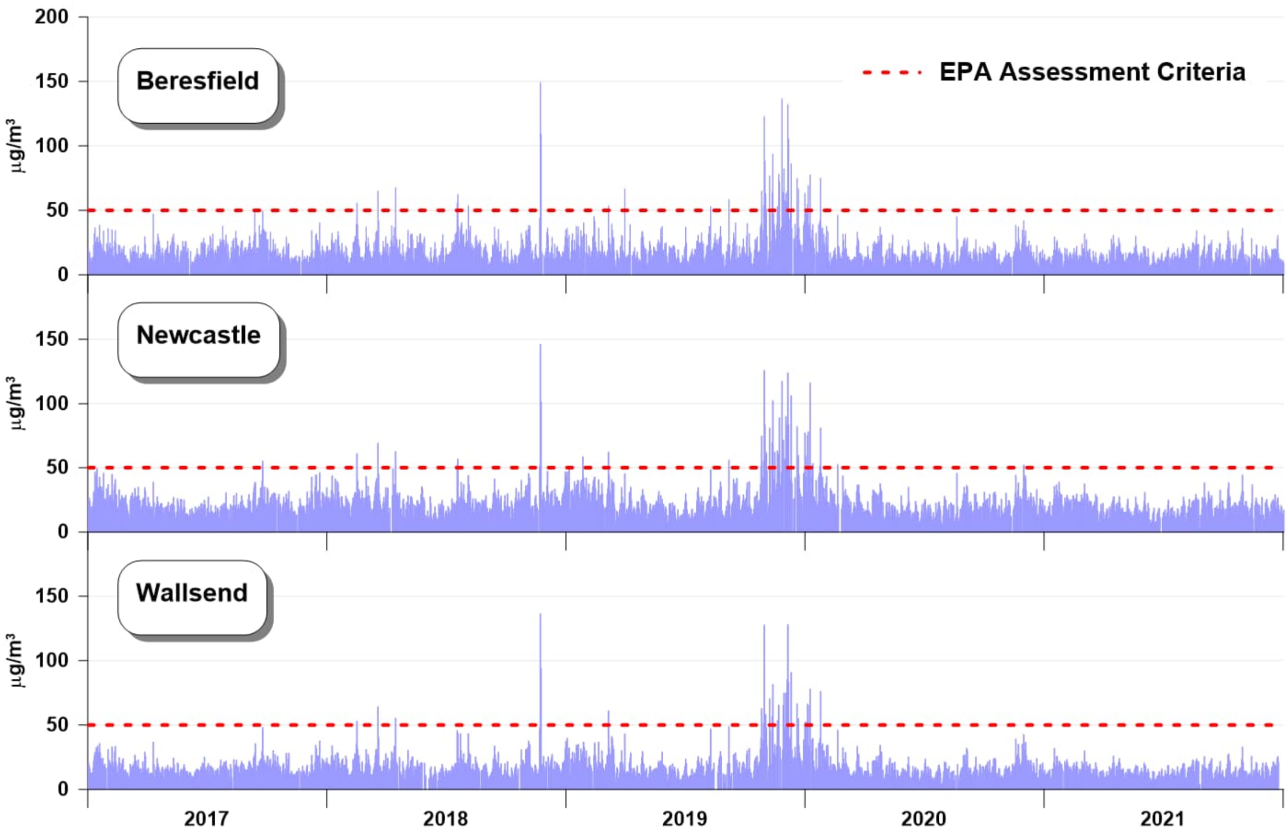


Figure 4.7. Measured 24-hour average PM_{10} concentrations

Table 4.2 provides a summary of all data. The data from Figure 4.7 and Table 4.2 show that PM_{10} concentrations increased from 2017 to 2020 coinciding with drought conditions and lower than average rainfall. These conditions led to increases in the number of days when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3 (the EPA assessment criterion) and increases in the annual average PM_{10} concentrations. As demonstrated in Figure 4.6 these increases in PM_{10} concentrations were not unique to the Lower Hunter region. In addition, there are seasonal variations with higher PM_{10} concentrations generally occurring in the warmer months. Concentrations of PM_{10} near the Project are expected be lower than those measured at Beresfield, Newcastle and Wallsend given that the Project is situated in an area with a lower population density hence fewer sources of dust.

Table 4.2. Summary of measured PM_{10} concentrations

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
Maximum 24-hour average (µg/m^3)				
2017	49	55	48	50
2018	149	146	137	50
2019	137	126	128	50
2020	78	116	78	50
2021	36	44	33	50
Number of days above 50 µg/m^3				
2017	0	1	0	-
2018	8	8	5	-
2019	30	29	21	-

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
2020	6	9	6	-
2021	0	0	0	-
Annual average (µg/m³)				
2017	20	22	17	25
2018	22	24	19	25
2019	26	28	23	25
2020	19	22	18	25
2021	16	19	15	25

4.3.3 Particulate Matter (as $PM_{2.5}$)

Air quality criteria for $PM_{2.5}$ are usually set to protect against adverse health impacts. The closest DPE monitoring station that monitors $PM_{2.5}$ is located at Beresfield, approximately 15 km to the southwest of the Project site. Data from Beresfield and two other stations (Newcastle and Wallsend) have been reviewed. Figure 4.8 shows the measured 24-hour average $PM_{2.5}$ concentrations from each monitoring site for data collected between 2017 and 2021.

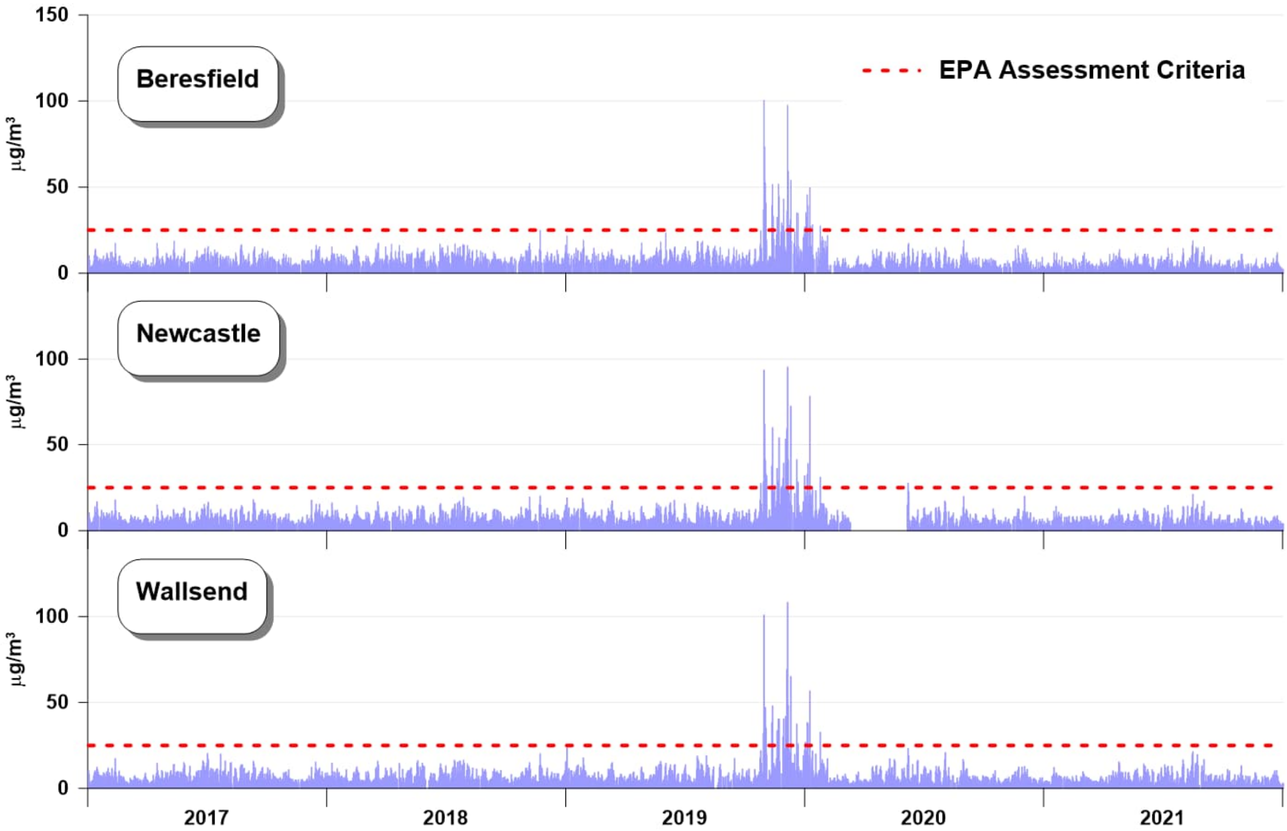


Figure 4.8. Measured 24-hour average $PM_{2.5}$ concentrations

Table 4.3 provides a summary of all data. The data from Figure 4.8 and Table 4.3 show that $PM_{2.5}$ concentrations increased from 2019 to 2020 coinciding with drought conditions and lower than average rainfall. These conditions led to increases in the number of days when the 24-hour average $PM_{2.5}$ concentration exceeded 25 µg/m^3 (the EPA assessment criterion) and increases in the annual average $PM_{2.5}$ concentrations. The increases in $PM_{2.5}$ concentrations were not unique to the Lower Hunter region.

$PM_{2.5}$ concentrations are strongly influenced by combustion-related sources such as bushfires, motor vehicles and wood smoke from domestic heating. The *Upper Hunter Fine Particle Characterisation Study* (OEH, 2013) investigated the factors which contributed to elevated $PM_{2.5}$ concentrations in the Hunter Valley region. This study identified a clear seasonal trend with higher $PM_{2.5}$ concentrations occurring in the cooler months, and predominantly due to wood smoke from domestic heating.

As for PM_{10}, concentrations of $PM_{2.5}$ near the Project are expected to be lower than those measured at Beresfield given that the Project is situated in an area with a lower population density.

Table 4.3. Summary of measured $PM_{2.5}$ concentrations

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
Maximum 24-hour average (µg/m³)				
2017	19	18	20	25
2018	25	20	20	25
2019	101	96	108	25
2020	50	79	57	25
2021	19	21	21	25
Number of days above 25 µg/m³				
2017	0	0	0	-
2018	0	0	0	-
2019	23	25	19	-
2020	8	5	5	-
2021	0	0	0	-
Annual average (µg/m³)				
2017	7.6	7.4	7.3	8
2018	8.7	7.8	7.5	8
2019	12.1	10.9	10.4	8
2020	7.7	8.1	7.3	8
2021	5.9	6.3	6.1	8

4.3.4 Particulate Matter (as TSP)

Air quality criteria for TSP are usually set to protect against nuisance amenity impacts. No known ambient air monitoring of TSP is conducted near the Project. The NSW Minerals Council estimated that, for rural environments in NSW, annually averaged PM_{10} concentrations are typically 40 per cent of the TSP concentrations (Minerals Council 2000). Table 4.4 shows the estimated TSP concentrations at the DPE monitoring locations based on this PM_{10} to TSP relationship. Concentrations are estimated to be much lower than the EPA assessment criterion.

Table 4.4. Estimated TSP concentrations

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
Annual average (µg/m³)				
2017	49	56	44	90

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
2018	54	61	49	90
2019	65	71	57	90
2020	46	56	44	90
2021	40	48	37	90

4.3.5 Deposited Dust

Air quality criteria for deposited dust are usually set to protect against nuisance amenity impacts. No known monitoring of deposited dust is conducted near the Project. Deposited dust levels have been estimated on the assumption that 90 µg/m^3 TSP can be related to 4 g/m^2/month deposited dust, based on Jacobs' experience with previous dust modelling studies. Table 4.5 shows the estimated deposited dust levels at the DPE monitoring locations based on this approach. Deposited dust levels are estimated to be much lower than the EPA assessment criterion.

Table 4.5. Estimated deposited dust levels

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
Annual average (g/m^2/month)				
2017	2.2	2.5	1.9	4
2018	2.4	2.7	2.2	4
2019	2.9	3.2	2.5	4
2020	2.1	2.5	2.0	4
2021	1.8	2.1	1.6	4

4.3.6 Nitrogen Dioxide (NO_2)

Table 4.6 provides a summary of the measured NO_2 concentrations from Beresfield, Newcastle, and Wallsend. This data show that the maximum NO_2 concentrations have not exceeded the EPA's 1-hour average assessment criterion of 164 µg/m^3. Annual averages have not exceeded the EPA's annual average assessment criterion of 31 µg/m^3.

Table 4.6. Summary of measured NO_2 concentrations

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
Maximum 1-hour average (µg/m^3)				
2017	82	76	76	164
2018	82	92	72	164
2019	115	90	86	164
2020	72	70	60	164
2021	70	72	68	164
Annual average (µg/m^3)				
2017	18	14	16	31
2018	18	14	14	31

Year	Beresfield	Newcastle	Wallsend	EPA assessment criterion
2019	16	16	14	31
2020	14	10	12	31
2021	12	10	10	31

Nitrogen dioxide is a component of NO_x. Emissions of NO_x from combustion related sources will include both nitric oxide (NO) and NO_2. In general, at the point of emission, NO will comprise the greatest proportion of the total NO_x emission. Typically, this is 90% by volume of the NO_x. The remaining 10% will comprise mostly NO_2. Ultimately over time however, the majority of NO emitted into the atmosphere is oxidised to NO_2. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions including temperature, humidity, and the presence of other substances in the atmosphere such as ozone. It can vary from a few minutes to many hours. The rate of conversion is important because from the point of emission to the point of maximum ground-level concentration there will be an interval of time during which some oxidation will take place. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low, then the level of oxidation is unimportant. However, if the oxidation is rapid and the dispersion is slow then high concentrations of NO_2 can occur.

The NO_x monitoring data in the Lower Hunter show that percentage of NO_2 in the NO_x is inversely proportional to the total NO_x concentration, and when NO_x concentrations are high, the percentage of NO_2 in the NO_x is typically of the order of 20%. This is demonstrated by Figure 4.9 which shows that, for high NO_x concentrations, the NO_2 to NO_x ratio reduces to less than 20%.

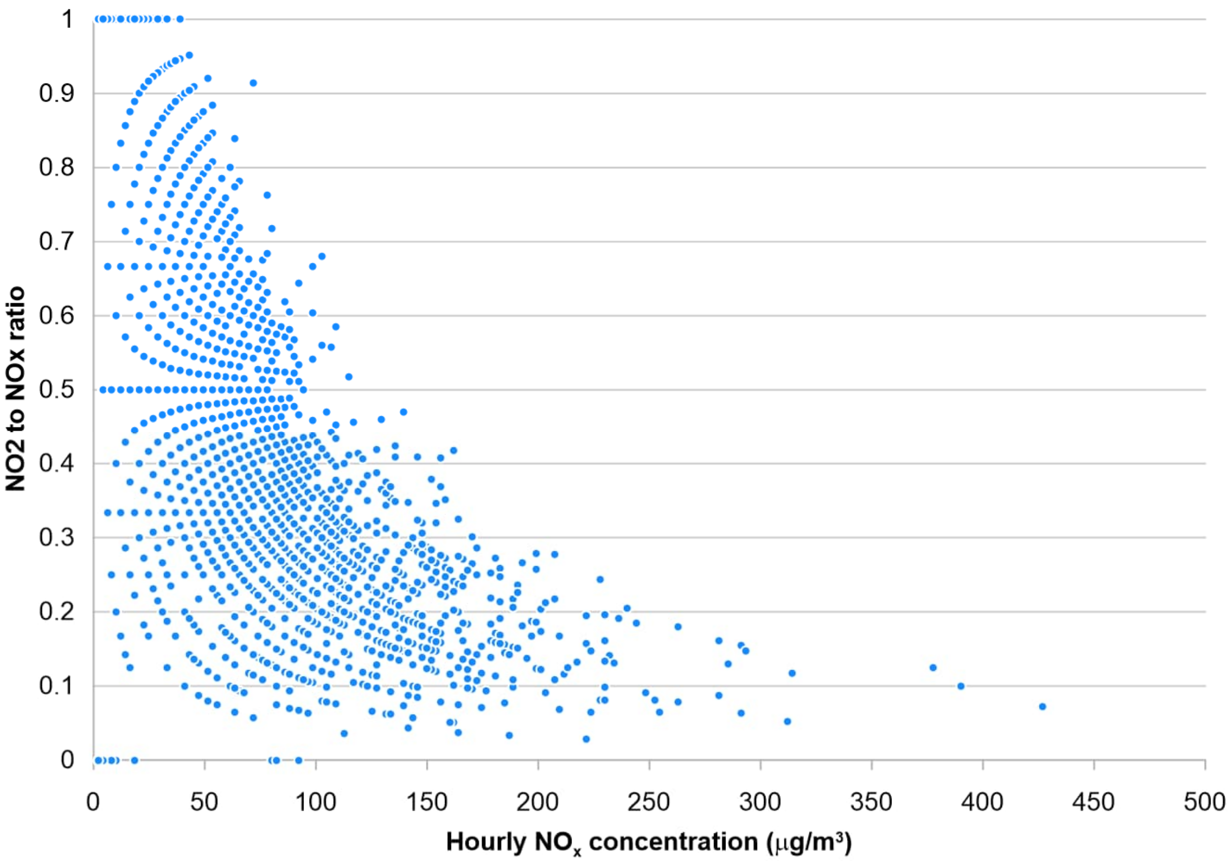


Figure 4.9. Measured NO_2 to NO_x ratios from hourly average data collected at Beresfield in 2021

4.4 Greenhouse Gas

The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Measurement Determination) provides methods, criteria, and measurement standards for calculating and reporting greenhouse gas emissions and energy data under the NGER Act. It covers scope 1 and scope 2 emissions and energy production and consumption. The Measurement Determination is used for historical reporting of activities. Noting that the Project is a new development, there are no historical greenhouse gas emissions.

4.5 Summary of Existing Environment

The review of the existing environment led to the following observations:

- Meteorological conditions do not vary significantly from year to year and conditions in 2021 can be considered as representative of the long-term meteorological conditions near the Project.
- Air quality conditions are strongly correlated to the climatic conditions. For example, there was a deterioration in air quality conditions between 2017 and early 2020 that were heavily influenced by drought, dust storms and bushfires. These conditions were not unique to the Lower Hunter.
- Concentrations of key air quality indicators would be expected to be lower near the Project than in areas of higher population densities.

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to Project contributions for the assessment of potential cumulative impacts. Table 4.7 shows the assumed background levels that apply at sensitive receptors. These levels have been added to Project contributions to determine the potential cumulative impacts, as per the Approved Methods.

Table 4.7. Assumed background levels that apply at sensitive receptors

Air quality indicator	Averaging time(s)	Assumed background level that applies at sensitive receptors	Notes
Particulate matter (PM_{10})	24-hour	Variable by day (**Figure 4.7**)	Measured daily PM_{10} concentrations from Beresfield in the representative year, (2021) used as background
Particulate matter (PM_{10})	Annual	16 $\mu g/m^3$	Measured annual PM_{10} concentrations from Beresfield in the representative year, (2021) used as background
Particulate matter ($PM_{2.5}$)	24-hour	Variable by day (**Figure 4.8**)	Measured daily $PM_{2.5}$ concentrations from Beresfield in the representative year, (2021) used as background
Particulate matter ($PM_{2.5}$)	Annual	5.9 $\mu g/m^3$	Measured annual $PM_{2.5}$ concentrations from Beresfield in the representative year, (2021) used as background
Particulate matter (TSP)	Annual	40 $\mu g/m^3$	Calculated from measured annual average concentration for Beresfield in the representative year, (2021) used as background
Deposited dust	Annual	1.8 g/m^2/month	Estimated annual average deposited dust level
Nitrogen dioxide (NO_2)	1-hour	70 $\mu g/m^3$	Maximum measured NO_2 concentrations from Beresfield in the representative year, (2021) used as background
Nitrogen dioxide (NO_2)	Annual	12 $\mu g/m^3$	Measured NO_2 concentrations from Beresfield in the representative year, (2021) used as background

5. Assessment Methodology

5.1 Construction Dust

Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. In practice, it is not possible to realistically quantify impacts using air dispersion modelling as the activities take place over a relatively short period of time and in different locations and with differing intensities. To do so would also require knowledge of weather conditions for the period in which the work will be taking place in each location on the site. The potential significance and impacts of construction dust have therefore been determined from a qualitative review, taking into consideration the intensity, scale, location and duration of the proposed works and their relative scale in relation to the operational impacts modelled (refer to Section 5.2). Section 6.1 provides the assessment of construction dust.

5.2 Operational Dust

Operational dust has been quantified by air dispersion modelling. The choice of model has considered the expected transport distances for the emissions, as well as the potential for temporally and spatially varying flow fields due to influences of the locally complex terrain, non-uniform land use, and potential for stagnation conditions characterised by calm or very low wind speeds with variable wind directions. The CALPUFF model has been selected. This model is specifically listed in the Approved Methods and has been used to predict ground-level particulate matter concentrations and dust deposition levels due to the Project and other sources. Concentrations and deposition levels have been simulated for every hour of the representative year and results at local communities and sensitive receptors have then been compared to the relevant air quality assessment criteria.

Figure 5.1 shows and overview of the model inputs. Appendix B provides details of all model settings. A summary of the four key inputs as displayed in Figure 5.1 is provided in the following subsections.

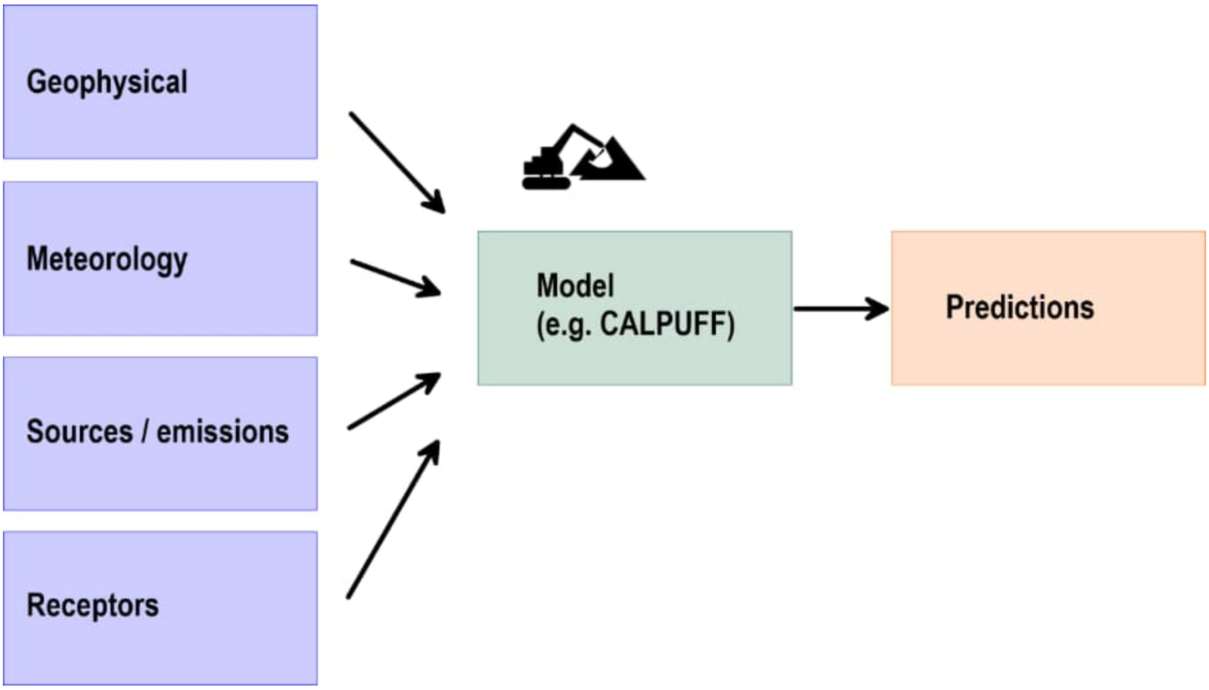


Figure 5.1. Overview of model inputs

5.2.1 Geophysical

The geophysical inputs of the model are the terrain and land-use information applied. Elevations across the modelling domain were determined using 1 second (30 metre) digital elevation data from the Shuttle Research Topography Mission (SRTM). The terrain applied in the model is displayed in Figure 4.1. Land uses were digitised from aerial imagery and classified in-line with the land use types specified in 'CALPUFF Modeling System Version 6 User Instructions', (TRC, 2011). The inputs applied are displayed in Appendix B.

5.2.2 Meteorology

CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radiosondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

Meteorological data collected in 2021 from the BoM Williamtown Airport and DPE Beresfield surface stations and upper air data generated by TAPM at these locations were used to initialise the CALMET model. The meteorological modelling followed the guidance of TRC (2011) and adopted the "observations" mode. Key setup details for TAPM and CALMET are listed in Appendix B, with predicted annual and seasonal wind roses displayed in Appendix A.

5.2.3 Emissions

Dust (particulate matter) is the most significant emission to air during the operational phase of the Project and estimates of these emissions are required to run the dispersion model. Total dust emissions have been estimated for selected operational scenarios using the material handling schedule, equipment listing, and mine plans combined with emission factors from:

- Emission Estimation Technique Manual for Mining (NPI, 2012); and
- AP 42 (US EPA 1985 and updates). Key chapters included 11.19.2 (Mineral Products Industry, Crushed Stone Processing and Pulverized Mineral Processing) and 13.2.1 (Miscellaneous Sources, Paved Roads).

The Project stage plans have been used to identify a range of future operational years to be assessed. There are no specific guidelines or procedures which define an adequate level of information to demonstrate that selected scenarios are representative of worst-case impacts. The worst-case for one location may be different to the worst-case for another location so it is important to consider the scenarios of quarrying activities at various locations and intensities as well as potential for cumulative effects with other existing or approved operations.

Three future operational scenarios have been selected being: Stage 1, Stage 5, and Stage 9. These years address the maximum material handling quantities, maximum haul distances, varying proximities to local communities, and combined interactions with other existing or approved mining operations. The locations where different sources and activities were modelled for each of these Stages is shown in further detail in Appendix C.

Table 5.1 summarises the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions, respectively, for assessment Stages 1, 5 and 9 of the Project. Full details on the emission calculations, including assumptions, emission controls and allocation of emissions to modelled locations are provided in Appendix C.

Table 5.1. Estimated annual emissions, operations (kg/year)

Activity	Stage 1			Stage 5			Stage 9		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Northern Quarry Pit									
Dozer - Construction of Northern Haul Road	269	58	28	0	0	0	0	0	0
Grader - Construction of Northern Haul Road	38	17	2	0	0	0	0	0	0

Activity	Stage 1			Stage 5			Stage 9		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Drilling rock - Northern Quarry Pit	35	18	2	61	32	3	0	0	0
Blasting rock - Northern Quarry Pit	8	4	0	14	7	1	0	0	0
Loading to Crusher (Primary) - Northern Quarry Pit	13	5	1	Included below noting that processing of materials from northern quarry pit takes place at central processing area during stage 5.			0	0	0
Crushing (Primary) - Northern Quarry Pit	928	371	46				0	0	0
Loading to Screening - Northern Quarry Pit	13	5	1				0	0	0
Screening - Northern Quarry Pit	1,161	399	58				0	0	0
Loading Product to Trucks - Northern Quarry Pit	12	4	1				0	0	0
Hauling Product to Stockpiling Area from Northern Quarry Pit (Unsealed)	4,655	1324	66				0	0	0
Unloading Product from Northern Quarry Pit trucks at Stockpiling Area	2	1	0				0	0	0
Placement of Product into Stockpiles	278	131	14				0	0	0
Loading rock to Trucks	0	0	0	670	317	34	0	0	0
Hauling rock to Central Processing Plant	0	0	0	17,289	4,916	246	0	0	0
Unloading from Trucks to Central Processing Plant	0	0	0	28	10	1	0	0	0
Overburden from Northern Quarry Pit - Load to Trucks	5	2	0	0	0	0	0	0	0
Hauling Overburden from Northern Quarry Pit to Stockpiling Area	254	72	4	0	0	0	0	0	0
Unloading Overburden from Northern Quarry Pit at Stockpiling Area	55	20	3	0	0	0	0	0	0
Main Quarry Pit									
Drilling rock - Main Quarry Pit	592	311	30	566	297	28	985	518	49

Activity	Stage 1			Stage 5			Stage 9		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Blasting rock - Main Quarry Pit	138	71	7	132	68	7	146	76	7
Loading rock to Trucks	5,228	2,473	261	4,866	2,302	243	5,536	2,619	277
Hauling rock to Central Processing Plant	40,471	11,508	575	62,785	17,854	893	92,859	26,406	1,320
Unloading from Trucks to Central Processing Plant	222	79	11	206	73	10	235	83	12
Crushing (primary) - Central Processing Area	4,721	1,889	236	5,000	2,000	250	5,000	2,000	250
Conveyors to Secondary Crushing	1,180	433	59	1,250	458	63	1,250	458	63
Crushing (Secondary) - Central Processing Area	14,164	5,666	708	15,000	6,000	750	15,000	6,000	750
Conveyors to Tertiary Crushing	1,180	433	59	1,250	458	63	1,250	458	63
Crushing (Tertiary) - Central Processing Area	1,275	567	64	1,350	600	68	1,350	600	68
Conveyors to Screening	1,180	433	59	1,250	458	63	1,250	458	63
Screening - Central Processing Area	5,902	2,030	295	6,250	2,150	313	6,250	2,150	313
Unloading Product to Trucks	199	71	10	211	75	11	211	75	11
Hauling Product from Main Quarry Pit (Central Processing Area) to Stockpiling Area	24,282	6,905	345	25,715	7,312	366	25,715	7,312	366
Unloading Product from Main Quarry Pit (Central Processing Area) Trucks at Stockpiling Area	32	11	2	34	12	2	34	12	2
Placement of Product into Stockpiles	4,705	2,225	235	4,983	2,357	249	4,983	2,357	249
Overburden from Main Quarry Pit - Load to Trucks	74	35	4	34	16	2	17	8	1
Hauling Overburden from Main Quarry Pit to Stockpiling Area	2,189	622	31	1,264	359	18	629	179	9
Unloading Overburden from Main Quarry Pit at Stockpiling Area	773	275	39	357	127	18	178	63	9

Activity	Stage 1			Stage 5			Stage 9		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Export of Product									
Loading product to trucks	211	75	11	211	75	11	211	75	11
Hauling product off-site (paved)	29,949	5,749	1,197	29,949	5,749	1197	29,949	5,749	1,197
Wind erosion									
Wind erosion from Product stockpiles - >5mm Aggregates	0	0	0	0	0	0	0	0	0
Wind erosion from Product stockpiles - <5mm Crusher dust	342	171	17	342	171	17	342	171	17
Wind erosion from Product stockpiles - Blended Road Base	2,380	1,190	119	2,380	1,190	119	2,380	1,190	119
Wind erosion from exposed areas - Northern Quarry Pit	1,226	613	61	5,782	2,891	289	959	479	48
Wind erosion from exposed areas - Main Quarry Pit	7,884	3,942	394	30,660	15,330	1,533	58,867	29,434	2943
Wind erosion from exposed areas - Stockpile Area (exc Product Stockpiles)	12,509	6,255	625	12,509	6,255	625	12,509	6,255	625
Wind erosion from exposed areas - Central processing area	6,794	3,397	340	6,794	3,397	340	4,783	2,391	239
Overburden external to pits									
Overburden external to pits - Loading to Trucks	34	16	2	0	0	0	0	0	0
Overburden external to pits - Hauling to Stockpiling Area	746	212	11	0	0	0	0	0	0
Overburden external to pits - Unloading from Trucks	351	125	18	0	0	0	0	0	0
Total	**178,662**	**60,213**	**6,051**	**239,194**	**83,318**	**7,829**	**272,879**	**97,576**	**9,079**

Operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. Emissions from the dust generating activities and sources were assigned to one or more of source location (refer to Appendix B for details of the allocations).

Dust emissions for all modelled quarry-related sources have been considered to fit in one of three categories, as follows:

- Wind insensitive sources, where emissions are relatively insensitive to wind speed (for example, dozers).

- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3, a generic relationship published by the US EPA (1987). This relationship has been applied to sources such as loading and unloading of waste to/from trucks and results in increased emissions with increased wind speed.
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3, a generic relationship published by Skidmore (1998). This relationship has been applied to sources including wind erosion from stockpiles, overburden emplacement areas or active pits, and results in increased emissions with increased wind speed.

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation.

All activities were modelled as occurring between 7am and 6pm (i.e., operational hours) except product truck loading and haulage (6am to 10pm) and wind erosion (all hours).

Pit retention (that is, retention of dust particles within the open pits) has been included in the model simulations. The pit retention calculation determines the fraction of dust emitted in the pit that may escape the pit. The "escaped fraction" is a function of the gravitational settling velocity of the particles and the wind speed and is shown by the following relationship (US EPA, 1995).

To model the effect of pit retention, the emissions from mining sources within the open pits have been reduced, as per the calculation shown in Equation 1. This approach means that much of the coarser dust would remain trapped in the pits. Typically, five per cent of the PM_{10} emissions are trapped in the pit using this calculation.

Equation 1:

$$\varepsilon = \frac{1}{\left(1 + \frac{v_g}{(\alpha U_r)}\right)}$$

where:
ε = escaped fraction for the particle size category
V_g = gravitational settling velocity (m/s)
U_r = approach wind speed at 10 m (m/s)
α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit (0.029)

Finally, the model results at identified sensitive receptors were then compared with the EPA air quality assessment criteria, previously discussed in Section 3.1. Contour plots have also been created to show the spatial distribution of model results. Section 6.2 provides the assessment of operational dust.

5.2.4 Receptors

Predictions were made at approximately 1,000 discrete receptors (including those shown in Figure 1.1) to allow for contouring of results. The locations of the modelled discrete receptors are shown in Appendix B. This approach allowed the creation of a higher density of receptors near the proposal site where resulting concentrations and levels are expected to be higher.

5.3 Operational Post-Blast Fume

Blasting activities have the potential to result in fume and particulate matter emissions. Particulate matter emissions from blasting are produced from the modelling discussed in Section 0. Post-blast fume has also been quantified by modelling.

Post-blast fume can be produced in non-ideal explosive conditions for ammonium nitrate/fuel oil (ANFO) and is visible as an orange / brown plume. These events are referred to as significant blast fume events and are rated on a scale of 1-3 with 3 being the highest. This is typically associated with blasting in circumstances where charge holes can have higher levels of moisture due to groundwater conditions and longer sit times prior to blast; these conditions are considered less likely to occur for the Stone Ridge Quarry due to the relatively low permeability of the target resource and the absence of defined aquifers in the target rock strata. The fumes comprise of NO_x including NO and NO_2 and from the NO_x monitoring in the Lower Hunter (Section 4.3.6) the percentage of NO_2 in the NO_x is inversely proportional to the total NO_x concentration. When NO_x concentrations are high, the percentage of NO_2 in the NO_x is typically of the order of 20%.

The methodology for the operational post-blast fume modelling is outlined below:

- Blast is modelled as a single volume source in the centre of the current active pit. It is acknowledged that moving the blast location, for example further to the west, would lead to a corresponding shift in the contours, potentially changing the predicted extent of impacts. However, it will be seen in Section 6.3 that impacts are predicted to be well within criteria so an alternative assumption on the blast location would not change outcomes.
- Release height of 10 m, effective plume height of 20 m, initial horizontal spread (sigma y) of 25 m and initial vertical spread (sigma z) of 10 m. These are conservative estimates based on the data presented by Attalla et al. (2008). No plume rise due to buoyancy was modelled, which is again a conservative assumption.
- Emissions assumed to occur every hour between 10 am and 3 pm.
- Blasting could be on any day of the week (a conservative assumption as the Project does not propose any activities on Sundays).
- NO_x emissions based on data presented in the Queensland Guidance Note for the management of oxides in open cut blasting (DEEDI, 2011). It was conservatively assumed that the initial NO_2 concentration in the plume would be 17 ppm (34.9 mg/m^3) based on the Rating 3 Fume Category in the Queensland Guidance Note.
- The initial NO_2 concentration in the plume was converted to a total NO_x emission rate based on a detailed measurement program of NOx in blast plumes in the Hunter Valley made by Attalla et al. (2008) which found that the NO:NO_2 ratio was typically 27:1, giving a NO_x:NO_2 ratio of approximately 18.6 g NO_x/g NO_2.
- Calculated emission of 43 g/s of NO_x per blast and an emission release time of 5 minutes.
- 20% of the NO_x is NO_2 at the points of maximum 1-hour average concentrations and at sensitive receptors.

Model results for post-blast fume have been compared to the applicable EPA air quality assessment criterion for NO_2; that is 164 µg/m^3 as a 1-hour average and taking background levels into account. Section 6.3 provides the assessment of operational post blast fume. Again, it is noted that the methodology applied is conservative as Rating 3 events are not expected at the quarry based on the proposed blast practices and hydrogeological conditions.

5.4 Operational Diesel Exhaust

Emissions from diesel exhausts associated with off-road vehicles and equipment at quarries are often deemed a lower air quality impact risk than dust emissions from the material handling activities. This is because of the relatively few emission sources involved, for example when compared to a busy motorway, and the large distances between the sources and sensitive receptors. Nevertheless, a review of the potential impacts from diesel exhausts has been carried out, including modelling to quantify the potential impacts.

The most significant emissions from diesel exhausts are products of combustion including CO, NO_x, PM_{10} and $PM_{2.5}$. It is the NO_x, or more specifically NO_2, and PM_{10} (including $PM_{2.5}$) which have been assessed. DPE monitoring data has shown that CO concentrations have not exceeded relevant air quality criteria at rural or urban monitoring stations in NSW, indicating that this indicator represents a much lower air quality risk and has therefore not been assessed.

The modelling for operational dust (Section 5.2.3) has considered emission factors that represent the contribution from both wheel-generated particulate sources and the exhaust particulate sources. These emission factors, including with control factors, are based on measured emissions which included diesel particulates in the form of both PM_{10} and $PM_{2.5}$ (i.e., include those emissions listed below in Table 5.2). The emission factors are also likely to include more diesel exhaust particulate than would be expected from a modern truck as the factors were developed based on emissions from trucks measured in the 1980s (that is, older trucks). Todoroski Air Sciences has also reported (TAS, 2016) that several studies, reported to the EPA, confirmed that a control factor of 85% can be maintained, representing all components of the truck haulage emission. This information highlights that the potential impacts of diesel exhaust emissions (as PM_{10} and $PM_{2.5}$) are represented in the model results for operational dust (Section 6.2).

Table 5.2 provides the explicit estimates of PM_{10} and $PM_{2.5}$ emissions due only to diesel plant and equipment exhausts. Emission factors from 'Emission estimation technique manual for Combustion Engines Version 3.0', (Department of the Environment, Water, Heritage and the Arts [DEWHA], 2008) were used for the calculations and it has been conservatively assumed that there will be no reduction to emissions in the future. These factors relate to diesel exhaust and evaporative emissions. By year 3 (i.e., 2025) it is planned that the energy needs at the site would be provided by an electricity grid connection rather than the two on-site diesel generators. This change is reflected in the quantities of on-site fuel usage and emissions below in Table 5.2 and Table 5.3.

Table 5.2. Estimated PM_{10} and $PM_{2.5}$ emissions from diesel engines

Parameter	Stage 1	Stage 5	Stage 9	Calculation reference
Estimated fuel usage (Bobcat) (kL)	10.4	10.4	10.4	Source: ARDG
Estimated fuel usage (Excavators) (kL)	174.7	174.7	174.7	Source: ARDG
Estimated fuel usage (Wheeled loader) (kL)	104.0	104.0	104.0	Source: ARDG
Estimated fuel usage (Dump Trucks) (kL)	255.8	255.8	255.8	Source: ARDG
Estimated fuel usage (Dozer) (kL)	41.6	41.6	41.6	Source: ARDG
Estimated fuel usage (Grader) (kL)	3.1	3.1	3.1	Source: ARDG
Estimated fuel usage (Service vehicle, water cart) (kL)	91.5	91.5	91.5	Source: ARDG
Estimated fuel usage (Light vehicles) (kL)	15.4	15.4	15.4	Source: ARDG
Estimated fuel usage (Generators) (kL)	461.0	0	0	Source: ARDG
Estimated fuel usage (total) (kL)	**1158**	**697**	**697**	**Source: ARDG**
PM_{10} calculations				
Diesel exhaust emission factor, Bobcat (kg/kL)	3.1	3.1	3.1	Table 26 (DEWHA, 2008)
Diesel exhaust emission factor, Excavator (kg/kL)	2.3	2.3	2.3	Average value, Heidari & Marr, 2015
Diesel exhaust emission factor, Wheeled loader (kg/kL)	3.6	3.6	3.6	Table 31, (DEWHA, 2008)
Diesel exhaust emission factor, Dump trucks (kg/kL)	2.1	2.1	2.1	Table 33, (DEWHA, 2008)

Parameter	Stage 1	Stage 5	Stage 9	Calculation reference
Diesel exhaust emission factor, Dozer (kg/kL)	1.8	1.8	1.8	Table 28, (DEWHA, 2008)
Diesel exhaust emission factor, Grader (kg/kL)	2.7	2.7	2.7	Table 30, (DEWHA, 2008)
Diesel exhaust emission factor, Service vehicle, Water cart (kg/kL)	2.3	2.3	2.3	Table 20, (DEWHA, 2008)
Diesel exhaust emission factor, Light vehicles (kg/kL)	2.4	2.4	2.4	Table 15, (DEWHA, 2008)
Diesel exhaust emission factor, Generators (kg/kL)	5.1	5.1	5.1	Table 50, (DEWHA, 2008)
Diesel exhaust emissions - all equipment (kg/y)	**4,040**	**1,689**	**1,689**	**Calculated**
$PM_{2.5}$ calculations				
Diesel exhaust emission factor, Bobcat (kg/kL)	2.8	2.8	2.8	Table 26 (DEWHA, 2008)
Diesel exhaust emission factor, Excavator (kg/kL)	2.2	2.2	2.2	Average value, Heidari & Marr, 2015
Diesel exhaust emission factor, Wheeled loader (kg/kL)	3.3	3.3	3.3	Table 31, (DEWHA, 2008)
Diesel exhaust emission factor, Dump trucks (kg/kL)	2.0	2.0	2.0	Table 33, (DEWHA, 2008)
Diesel exhaust emission factor, Dozer (kg/kL)	1.6	1.6	1.6	Table 28, (DEWHA, 2008)
Diesel exhaust emission factor, Grader (kg/kL)	2.5	2.5	2.5	Table 30, (DEWHA, 2008)
Diesel exhaust emission factor, Service vehicle, Water cart (kg/kL)	2.2	2.2	2.2	Table 20, (DEWHA, 2008)
Diesel exhaust emission factor, Light vehicles (kg/kL)	2.3	2.3	2.3	Table 15, (DEWHA, 2008)

Parameter	Stage 1	Stage 5	Stage 9	Calculation reference
Diesel exhaust emission factor, Generators (kg/kL)	5.0	5.0	5.0	Table 50, (DEWHA, 2008)
Diesel exhaust emissions - all equipment (kg/y)	**3,878**	**1,573**	**1,573**	**Calculated**

Emissions of NO_x from diesel exhausts have been estimated using fuel consumption data, provided by ARDG, and emission factors from DEWHA, 2008. Table 5.3 shows the calculations. Again, it has been assumed that there will be no reduction to emissions in the future, a conservative approach.

Table 5.3. Estimated NO_x emissions from diesel engines

Parameter	Stage 1	Stage 5	Stage 9	Calculation reference
Estimated fuel usage (Bobcat) (kL)	10.4	10.4	10.4	Source: ARDG
Estimated fuel usage (Excavators) (kL)	174.7	174.7	174.7	Source: ARDG
Estimated fuel usage (Wheeled loader) (kL)	104.0	104.0	104.0	Source: ARDG
Estimated fuel usage (Dump Trucks) (kL)	255.8	255.8	255.8	Source: ARDG
Estimated fuel usage (Dozer) (kL)	41.6	41.6	41.6	Source: ARDG
Estimated fuel usage (Grader) (kL)	3.1	3.1	3.1	Source: ARDG
Estimated fuel usage (Service vehicle, water cart) (kL)	91.5	91.5	91.5	Source: ARDG
Estimated fuel usage (Light vehicles) (kL)	15.4	15.4	15.4	Source: ARDG
Estimated fuel usage (Generators) (kL)	461.0	0	0	Source: ARDG
Estimated fuel usage (total) (kL)	**1157**	**697**	**697**	**Source: ARDG**
NO_x calculations				
Diesel exhaust emission factor, Bobcat (kg/kL)	33.0	33.0	33.0	Table 26 (DEWHA, 2008)
Diesel exhaust emission factor, Excavator (kg/kL)	17.3	17.3	17.3	Average value, Heidari & Marr, 2015
Diesel exhaust emission factor, Wheeled loader (kg/kL)	39.6	39.6	39.6	Table 31, (DEWHA, 2008)
Diesel exhaust emission factor, Dump trucks (kg/kL)	35.2	35.2	35.2	Table 33, (DEWHA, 2008)

Parameter	Stage 1	Stage 5	Stage 9	Calculation reference
Diesel exhaust emission factor, Dozer (kg/kL)	35.2	35.2	35.2	Table 28, (DEWHA, 2008)
Diesel exhaust emission factor, Grader (kg/kL)	30.7	30.7	30.7	Table 30, (DEWHA, 2008)
Diesel exhaust emission factor, Service vehicle, Water cart (kg/kL)	17.0	17.0	17.0	Table 20, (DEWHA, 2008)
Diesel exhaust emission factor, Light vehicles (kg/kL)	8.9	8.9	8.9	Table 15, (DEWHA, 2008)
Diesel exhaust emission factor, Generators (kg/kL)	72.0	72.0	72.0	Table 50, (DEWHA, 2008)
Diesel exhaust emissions - all equipment (kg/y)	**52,935**	**19,743**	**19,743**	**Calculated**

The NO_x emission estimates for Stage 1 from Table 5.3 have been explicitly modelled to provide an indication of the off-site NO_2 concentrations due to diesel exhaust emissions from site-operated plant and equipment. Section 6.4 provides the assessment of operational diesel exhaust.

5.5 Road Transport

As well as emissions generated from processing and operational activities, the SEARs also require an assessment of emissions associated with the transportation of quarry products. Emissions from transportation along internal roads have already considered as outlined above. Roads and Maritime Services air quality screening tool known as TRAQ ("Tool for Roadside Air Quality") was used to assess the effects of diesel emissions from trucks transporting quarry products along public roads. TRAQ adopts emission factors from the EPA's Motor Vehicle Emissions Inventory (MVEI) and uses the CALINE air dispersion model to predict the maximum near roadside air pollutant concentrations based on traffic volume, traffic mix, traffic speed, road type, road grade, and other factors. The model considers conservative, worst-case conditions to determine the potential for impacts. The key conservative assumptions include worst-case wind angles, stable atmospheric conditions, and low winds that allow for high air pollutant concentrations to occur. A high-level summary of the assessment process is shown in Figure 5.2.

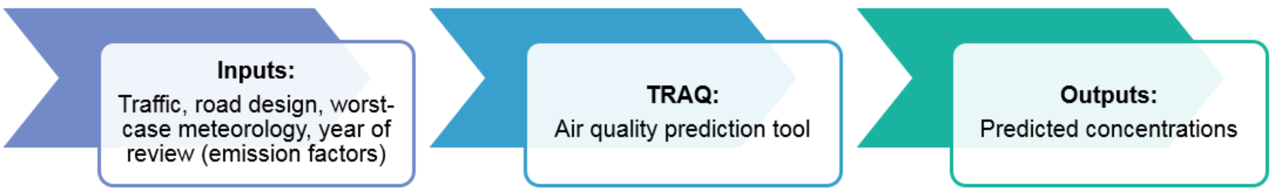


Figure 5.2. Overview of TRAQ assessment process

The key input settings that were applied in the model are listed below in Table 5.4

Table 5.4. TRAQ inputs

Model Setting	Input value(s)
Model version	TRAQ version 1.3 (2017)

Model Setting	Input value(s)
Modelled meteorological conditions	Worst-case meteorological conditions assumed (that is, wind speed of 1 metre per second, Pasquil atmospheric stability Class F (i.e., highly stable), and 15 degrees Celsius).
Assessment location	Worst-case, roadside along Italia Road and the Pacific Motorway
Road geometry	Single lane in either direction along Italia Road; 2 lanes in each direction separated by 10 metre median strip along Pacific Highway
Traffic inputs	Peak daily traffic generated from the Project as follows: - 314 heavy vehicle movements - 30 light vehicle movements
Vehicle emissions	2021, 2031 and 2036 (latest available) NSW EPA emission factors were applied for Stage 1, 5 and 9 respectively. Emissions included worst-case cold start effects.

Results were assessed by comparing predictions with impact assessment criteria from the EPA's Approved Methods. This aspect of the assessment is presented below in Section 6.5.

5.6 Crystalline Silica

Silica (SiO_2) occurs in abundance in nature and comprises minerals composed of silicon and oxygen. It exists in crystalline and amorphous forms which relate to the structural arrangement of the oxygen and silicon atoms. Only the crystalline forms are known to be fibrogenic (that is, dust which causes an increase of scar tissue after deposition in the gas exchange region of the lung) and only the respirable particles (i.e., $PM_{2.5}$), being those which are capable of reaching the gas exchange region of the lungs, are considered in determining health effects of crystalline silica.

Dust from quarrying activities such as crushing may contain silica. The potential impacts have been assessed by comparing the annually averaged $PM_{2.5}$ predictions (conservatively assuming all $PM_{2.5}$ as crystalline silica) with the health-based air pollution assessment criterion adopted from VIC EPA's Publication 1961 above in Section 3.1.

5.7 Odour

Potential odour impacts were similarly evaluated using the CALMET/CALPUFF site meteorological and dispersion model. Odour may be generated during the use of the on-site mobile emulsion road chip precoating plant. Odour may arise from the tank used to store the heated emulsion product that is applied, and during the process of coating the road chip. Details of how these sources were modelled are summarised below in Table 5.5. Some uncertainty is noted regarding the odour emission rates, with indicative reference values considered with scaling applied to account for the expected rate of production.

Table 5.5 Odour assessment inputs, road chip precoating plant

Model Setting	Input value(s)	Reference
X-coordinate (m)	388545	Source: Approximate location within the Central Processing Area where the mobile precoat plant is expected to be mostly used
Y-coordinate (m)	6385134	
Effective height (m)	3	Source: Indicative drawings provided by ARDG
Base elevation (m)	41.3	Source: Stage 1 DGM provided by ARDG
Initial sigma y (m)	3	Source: Calculated based on indicative drawings provided by ARDG
Initial sigma z (m)	10	
Emission rate (OU.m^3/s Emulsion tank	85	Source: Emission rate of 204 OU.m^3/s for production rate of 240 t/hr outlined in "Supplementary Air Quality Information, Bathurst Asphalt Plant" (Jacobs, 2018), citing information from Narangba ABP. Emission rate estimated from this and scaled to the expected maximum production rate of 100 t/hr.
Emission rate (OU.m^3/s), plant production	1,000	Source: Emission rate of 400 OU.m^3/s for loadout of a hot mix ABP at a rate of 40 t/hr provided in "Air Quality Assessment for Proposed Asphalt Plant Wesley Vale, Tasmania", (Ektimo,

Model Setting	Input value(s)	Reference
		2016). Emission rate estimated from this and scaled to the expected maximum production rate of 100 t/hr.

Odours can also arise during blasting, although the planned magnitude and extent of blasting is not considered sufficient as to generate off-site odour impacts and hasn't been considered further.

5.8 Cumulative Impact Assessment

'Cumulative Impact Assessment Guidelines for State Significant Projects' (DPIE, 2022) outlines the requirements for assessment of potential cumulative impacts for SSD projects. The Guideline outlines the approach for assessing the 'combined cumulative impacts' in addition to the 'incremental cumulative impacts. 'Incremental cumulative impacts' refer to the overall impact from the project plus baseline or background conditions. 'Combined cumulative impacts' considers this, as well as impacts from existing and potential future nearby developments that may not be completely accounted for in the background conditions.

Consistent with Section 3 of the guideline (DPIE, 2022), the following existing and potential future projects were identified as having the potential to result in further combined cumulative air quality impacts, along with the Project:

Table 5.6. Nearby existing and future developments

Site / Project / Proposal	Development type	Status	Approved extraction limit (tpa)	Location	Approximate distance (km) and direction from the Project
Boral Quarries Seaham (Balickera)	Extractive industry	Existing, operational	2,000,000	139 Italia Rd, Balickera NSW	2 km Southwest
Brandy Hill Quarry	Extractive industry	Existing, operational (expansion approved July 2020)	1,500,000	979 Clarence Town Rd, Seaham NSW	10 km West
Eagleton Quarry Project	Extractive industry	Under assessment	600,000	13 Barleigh Ranch Way, Eagleton NSW	3.5 km South

Where available, results from the impact assessments prepared for these projects have been combined with the results from the assessment (including the adopted background concentrations) to assess the potential for combined cumulative air quality impacts. This review is presented below in Section 6.8.

5.9 Greenhouse Gas Emissions

The GHG inventory in this document has been calculated in accordance with the principles of the GHG Protocol. The initial actions for a greenhouse gas inventory are to determine the sources of greenhouse gas emissions, assess their likely significance and set a boundary for the assessment. Creating an inventory of the likely GHG emissions associated with the Project has the benefit of determining the scale of the emissions and providing a baseline from which to develop and deliver GHG reduction options.

The results of this assessment are presented in terms of the previously mentioned 'Scopes' (refer to Section 3.2.1 above) to help understand the direct and indirect impacts of the Project. The GHG Protocol (and similar reporting schemes) dictates that reporting Scope 1 and 2 sources is mandatory, whilst reporting Scope 3 sources is optional. Reporting significant Scope 3 sources is recommended. 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 include the extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services. The inventory for this assessment includes all significant sources of GHGs (Scopes 1, 2 and 3) associated with the Project.

Table 5.7 shows the key emission sources that have been considered in this assessment as well as the greenhouse gas emission estimation methodologies. Section 7 provides the assessment of greenhouse gas emissions.

Table 5.7. Greenhouse gas emission sources and estimation methodologies

Activity	Description	Scope(s)	Emission estimation methodology
Diesel usage	Combustion of diesel fuel from mobile and stationary plant and equipment (including diesel generators used prior to grid connection).	1, 3	Emission factors from NGA Factors (DCCEEW, 2023), based on the quantities of diesel year expected to be used.
Blasting	Detonation of explosives used for blasting.	1	Emission factors from NGA Factors (DCC, 2008) combined with the quantity of explosives expected to be used per year. Blasting emissions are not reported in recent NGA Factors publications.
Vegetation	Loss of carbon sink due to removal of vegetation.	1	Calculated using “Carbon Gauge” developed by the Transport Authorities Greenhouse Group (TAGG, 2013). Clearing areas per year over the life of the Project were provided by ARDG. Vegetation assumed to be “Class C Open woodlands”. Biomass class set to “Class 5:250-350 (tonnes of dry matter per hectare [t dry matter/ha])” based on Project location (see **Figure 5.3** below). It is noted that this approach is conservative given the no-net loss principle on offsetting which will necessarily involve vegetation improvement at offset sites, and that this method doesn’t consider any sequestration associated with revegetation/rehabilitation.
Construction materials	Embodied energy contained in construction materials	3	Calculated using “Carbon Gauge” based on the estimated quantities of materials expected to be used.
Electricity	Indirect emissions from sources used to generate electricity used at the site.	2, 3	Emission factors from NGA Factors (DCCEEW, 2023) combined with the quantity of electricity expected to be used at the site per year.

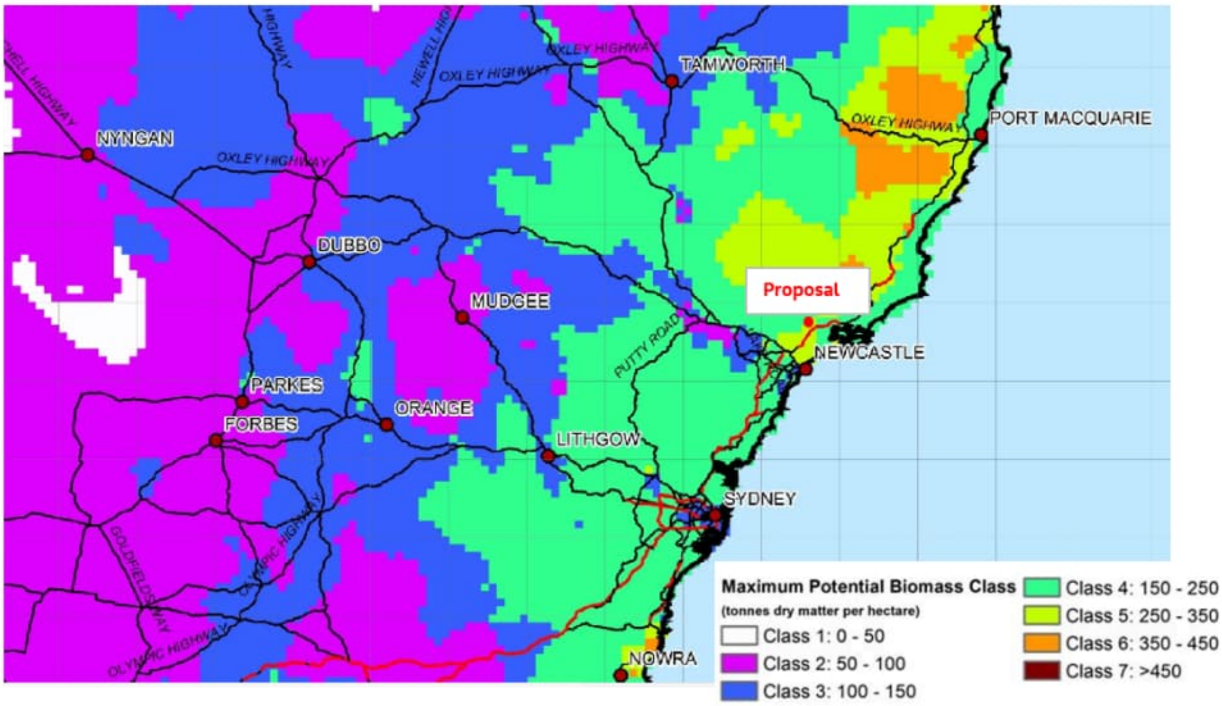


Figure 5.3. Maximum potential biomass classification (class 5), (Source: TAGG, 2013)

6. Air Quality Assessment

6.1 Construction Dust

Air quality impacts during construction would largely result from dust generated during earthworks and other engineering activities associated with the proposed construction works. Specifically, these works will primarily include:

- Initial vegetation clearing of areas to be used for internal haulage roads, site infrastructure, central processing area and product stockpiling area.
- Earthworks and construction of internal haulage roads, including main access road linking to Italia Road.
- Construction of site infrastructure (weighbridge, support site amenities, office and workshop buildings, carpark areas) and installation of generators.
- Excavation of water management (i.e., storage) areas.
- Commencement of earthworks and construction of central processing area.
- Commencement of earthworks and construction of product storage area.

Estimated emissions associated with Project construction activities are listed below in Table 6.1. These were determined using the same guidance from NPI, 2012 and the US EPA's AP-42 as were applied for operations.

Table 6.1: Estimated annual emissions, operations (kg/year)

Source	TSP	PM_{10}	$PM_{2.5}$
Wind erosion from cleared areas	26,052	13,026	1,303
Emissions from the handling and transport of excavated materials	10,363	3,021	175
Emissions from activities associated with the construction of site facilities	613	150	60
Total	**37,029**	**16,198**	**1,538**

Estimated TSP, PM_{10} and $PM_{2.5}$ emissions from construction are shown in comparison to those calculated for the different stages of operations below in Table 6.2.

Table 6.2. Comparison of estimated annual emissions for construction and operations

Air quality indicator	Construction	Operations		
		Stage 1	Stage 5	Stage 9
Total estimated emissions (kg/year)				
TSP	37,029	178,662	239,194	272,879
PM_{10}	16,198	60,213	83,318	97,576
$PM_{2.5}$	1,538	6051	7,829	9,079
Construction as a percentage (%) of operations				
TSP	-	21	15	14
PM_{10}	-	27	19	17
$PM_{2.5}$	-	25	20	17

Table 6.2 shows how expected emissions during construction equate to 27% or less of emissions estimated and assessed for operations. Noting the impact outcomes as discussed below for operations, it is considered unlikely that the construction phase of the Project would cause air quality impacts greater than those predicted for operations. Accordingly, the modelling of impacts for construction activities has not been

undertaken. Measures to minimise and effectively control emissions during construction should be implemented and are discussed below in Section 8.

6.2 Operational Dust

6.2.1 Particulate Matter (as PM_{10})

Predicted contributions from the Project and cumulative annually averaged PM_{10} concentrations at the identified surrounding sensitive receptors are shown below in Table 6.3. The cumulative results consider a background concentration of 16 µg/m^3 as established above in Section 4.5.

Table 6.3. Predicted results, annually averaged PM_{10}

Receptor	Project contribution (µg/m^3)			Cumulative concentration (µg/m^3)			EPA criterion (µg/m^3)
	Stage 1	Stage 5	Stage 9	Stage 1	Stage 5	Stage 9	
R1	0.2	0.2	0.2	16.2	16.2	16.2	25
R5	0.3	0.4	0.5	16.3	16.4	16.5	
R6	0.3	0.4	0.5	16.3	16.4	16.5	
R7	0.3	0.4	0.5	16.3	16.4	16.5	
R8	0.3	0.4	0.4	16.3	16.4	16.4	
R9	0.3	0.4	0.4	16.3	16.4	16.4	
R10	0.2	0.3	0.3	16.2	16.3	16.3	
R11	0.1	0.1	0.1	16.1	16.1	16.1	
R12	0.1	0.1	0.2	16.1	16.1	16.2	
R13	0.1	0.2	0.2	16.1	16.2	16.2	
R14	0.1	0.2	0.2	16.1	16.2	16.2	
R15	0.2	0.2	0.2	16.2	16.2	16.2	
R16	0.2	0.3	0.3	16.2	16.3	16.3	
R17	0.3	0.4	0.4	16.3	16.4	16.4	
R18	0.3	0.4	0.5	16.3	16.4	16.5	
R19	0.1	0.2	0.2	16.1	16.2	16.2	
R20	0.2	0.3	0.3	16.2	16.3	16.3	
R21	0.3	0.3	0.4	16.3	16.3	16.4	

** Note: Background concentration of 16 µg/m^3 adopted as measured at Beresfield in 2021 for displayed cumulative results*

As Table 6.3 displays, predicted Project contributions to PM_{10} levels at all modelled receivers are 0,5 µg/m^3 or lower. This level of incremental impacts is negligible. Cumulative annually averaged PM_{10} concentrations are predicted to remain below the EPA's 25 µg/m^3 impact assessment criterion at all surrounding sensitive receptors, during all assessed stages of the Project. While the 2021 Beresfield data has been used as background for this assessment, it is noted that using any other annual average data for Beresfield, Newcastle, or Williamtown other than 2020 would result in the same assessment result. As noted in Section 4.3, the 2020 data is heavily influenced by the extreme bushfire events which occurred in the early months of 2020, and this is not considered to be representative of typical background conditions. Annually averaged PM_{10} contributions from the Project alone are also displayed as ground-level concentration contour plots below in Figure 6.1, Figure 6.2 and Figure 6.3 for Stages 1, 5 and 9 respectively.

Figure 6.1. Stage 1, ground-level concentration contours, Project annually averaged PM_{10} contributions (µg/m^3)

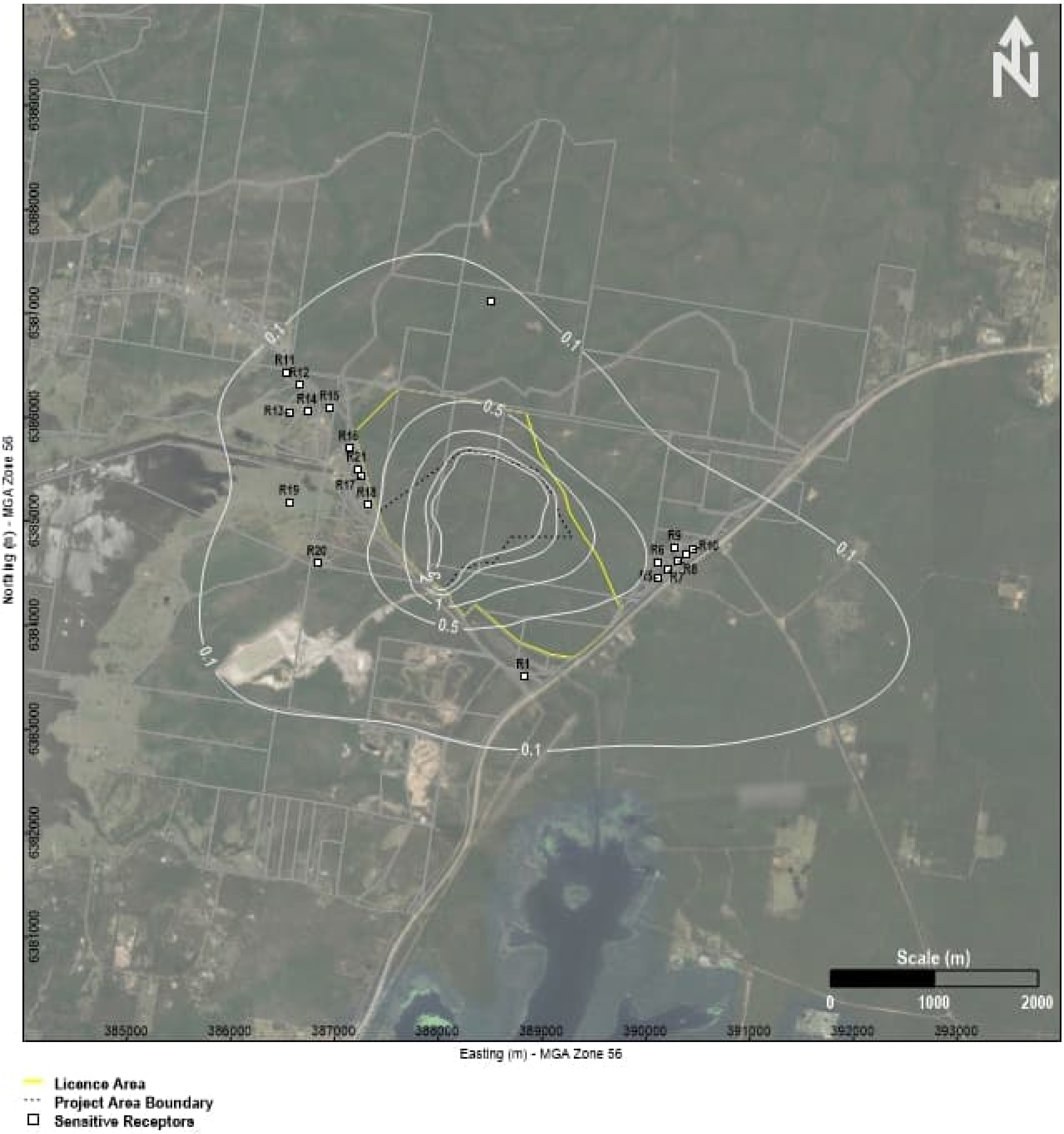


Figure 6.2. Stage 5, ground-level concentration contours, Project annually averaged PM_{10} contributions (µg/m^3)

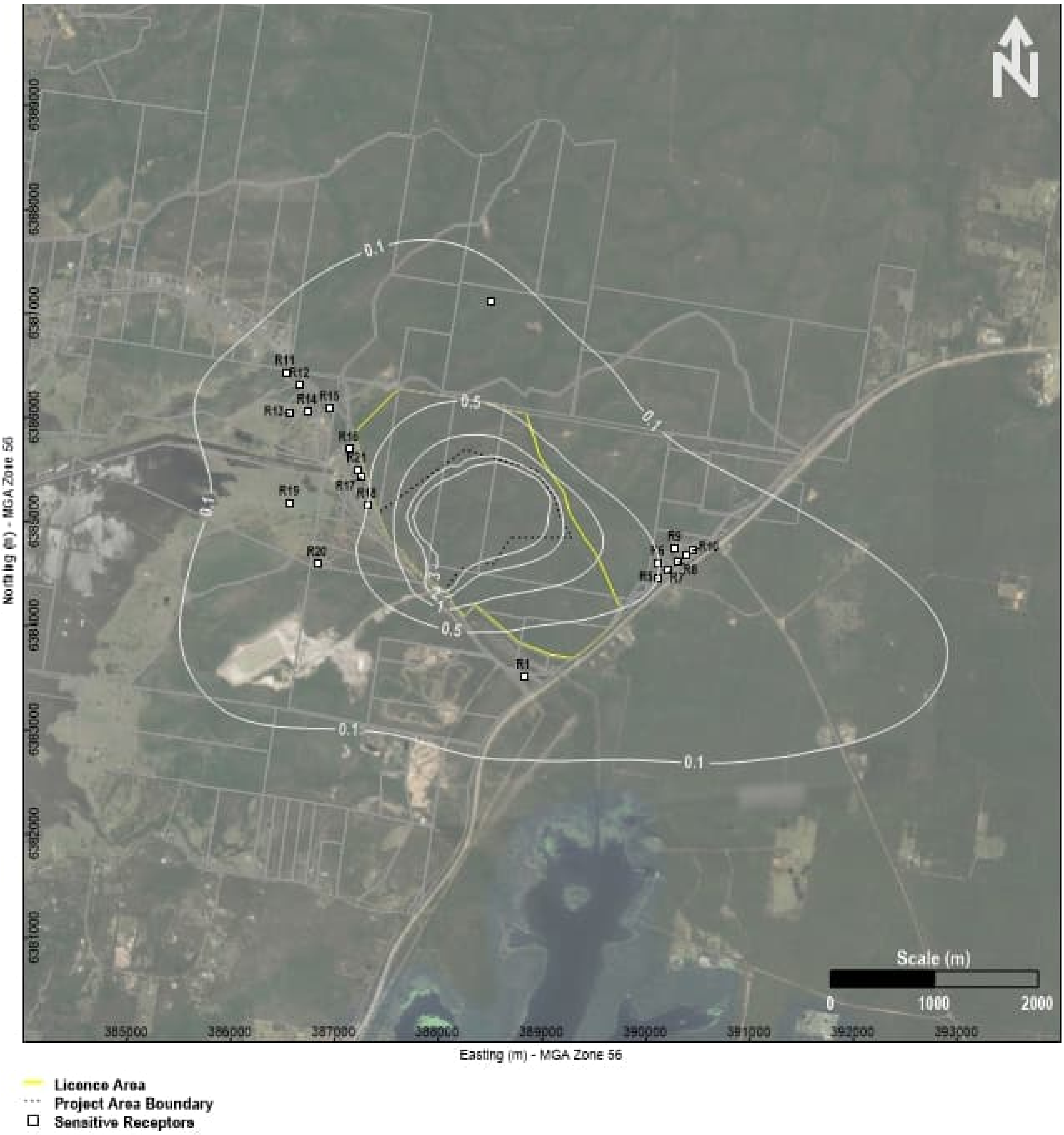


Figure 6.3. Stage 9, ground-level concentration contours, Project annually averaged PM_{10} contributions (µg/m^3)

The maximum 24-hour averaged PM_{10} concentration in 2021 at the DPE's Beresfield station was 36 µg/m^3 (see Table 4.2). As such the objective of this aspect of the assessment was to determine whether the Project could result in exceedances of the EPA's 50 µg/m^3 criterion at the surrounding sensitive receptors. The results from the dispersion modelling are listed below in Table 6.4. The cumulative concentrations conservatively consider the worst-case (i.e., highest 36 µg/m^3 2021 DPE Beresfield measured value) rather than applicable time-varying concentration.

Table 6.4. Predicted results, maximum 24-hour averaged PM_{10}

Receptor	Proposal contribution (µg/m³)			Cumulative concentration (µg/m³)			EPA criterion (µg/m³)
	Stage 1	Stage 5	Stage 9	Stage 1	Stage 5	Stage 9	
R1	2.0	2.4	2.5	38	38.4	38.5	50
R5	2.2	2.7	3.0	38.2	38.7	39	
R6	2.2	2.9	3.1	38.2	38.9	39.1	
R7	1.9	2.4	2.7	37.9	38.4	38.7	
R8	1.9	2.4	2.7	37.9	38.4	38.7	
R9	2.0	2.5	2.8	38	38.5	38.8	
R10	1.6	2.1	2.3	37.6	38.1	38.3	
R11	1.0	1.2	1.3	37	37.2	37.3	
R12	1.1	1.4	1.5	37.1	37.4	37.5	
R13	1.5	2.0	2.1	37.5	38	38.1	
R14	1.6	2.1	2.1	37.6	38.1	38.1	
R15	1.5	1.9	2.0	37.5	37.9	38	
R16	2.6	3.3	3.6	38.6	39.3	39.6	
R17	3.2	4.3	5.4	39.2	40.3	41.4	
R18	4.2	5.4	7.2	40.2	41.4	43.2	
R19	1.4	1.8	2.1	37.4	37.8	38.1	
R20	2.5	3.0	3.3	38.5	39	39.3	
R21	2.7	3.7	4.5	38.7	39.7	40.5	

** Note: Background concentration of 36 µg/m³ adopted as measured at Beresfield in 2021 for displayed cumulative results*

As shown, even with the conservatively adopted background assumption, maximum 24-hour averaged PM_{10} concentrations were predicted remain below the 50 µg/m³ impact assessment criterion. This was the case at all identified surrounding sensitive receptors, and for all three assessment stages considered. These results are also displayed as ground-level contours below in Figure 6.4, Figure 6.5 and Figure 6.6.

Figure 6.4. Stage 1, ground-level concentration contours, Project maximum 24-hour averaged PM_{10} contributions ($\mu g/m^3$)

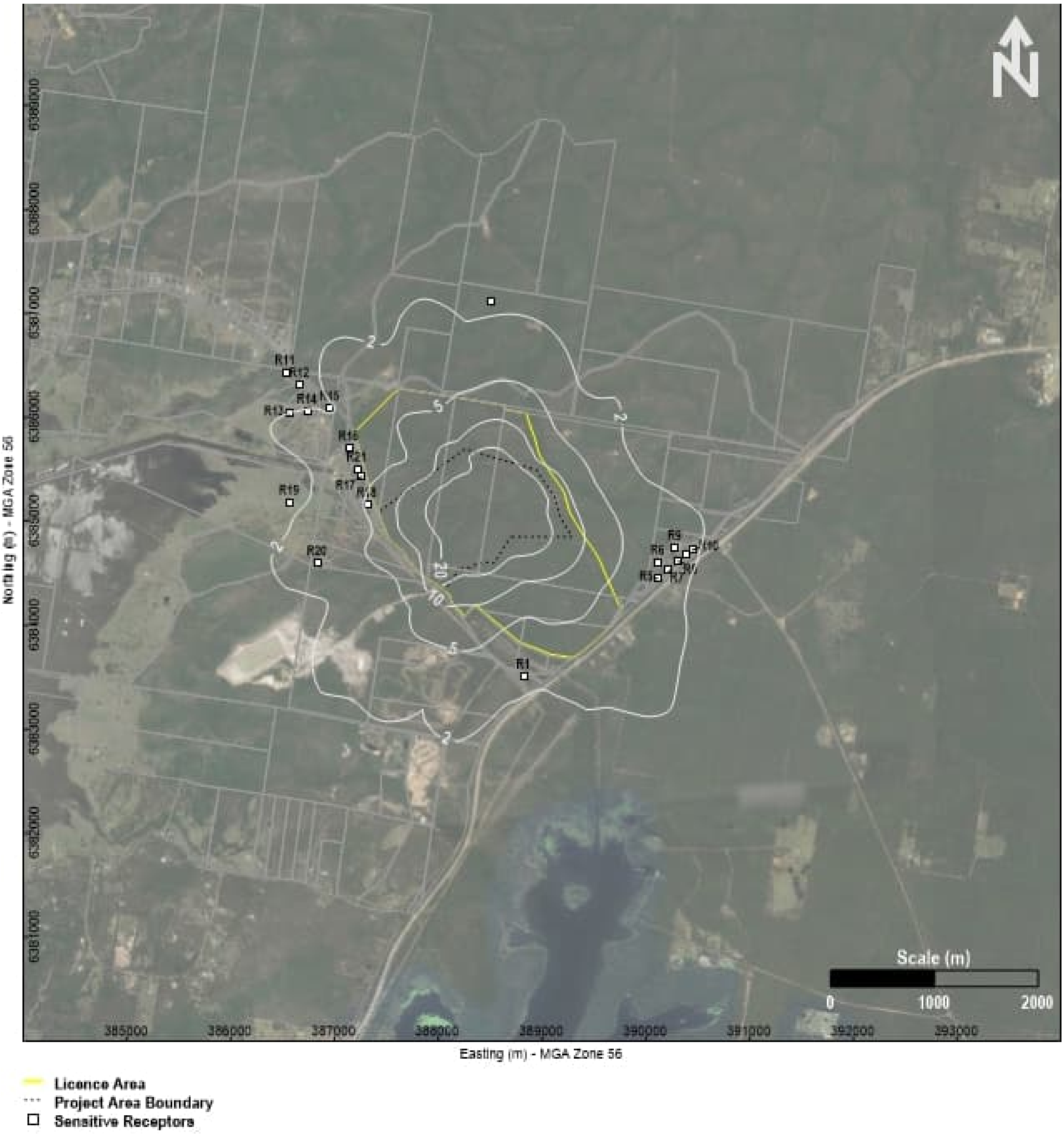


Figure 6.5. Stage 5, ground-level concentration contours, Project maximum 24-hour averaged PM_{10} contributions (µg/m^3)

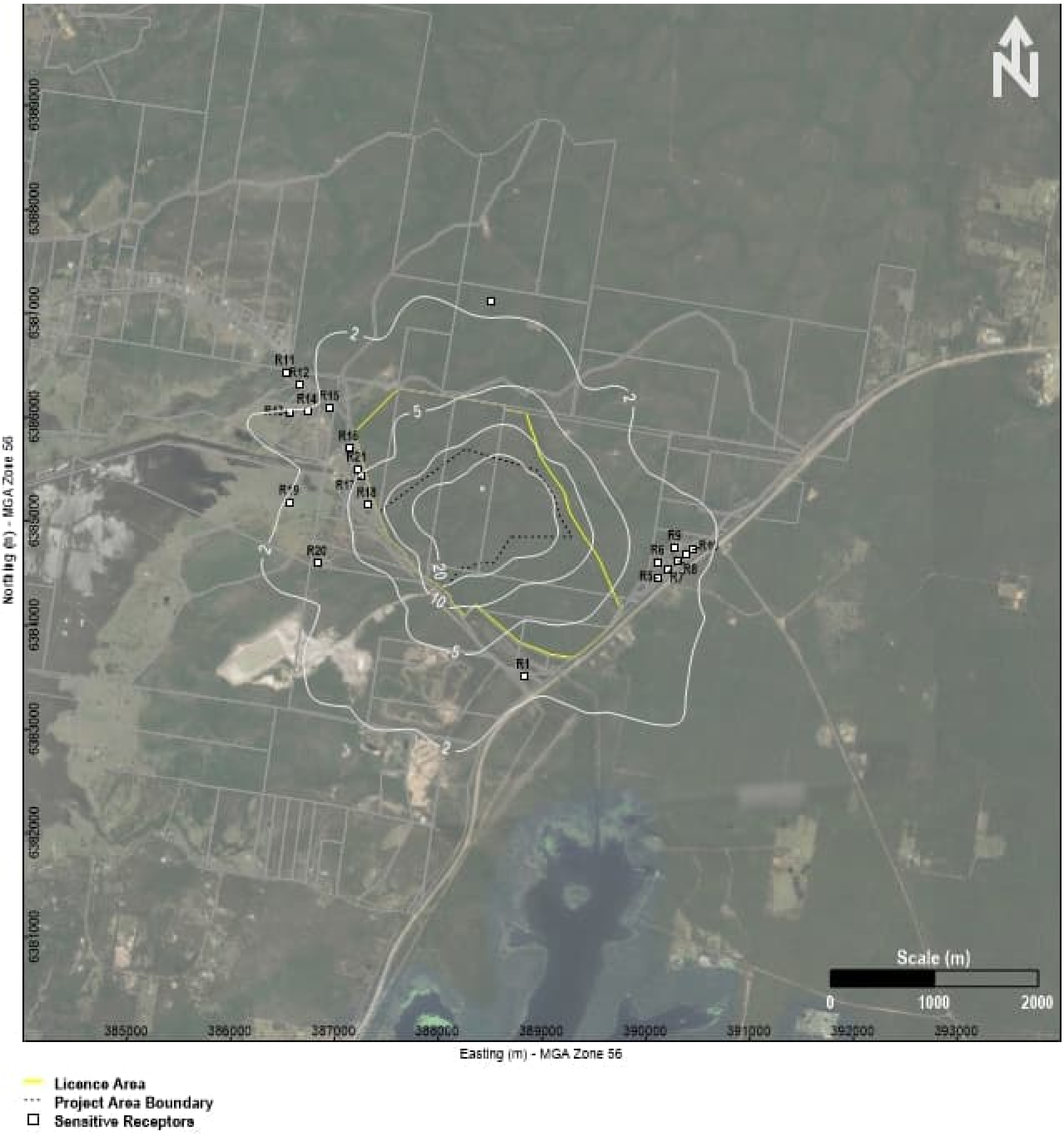


Figure 6.6. Stage 9, ground-level concentration contours, Project maximum 24-hour averaged PM_{10} contributions ($\mu g/m^3$)

Based on the results presented and discussed above it was determined that there would be no unacceptable changes in annually averaged and maximum daily PM_{10} concentrations at surrounding sensitive receptors over the operational life of the Project. Still, measures to control PM_{10} emissions from the Project are recommended in Section 8.

6.2.2 Particulate Matter (as $PM_{2.5}$)

Predicted changes in annually averaged $PM_{2.5}$ concentrations because of the Project are listed below in Table 6.5. Contributions from the Project are also displayed as ground-level concentration contour plots below in Figure 6.7, Figure 6.8 and Figure 6.9 for Stages 1, 5 and 9 respectively..

Table 6.5. Predicted results, annually averaged $PM_{2.5}$

Receptor	Project contribution (µg/m³)			Cumulative concentration (µg/m³)			EPA criterion (µg/m³)
	Stage 1	Stage 5	Stage 9	Stage 1	Stage 5	Stage 9	
R1	0.03	0.03	0.04	<6.0	<6.0	<6.0	8
R5	0.04	0.06	0.07	<6.0	<6.0	<6.0	
R6	0.05	0.06	0.07	<6.0	<6.0	<6.0	
R7	0.04	0.05	0.06	<6.0	<6.0	<6.0	
R8	0.04	0.05	0.06	<6.0	<6.0	<6.0	
R9	0.04	0.05	0.05	<6.0	<6.0	<6.0	
R10	0.03	0.04	0.05	<6.0	<6.0	<6.0	
R11	0.01	0.02	0.02	<6.0	<6.0	<6.0	
R12	0.02	0.02	0.02	<6.0	<6.0	<6.0	
R13	0.02	0.02	0.02	<6.0	<6.0	<6.0	
R14	0.02	0.02	0.02	<6.0	<6.0	<6.0	
R15	0.02	0.02	0.03	<6.0	<6.0	<6.0	
R16	0.03	0.03	0.04	<6.0	<6.0	<6.0	
R17	0.04	0.04	0.05	<6.0	<6.0	<6.0	
R18	0.04	0.05	0.06	<6.0	<6.0	<6.0	
R19	0.02	0.02	0.02	<6.0	<6.0	<6.0	
R20	0.03	0.03	0.04	<6.0	<6.0	<6.0	
R21	0.03	0.04	0.04	<6.0	<6.0	<6.0	

** Note: Background concentration of 5.9 µg/m³ adopted as measured at Beresfield in 2021 for displayed cumulative results*

As shown, cumulative annually averaged $PM_{2.5}$ concentrations were predicted to remain below the EPA's 8 µg/m³ impact assessment criterion. The highest predicted contribution (0.07 µg/m³ at R5 and R6 during Stage 9) was less than 1% of the 8 µg/m³ criterion, demonstrating the negligible expected effect of Project operations on local annually averaged $PM_{2.5}$. It is also noted that the predicted cumulative impacts are more than 1 µg/m³ below the future 2025 NEPM target criteria of 7 µg/m³.

Figure 6.7. Stage 1, ground-level concentration contours, Project annually averaged $PM_{2.5}$ contributions ($\mu g/m^3$)

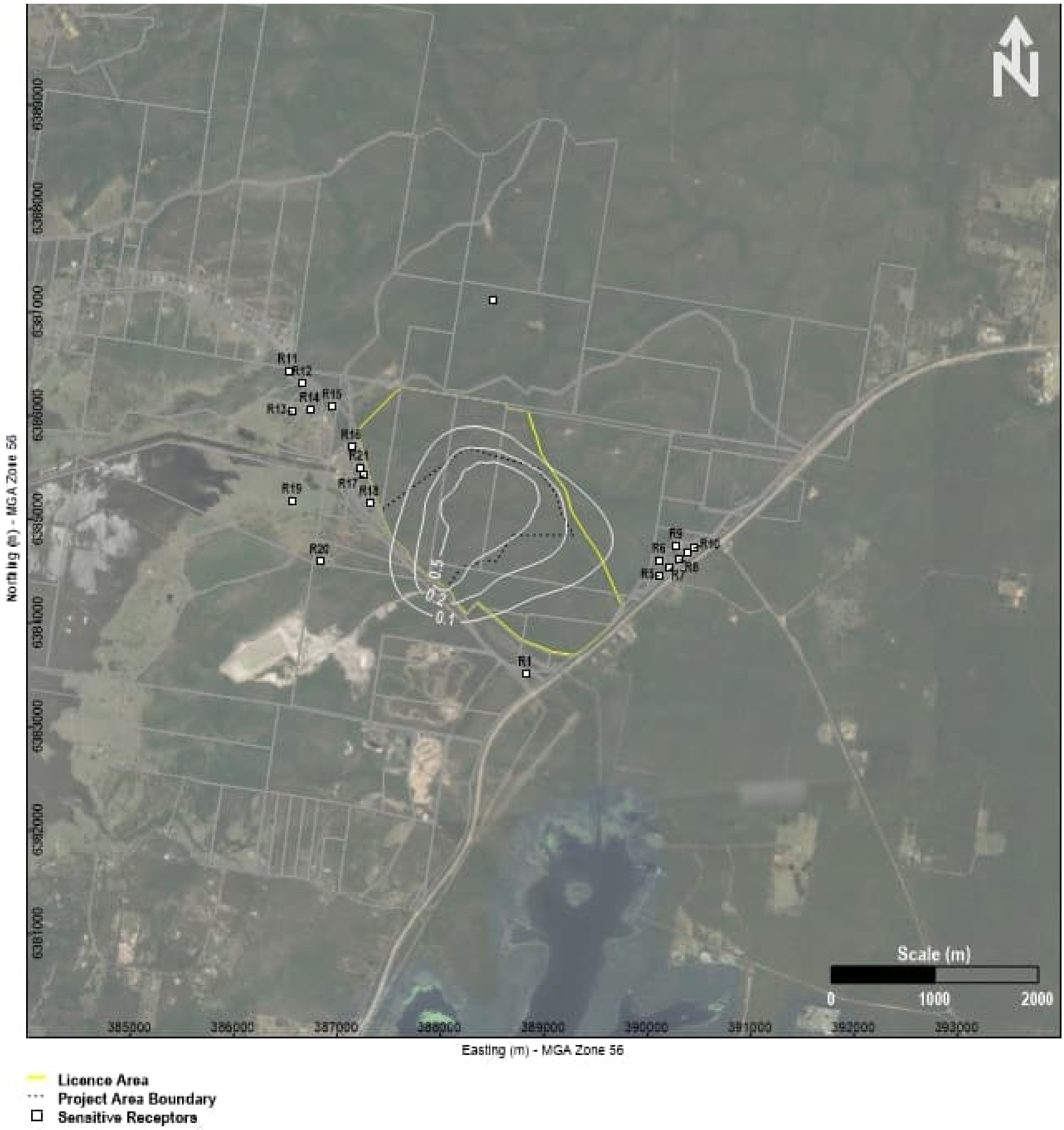


Figure 6.8. Stage 5, ground-level concentration contours, Project annually averaged $PM_{2.5}$ contributions ($\mu g/m^3$)

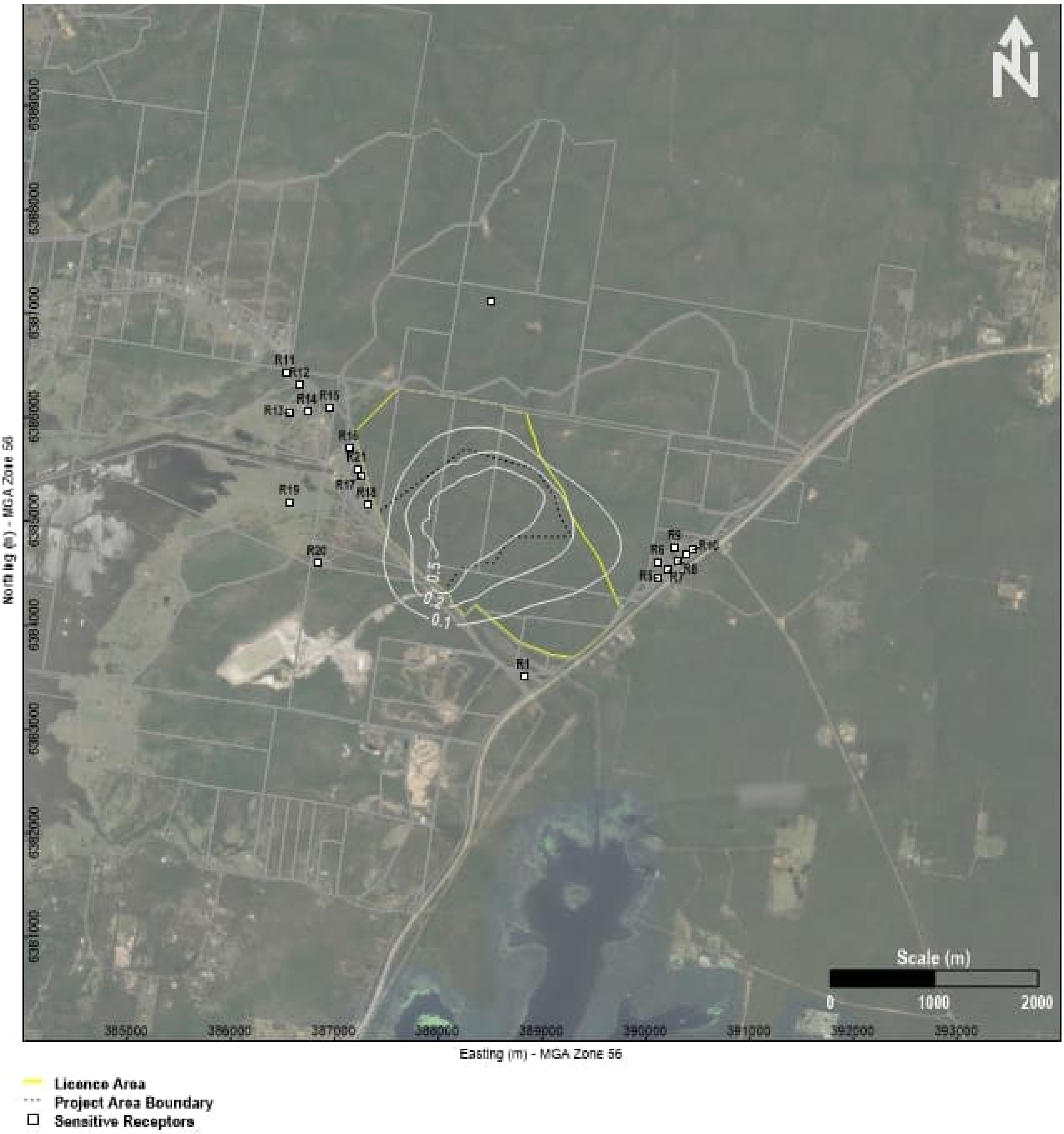


Figure 6.9. Stage 9, ground-level concentration contours, Project annually averaged $PM_{2.5}$ contributions ($\mu g/m^3$)

The maximum 24-hour averaged $PM_{2.5}$ concentration in 2021 at the DPE's Beresfield station was 19 $\mu g/m^3$ (refer to Table 4.3). Given that this is below the EPA's 25 $\mu g/m^3$ criterion, the objective of the assessment was to assess whether the Project had the potential to result in exceedances of this value at the surrounding sensitive receptors. The results are listed below in Table 6.6. The. As for PM_{10}, the cumulative concentrations displayed conservatively consider the worst-case (i.e., highest 19 $\mu g/m^3$ 2021 DPE Beresfield measured value) rather than applicable time-varying concentrations.

Table 6.6. Predicted results, maximum 24-hour averaged $PM_{2.5}$

Receptor	Project contribution (µg/m^3)			Cumulative concentration (µg/m^3)			EPA criterion (µg/m^3)
	Stage 1	Stage 5	Stage 9	Stage 1	Stage 5	Stage 9	
R1	0.3	0.3	0.3	19.3	19.3	19.3	25
R5	0.3	0.3	0.4	19.3	19.3	19.4	
R6	0.3	0.3	0.4	19.3	19.3	19.4	
R7	0.3	0.3	0.3	19.3	19.3	19.3	
R8	0.2	0.3	0.3	19.2	19.3	19.3	
R9	0.2	0.3	0.3	19.2	19.3	19.3	
R10	0.2	0.2	0.3	19.2	19.2	19.3	
R11	0.1	0.1	0.1	19.1	19.1	19.1	
R12	0.1	0.2	0.2	19.1	19.2	19.2	
R13	0.2	0.2	0.2	19.2	19.2	19.2	
R14	0.2	0.2	0.2	19.2	19.2	19.2	
R15	0.2	0.2	0.2	19.2	19.2	19.2	
R16	0.3	0.3	0.3	19.3	19.3	19.3	
R17	0.4	0.5	0.5	19.4	19.5	19.5	
R18	0.5	0.6	0.7	19.5	19.6	19.7	
R19	0.2	0.2	0.2	19.2	19.2	19.2	
R20	0.3	0.3	0.3	19.3	19.3	19.3	
R21	0.3	0.4	0.5	19.3	19.4	19.5	

** Note: Background concentration of 19 µg/m^3 adopted as measured at Beresfield in 2021 for displayed cumulative results*

Even with this conservative approach to background levels, Table 6.6 shows that maximum 24-hour averaged concentrations were predicted to remain below 25 µg/m^3. The contribution of $PM_{2.5}$ from the Project on cumulative concentrations is minimal (i.e., less than 3% of the EPA's impact assessment criterion). Results are displayed as ground-level contours below in Figure 6.10, Figure 6.11 and Figure 6.12 for Stages 1, 5 and 9 respectively.

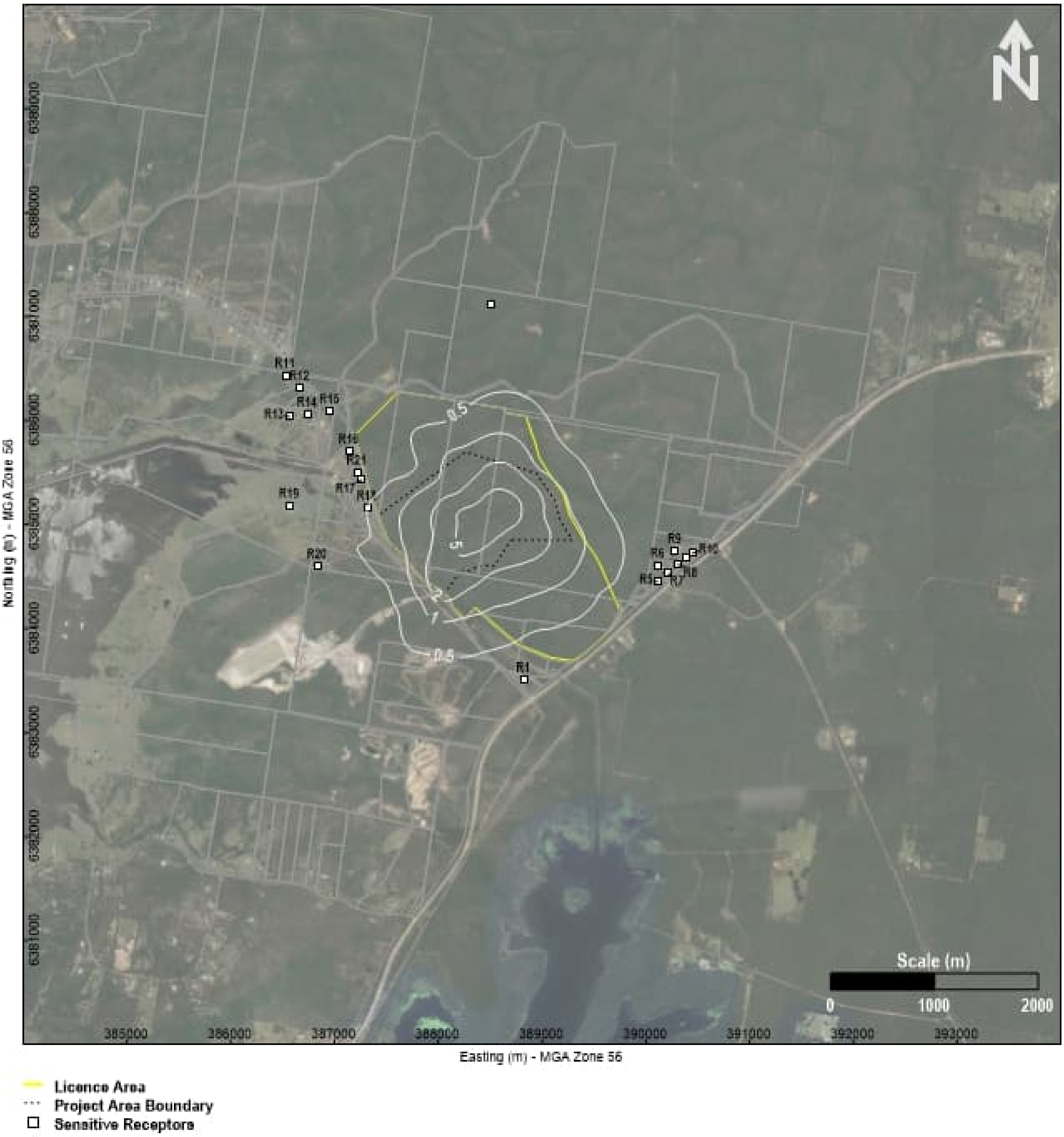


Figure 6.10. Stage 1, ground-level concentration contours, Project maximum 24-hour averaged $PM_{2.5}$ contributions (µg/m^3)

Figure 6.11. Stage 5, ground-level concentration contours, Project maximum 24-hour averaged $PM_{2.5}$ contributions (µg/m^3)

Figure 6.12 Stage 9, ground-level concentration contours, Project maximum 24-hour averaged $PM_{2.5}$ contributions (µg/m^3)

Based on these results it was determined that there would be no unacceptable changes in annually averaged and maximum daily $PM_{2.5}$ concentrations as a result of the Project. Still, measures committed in the inventory as well as other recommendations to reduce emissions are provided below in Section 8.

6.2.3 Particulate Matter (as TSP)

Changes in annually averaged TSP concentrations at surrounding sensitive receptors due to Project operations were also predicted. The results are displayed below in Table 6.7. Project contributions also displayed as ground-level concentration contour plots below in Figure 6.13, Figure 6.14 and Figure 6.15.

Table 6.7. Predicted results, annually averaged TSP

Receptor	Project contribution (µg/m³)			Cumulative concentration (µg/m³)			EPA criterion (µg/m³)
	Stage 1	Stage 5	Stage 9	Stage 1	Stage 5	Stage 9	
R1	0.3	0.3	0.3	40.3	40.3	40.3	90
R5	0.5	0.6	0.7	40.5	40.6	40.7	
R6	0.5	0.6	0.7	40.5	40.6	40.7	
R7	0.5	0.6	0.6	40.5	40.6	40.6	
R8	0.4	0.5	0.6	40.4	40.5	40.6	
R9	0.4	0.5	0.6	40.4	40.5	40.6	
R10	0.3	0.4	0.5	40.3	40.4	40.5	
R11	0.2	0.2	0.2	40.2	40.2	40.2	
R12	0.2	0.2	0.2	40.2	40.2	40.2	
R13	0.2	0.2	0.3	40.2	40.2	40.3	
R14	0.2	0.3	0.3	40.2	40.3	40.3	
R15	0.3	0.3	0.3	40.3	40.3	40.3	
R16	0.4	0.4	0.5	40.4	40.4	40.5	
R17	0.5	0.5	0.6	40.5	40.5	40.6	
R18	0.5	0.6	0.7	40.5	40.6	40.7	
R19	0.2	0.3	0.3	40.2	40.3	40.3	
R20	0.3	0.4	0.4	40.3	40.4	40.4	
R21	0.4	0.5	0.6	40.4	40.5	40.6	

** Note: Background concentration of 40 µg/m³ adopted as described in Section 4.5.*

Table 6.7 shows how the cumulative annually averaged TSP concentrations at surrounding sensitive receptors were predicted to remain below the EPA's 90 µg/m³ impact assessment criterion. Based on these findings it was determined that there would be no unacceptable changes in annually averaged TSP concentrations because of the Project.

Figure 6.13. Stage 1, ground-level concentration contours, Project annually averaged TSP contributions (µg/m^3)

Figure 6.14. Stage 5, ground-level concentration contours, Project annually averaged TSP contributions (µg/m^3)

Figure 6.15. Stage 9, ground-level concentration contours, Project annually averaged TSP contributions (µg/m^3)

6.2.4 Deposited Dust

Finally, regarding deposited dust, predicted results for Project operations are listed below in Table 6.8.

Table 6.8. Predicted results, annually averaged deposited dust

Receptor	Project contribution ($g/m^2/month$)			Cumulative concentration ($g/m^2/month$)			EPA criterion ($g/m^2/month$)
	Stage 1	Stage 5	Stage 9	Stage 1	Stage 5	Stage 9	
R1	0.05	0.05	0.06	1.85	1.85	1.86	4
R5	0.18	0.23	0.26	1.98	2.03	2.06	
R6	0.19	0.24	0.27	1.99	2.04	2.07	
R7	0.17	0.22	0.25	1.97	2.02	2.05	
R8	0.16	0.20	0.23	1.96	2	2.03	
R9	0.15	0.20	0.22	1.95	2	2.02	
R10	0.13	0.17	0.19	1.93	1.97	1.99	
R11	0.04	0.04	0.05	1.84	1.84	1.85	
R12	0.04	0.05	0.06	1.84	1.85	1.86	
R13	0.04	0.05	0.05	1.84	1.85	1.85	
R14	0.05	0.06	0.07	1.85	1.86	1.87	
R15	0.06	0.08	0.09	1.86	1.88	1.89	
R16	0.09	0.11	0.13	1.89	1.91	1.93	
R17	0.11	0.13	0.16	1.91	1.93	1.96	
R18	0.12	0.14	0.17	1.92	1.94	1.97	
R19	0.03	0.04	0.04	1.83	1.84	1.84	
R20	0.06	0.07	0.09	1.86	1.87	1.89	
R21	0.10	0.12	0.15	1.9	1.92	1.95	

** Note: Background level of 1.8 $g/m^2/month$ adopted as described in Section 4.5.*

Table 6.8 displays how deposited dust levels were predicted to remain below 4 $g/m^2/month$ at surrounding receptors with results generally around 2 $g/m^2/month$ below this criterion. Based on this, it is expected that changes in deposited dust associated with the Project would not result in unacceptable levels at surrounding sensitive receptors. Predicted Project contributions as ground-level contours have been displayed below in Figure 6.16, Figure 6.17 and Figure 6.18 for Stages 1, 5 and 9 respectively.

Figure 6.16. Stage 1, ground-level contours, Project annually averaged deposited dust contributions (g/m^2/month)

Figure 6.17. Stage 5, ground-level contours, Project annually averaged deposited dust contributions (g/m^2/month)

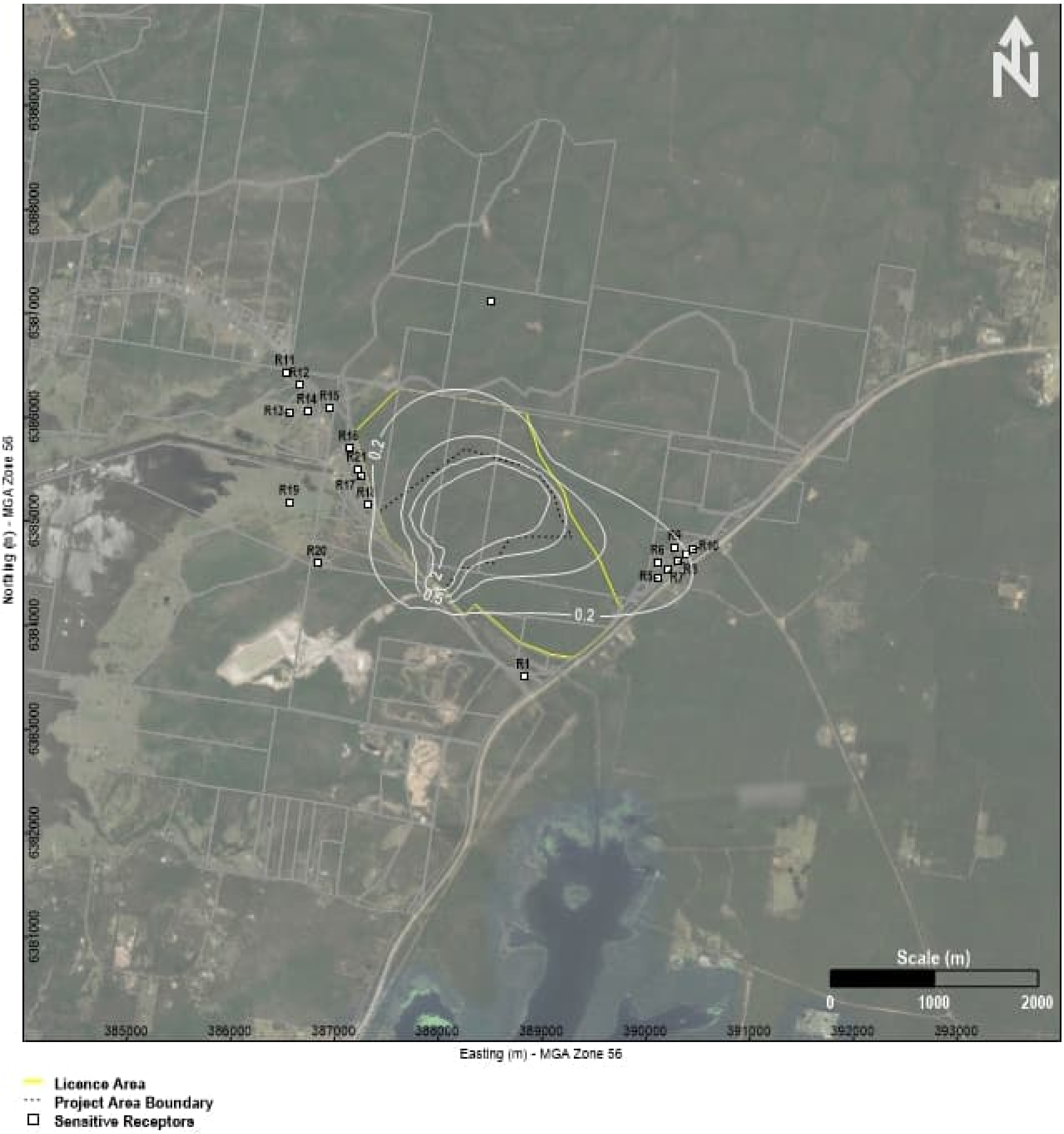


Figure 6.18. Stage 9, ground-level contours, Project annually averaged deposited dust contributions (g/m^2/month)

6.2.5 VLAMP Assessment

As noted in Section 3.1, the VLAMP specifies that voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in Table 3.3 at any residence or workplace on privately owned land, or 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.

Figure 6.19 shows the maximum extent of VLAMP criteria based on all assessment years and for all relevant air quality indicators. Table 6.9 provides an assessment of the model results against the VLAMP criteria.

Table 6.9. Assessment against VLAMP criteria

Air quality indicator	Averaging time	Acquisition criterion	Assessment outcome from modelling
Particulate matter (PM_{10})	24-hour	50 µg/m^3 **	Compliant. Highest (i.e., of all three stages assessed) 50 µg/m^3 incremental concentration was predicted to remain within the licence area (see **Figure 6.19** below).
	Annual	25 µg/m^3 *	Compliant. Highest (i.e., of all three stages assessed) 9 µg/m^3 (noting adopted background concentration was 16 µg/m^3) incremental concentration was predicted to remain within the licence area (see **Figure 6.19** below).
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3 **	Compliant. Highest (i.e., of all three stages assessed) 25 µg/m^3 incremental concentration was predicted to remain within the licence area (see **Figure 6.19** below).
	Annual	8 µg/m^3 *	Compliant. Highest (i.e., of all three stages assessed) 2.1 µg/m^3 (noting adopted background concentration was 5.9 µg/m^3) incremental concentration was predicted to remain within the licence area (see **Figure 6.19** below).
Particulate matter (TSP)	Annual	90 µg/m^3 *	Compliant. Highest (i.e., of all three stages assessed) 50 µg/m^3 (noting adopted background concentration was 40 µg/m^3) incremental concentration was predicted to remain within the licence area (see **Figure 6.19** below).
Deposited dust	Annual (increase)	2 g/m^2/month **	Compliant. Highest (i.e., of all three stages assessed) 2 g/m^2/month (incremental concentration was predicted to remain within the licence area and adjoining public road reserve (see **Figure 6.19** below).
	Annual (total)	4 g/m^2/month *	Compliant. Highest (i.e., of all three stages assessed) 2.2 g/m^2/month (noting adopted background concentration was 1.8 g/m^2/month) incremental concentration was predicted to remain within the licence area and adjoining public road reserve (see **Figure 6.19** below).

** Cumulative impact (i.e., increase in concentrations due to the development plus background concentrations due to all other sources).*

*** 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).*

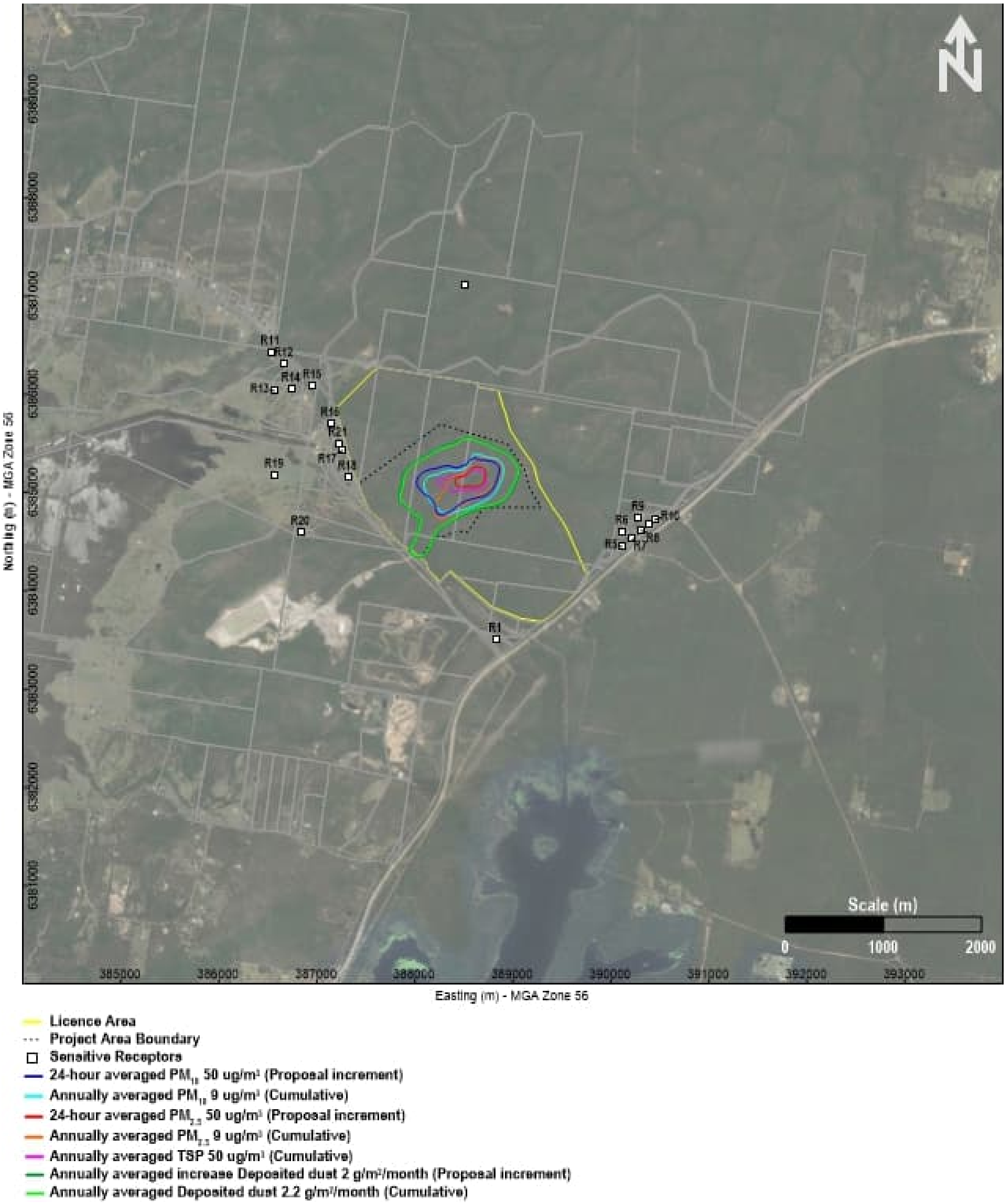


Figure 6.19. VLAMP extents

6.3 Operational Post-Blast Fume

Figure 6.20 shows the predicted maximum 1-hour average NO_2 concentrations due to post-blast fume, based on the methodology outlined above. These results show that, under worst-case meteorological conditions with a conservative rated 3 fume event, and blasting every day between 10 am and 3 pm, the predicted maximum 1-hour average NO_2 concentrations at the nearest sensitive receptors are less than 5 µg/m^3. With the addition of maximum background levels (70 µg/m^3 in 2021 from Table 4.6) the results demonstrate compliance with the EPA's 164 µg/m^3 1-hour average NO_2 criterion. The modelling therefore suggests that the Project will not result in adverse blast fume impacts due to blasting.

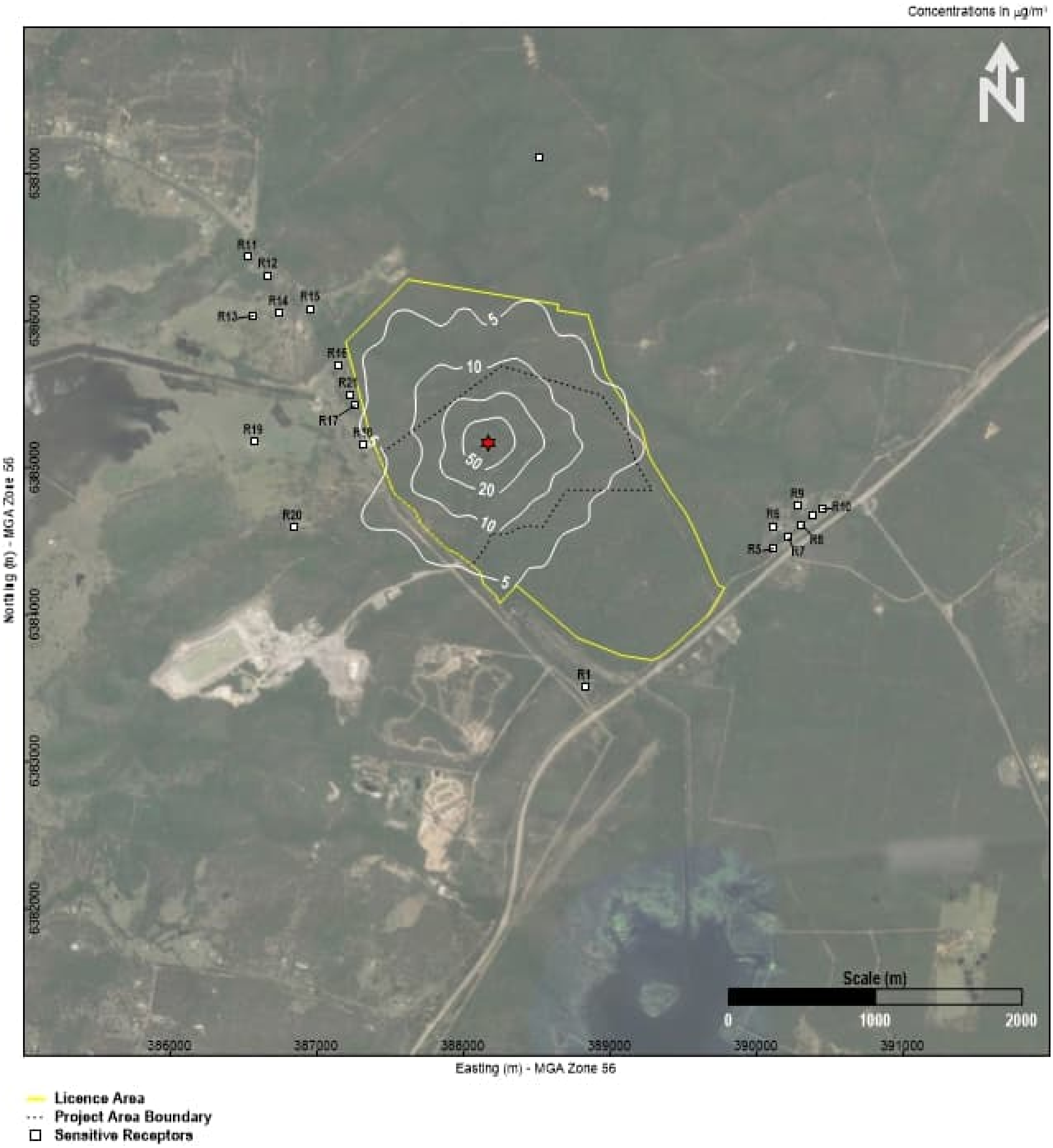


Figure 6.20. Modelled maximum 1-hour average NO_2 concentrations due to blasting (µg/m^3)

6.4 Operational Diesel Exhaust

6.4.1 Particulate Matter (as PM_{10} and $PM_{2.5}$)

The emission factors, presented in Section 0 and Appendix C, represent the contribution from both wheel-generated particulates and the exhaust particulates. These emission factors, including with control factors, are based on measured emissions which include diesel particulates in the form of both PM_{10} and $PM_{2.5}$. The emission factors are also likely to include more diesel exhaust particulate than from modern plant and equipment as the factors were developed on the basis of emissions from plant and equipment measured in the 1980s. Todoroski Air Sciences has also reported (TAS 2016) that several studies, reported to the EPA, confirmed that a control factor of 85% can be maintained, representing all components of the truck haulage emission.

Based on the information collated above, the potential impacts of diesel exhaust emissions (as PM_{10} and $PM_{2.5}$) are represented in the preceding results, in Section 6.2. Potential NO_2 impacts from diesel exhaust emissions are presented below in Section 6.4.2.

6.4.2 Nitrogen dioxide (NO_2)

Predicted NO_2 contributions from diesel exhaust emissions associated with the Project and cumulative annually concentrations at the identified surrounding sensitive receptors are summarised below in Table 6.10. Annual and maximum 1-hour ground level concentration results (Project contributions) are also displayed in Figure 6.21 and Figure 6.22.

Table 6.10. Predicted results, annual and maximum 1-hour averaged NO_2 from diesel exhaust (Stage 1)

Receptor	Annually averaged NO_2			Maximum 1-hour averaged NO_2		
	Project (µg/m^3)	Cumulative (µg/m^3)	EPA criterion (µg/m^3)	Project (µg/m^3)	Cumulative (µg/m^3)	EPA criterion (µg/m^3)
R1	0.4	12.4	31	7.4	77.4	164
R5	1.4	13.4		7.5	77.5	
R6	1.6	13.6		6.7	76.7	
R7	1.4	13.4		5.9	75.9	
R8	1.3	13.3		5.7	75.7	
R9	1.3	13.3		5.7	75.7	
R10	1.1	13.1		5.2	75.2	
R11	0.2	12.2		1.8	71.8	
R12	0.2	12.2		2.3	72.3	
R13	0.2	12.2		2.8	72.8	
R14	0.2	12.2		3.2	73.2	
R15	0.2	12.2		3.4	73.4	
R16	0.3	12.3		3.8	73.8	
R17	0.4	12.4		4.7	74.7	
R18	0.5	12.5		5.0	75.0	
R19	0.2	12.2		2.8	72.8	
R20	0.3	12.3		4.2	74.2	
R21	0.4	12.4		4.4	74.4	

As Table 6.10 shows, cumulative annually averaged NO_2 concentrations were predicted to remain below the EPA's 31 µg/m^3 impact assessment criterion. These concentrations were determined by assuming that 100% of annual NO_x is NO_2.

Maximum 1-hour averaged NO_2 concentrations were also calculated using the methodology outlined in Section 5.4. These results assume that 20% of the NO_x is NO_2 at the locations of maximum ground-level concentrations (as determined in Section 4.3.6) and a maximum background concentration of 70 $\mu g/m^3$.As shown, maximum 1-hour averaged NO_2 from Project diesel exhaust emissions were also predicted to remain below the EPA's 164 $\mu g/m^3$ impact assessment criterion. Based on these findings, it was determined that diesel exhaust emissions from the Project are unlikely to present an unacceptable risk. Still measures to ensure that all plant and equipment are operated in a proper and efficient manner to preserve this outcome are recommended below in Section 8.

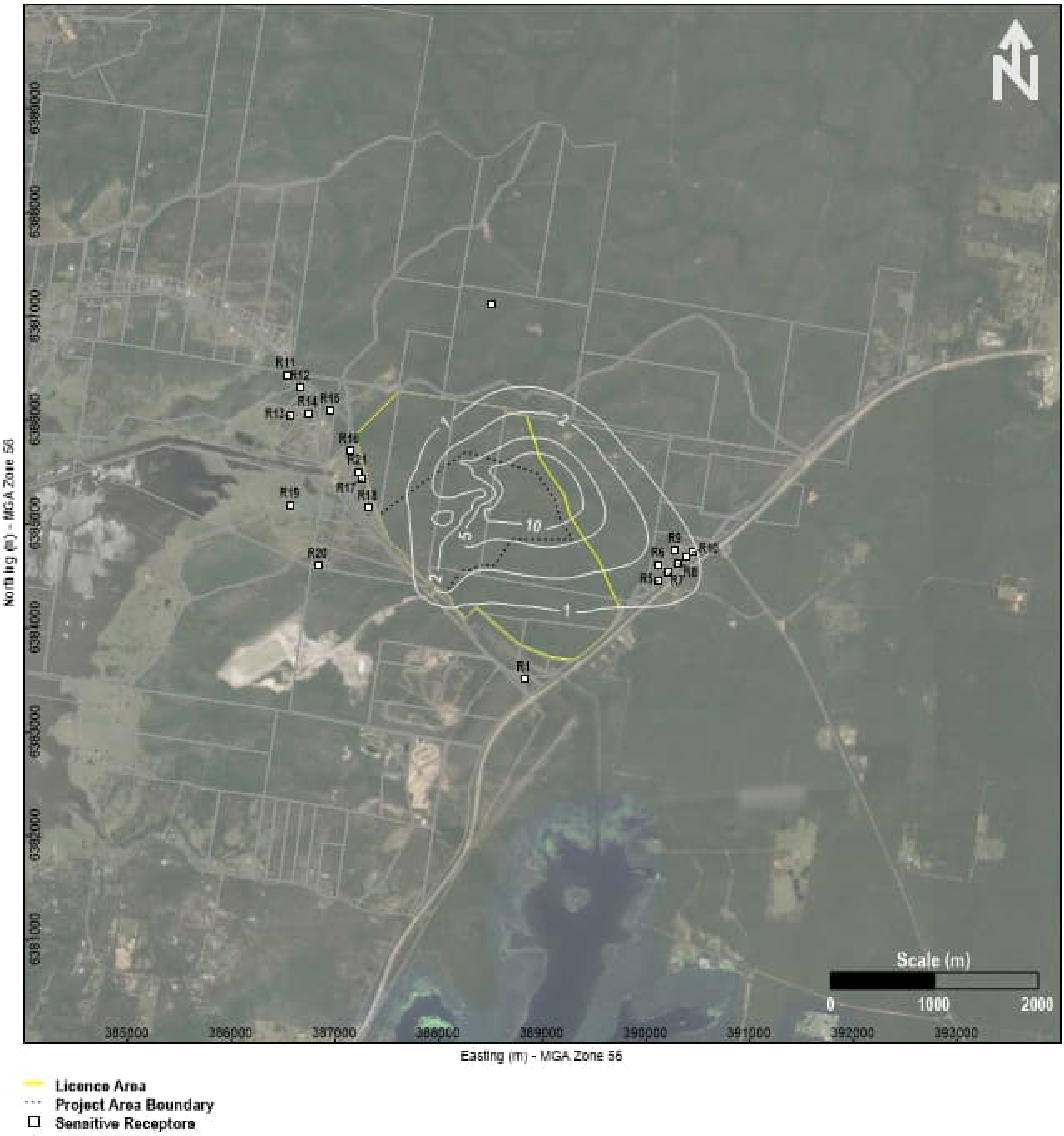


Figure 6.21. Modelled annually averaged NO_2 concentrations from diesel emissions ($\mu g/m^3$)

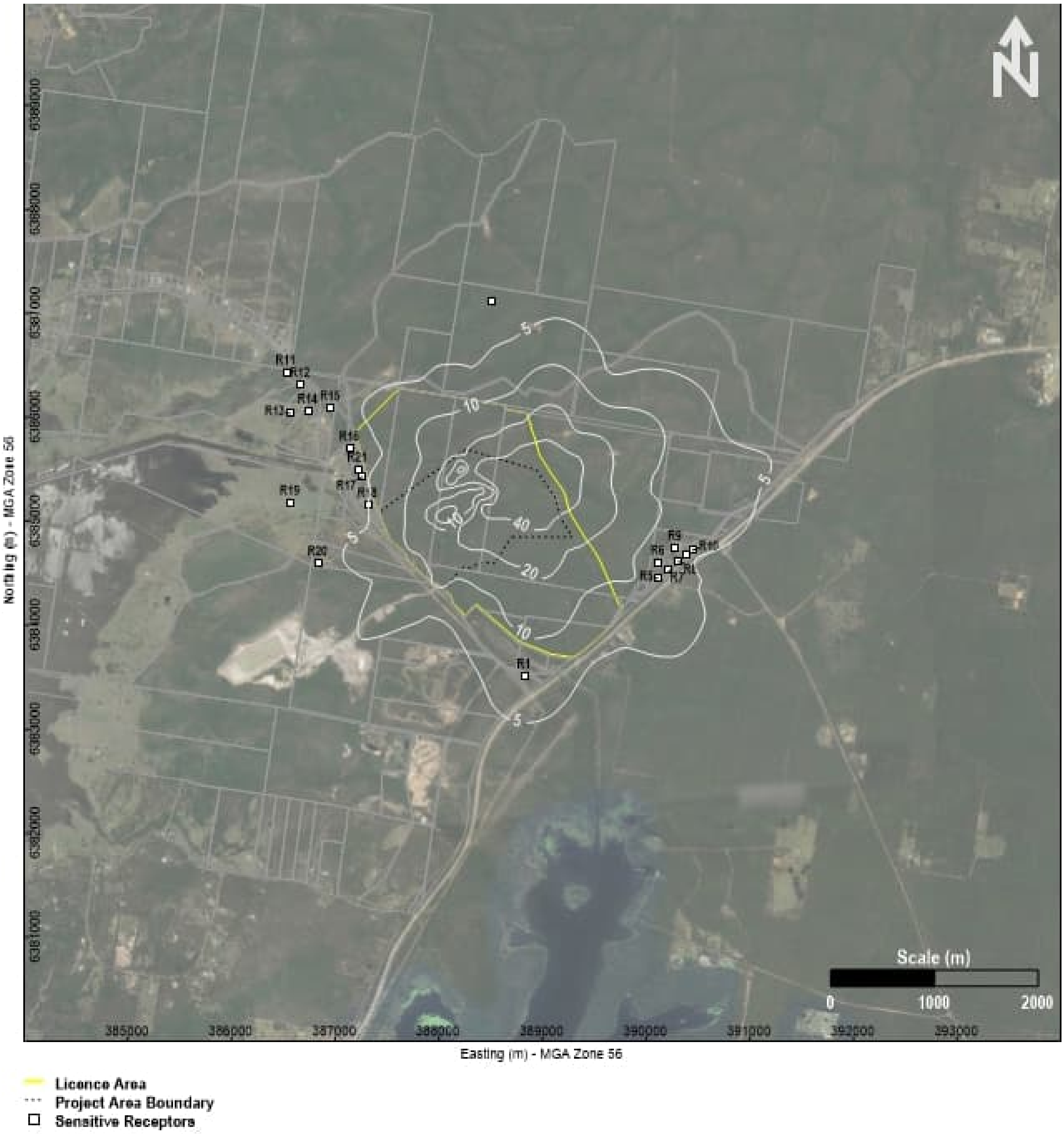


Figure 6.22. Modelled maximum 1-hour averaged NO_2 concentrations from diesel emissions (µg/m^3)

6.5 Road Transport

As outlined in Section 5.5, Roads and Maritime Services TRAQ was used to predict the effects of diesel emissions from trucks transporting quarry products along public roads. Table 6.11 and Table 6.12 show the maximum concentrations at kerbside of key air quality indicators as predicted by TRAQ along Italia Road and the Pacific Highway for operational stages 1, 5 and 9. The background concentrations for NO_2 and PM_{10} were applied as determined in Section 4.3, with the maximum 24-hour averaged PM_{10} value of 36 µg/m^3 measured at DPE Beresfield in 2021 applied. The default background 1-hour and 8-hour averaged CO concentrations for 'rural' environments were applied. The predictions from TRAQ were combined with these adopted background concentrations to predict resulting changes in cumulative roadside air quality because of the additional quarry-related transportation. These concentrations were evaluated by comparing the results against the applicable EPA assessment criteria.

Table 6.11. Predicted maximum concentrations at kerbside due to diesel exhaust emissions, Italia Road

Substance	Averaging time	Due to diesel exhaust emissions	Background level	Cumulative	Criterion
Italia Road, Stage 1					
Carbon monoxide (CO) (mg/m^3)	1-hour	<0.1	0.7*	<0.8	30
	8-hour	<0.1	0.7*	<0.8	10
Nitrogen dioxide (NO_2) (µg/m^3)	1-hour	2.2	70	72.2	164
	Annual	0.4	12	12.4	31
Particulate matter (PM_{10}) (µg/m^3)	24-hour	1.5	36	37.5	50
	Annual	0.6	16	16.6	25
Italia Road, Stage 5					
Carbon monoxide (CO) (mg/m^3)	1-hour	<0.1	0.7*	<0.8	30
	8-hour	<0.1	0.7*	<0.8	10
Nitrogen dioxide (NO_2) (µg/m^3)	1-hour	1.7	70	71.7	164
	Annual	0.3	12	70.3	31
Particulate matter (PM_{10}) (µg/m^3)	24-hour	1.3	36	37.3	50
	Annual	0.5	16	16.5	25
Italia Road, Stage 9					
Carbon monoxide (CO) (mg/m^3)	1-hour	<0.1	0.7*	<0.8	30
	8-hour	<0.1	0.7*	<0.8	10
Nitrogen dioxide (NO_2) (µg/m^3)	1-hour	1.6	70	71.6	164
	Annual	0.3	12	12.3	31
Particulate matter (PM_{10}) (µg/m^3)	24-hour	1.3	36	37.3	50
	Annual	0.5	16	16.5	25

* TRAQ defaults for "rural" environment

Table 6.12. Predicted maximum concentrations at kerbside due to diesel exhaust emissions, Pacific Highway

Substance	Averaging time	Due to diesel exhaust emissions	Background level	Cumulative	Criterion
Pacific Highway, Stage 1					
Carbon monoxide (CO) (mg/m^3)	1-hour	<0.1	0.7*	<0.8	30
	8-hour	<0.1	0.7*	<0.8	10
Nitrogen dioxide (NO_2) (µg/m^3)	1-hour	1.3	70	71.3	164
	Annual	0.3	12	12.3	31
Particulate matter (PM_{10}) (µg/m^3)	24-hour	0.7	36	36.7	50
	Annual	0.3	16	16.3	25
Pacific Highway, Stage 5					
	1-hour	<0.1	0.7*	<0.8	30

Substance	Averaging time	Due to diesel exhaust emissions	Background level	Cumulative	Criterion
Carbon monoxide (CO) (mg/m^3)	8-hour	<0.1	0.7*	<0.8	10
Nitrogen dioxide (NO_2) ($\mu g/m^3$)	1-hour	1.0	70	71.0	164
	Annual	0.2	12	12.2	31
Particulate matter (PM_{10}) ($\mu g/m^3$)	24-hour	0.6	36	36.6	50
	Annual	0.2	16	16.2	25
Pacific Highway, Stage 9					
Carbon monoxide (CO) (mg/m^3)	1-hour	<0.1	0.7*	<0.8	30
	8-hour	<0.1	0.7*	<0.8	10
Nitrogen dioxide (NO_2) ($\mu g/m^3$)	1-hour	0.9	70	70.9	164
	Annual	0.2	12	12.2	31
Particulate matter (PM_{10}) ($\mu g/m^3$)	24-hour	0.6	36	36.6	50
	Annual	0.2	16	16.2	25

* TRAQ defaults for “rural” environment

As Table 6.11 and Table 6.12 show, diesel exhausts emissions from traffic along on public roads generated from the Project will not lead to any exceedances of the EPA’s impact assessment criteria. On this basis it is considered that additional traffic from the quarry along the public network is unlikely to result in adverse air quality impacts.

6.6 Crystalline Silica

As outlined in Section 5.6, potential off-site impacts from crystalline silica were evaluated by comparing the results from $PM_{2.5}$ modelling with the air pollution assessment criterion adopted from the VIC EPA’s Publication 1961. This approach considers how respirable crystalline silica is a subset of $PM_{2.5}$. The highest predicted results for the three stages of development assessed (being Stage 9) are presented in Table 6.13.

Table 6.13. Predicted results, crystalline silica

Air quality indicator	Averaging time	Air pollution assessment criterion ($\mu g/m^3$)	Highest predicted concentration ($\mu g/m^3$)	
			Off-site receiver	At Boundary
Respirable crystalline silica (defined as the $PM_{2.5}$ fraction)	Annual	3	<0.1	0.8

As Table 6.13 shows, concentrations were predicted to be around 30 times below the air pollution assessment criterion at the most-affected sensitive receptor. As such, it can be expected that the Project is unlikely to cause adverse off-site air quality impacts with respect to crystalline silica.

6.7 Odour

Impacts from odour generated from the use of the mobile road chip precoating plant were predicted using the site dispersion model, with the emissions inputs applied as outlined in Section 5.7. As Table 6.14 shows, 99^{th} and 100^{th} percentile, 1-hour averaged odour concentrations both at the site, and at surrounding sensitive receptors were predicted to be well below the most stringent 2 OU criterion from the EPA’s Approved Methods.

Table 6.14. Predicted results, odour from mobile road chip precoating plant

Air quality indicator	Averaging time	Impact assessment criterion (OU)	Predicted results (OU)			
			Maximum on-site value		Maximum value at off-site receiver	
			100th percentile	99th percentile	100th percentile	99th percentile
Odour	1-hour	2	1.2	<0.1	<0.1	<0.1

Based on these results, the assessment indicates that odour from the mobile road chip precoating plant is unlikely to present an issue to surrounding amenity. This is expected to remain the case wherever the unit is used across the Central Processing Area, with sensitivity testing undertaken to determine that actual odour emissions would need to be more than two orders of magnitude (i.e., 100 times higher) before concentrations approaching 2 OU were predicted at off-site sensitive receptors.

6.8 Cumulative Impact Assessment

As outlined in Section 0, and consistent with the SEARs, further assessment was undertaken to determine the 'combined cumulative impacts' from existing and potential future nearby developments, in addition to the 'incremental cumulative' results presented above. Incremental air quality impacts from the three nearby existing and proposed Projects listed in Table 5.6 at sensitive receptors surrounding the Project were estimated as outlined in the following bullets:

- Boral Quarries Seaham (Balickera): This site operates in accordance with Environment Protection Licence (EPL) No. 3956, allowing a maximum annual rate of extraction and processing of 2,000,000 tpa. EPL No. 3956 does not include any air quality monitoring requirements, and no air quality impact assessment results were able to be identified. As displayed in Appendix A, prevailing local winds blow from the West Northwest (i.e., not in a direction whereby nearby sensitive receptors would be cumulatively impacted by this site and the Project). Still, the nearest receptors are located a similar distance as from the Project and the nature of products developed are expected to be similar. Accordingly, contributions from this site were estimated by multiplying the contributions from the Project at the equivalent locations by 1.33 to account for the higher (2,000,000 tpa compared with 1,500,000 tpa for the Project) approved maximum annual extraction and production allowed in EPL No. 3956.
- Brandy Hill Quarry: Potential air quality impacts from expanded operations (to an annual extraction rate of 1,500,00 tpa) were assessed in the report, 'Air Quality Impact Assessment Brandy Hill Quarry Expansion' (Todoroski Air Sciences, 2019). Results from the nearest sensitive receptor to those surrounding the Stone Ridge Quarry Project (located approximately seven kilometres to the West) are summarised in Table 6.15 below.

Table 6.15. Predicted contributions from expanded operations at Brandy Hill Quarry, Stage 4 (Todoroski Air Sciences, 2019)

Receptor	Project contributions, typical operations					
	PM_{10} (Annual) (µg/m^3)	PM_{10} (24-hour maximum) (µg/m^3)	$PM_{2.5}$ (Annual) (µg/m^3)	$PM_{2.5}$ (24-hour maximum) (µg/m^3)	TSP (Annual) (µg/m^3)	Deposited dust (g/m^2/month)
(R17) approximately 7 km to the west of the nearest assessed receptors	1.0	6.8	0.2	1.0	2.0	<0.1

Given the separation distance to the closest nearby receptor to the Project, incremental impacts from Brandy Hill Quarry at these locations are expected to be negligible.

- Eagleton Quarry Project: Potential air quality impacts associated with this Project are detailed in 'Eagleton Quarry Production Increase – Air Quality and Greenhouse Gas Assessment' (Pacific Environment Limited, 2017a) and ' Air Quality Assessment proposed Eagleton Quarry – Response to Comments' (Pacific Environment Limited, 2017b). For the proposed maximum annual extraction rate of 600,000 tpa under typical operations, the results summarised in Table 6.16 were predicted at selected surrounding receptors.

Table 6.16. Predicted contributions from Eagleton Quarry Project (Pacific Environment Limited, 2017b)

Receptor	Project contributions, typical operations					
	PM_{10} (Annual) (µg/m^3)	PM_{10} (24-hour maximum) (µg/m^3)	$PM_{2.5}$ (Annual) (µg/m^3)	$PM_{2.5}$ (24-hour maximum) (µg/m^3)	TSP (Annual) (µg/m^3)	Deposited dust (g/m^2/ month)
R1 (R1)	0.3	4.9	0.1	1.3	0.7	<0.1
R5 (R38)	<0.1	1.1	<0.1	0.7	0.1	<0.1
R18 (R70)	0.1	2.0	<0.1	1.1	0.2	<0.1
R19 (R71)	0.2	1.9	0.1	1.0	0.2	<0.1
R20 (R69)	0.3	2.9	0.1	1.7	0.4	<0.1

Note: Unbracketed receptor IDs are as defined in Figure 1.1. Bracketed receptor IDs are from Pacific Environment Limited, 2017b

Considering the potential contributions from the other similar existing and proposed developments determined above in addition to the contributions predicted for the Project and the adopted background levels, Table 6.17 to Table 6.22 list the estimated combined cumulative impacts of PM_{10}, $PM_{2.5}$, TSP and Deposited Dust at selected sensitive receptors. As displayed, resulting concentrations and levels were predicted to remain at or below the relevant impact assessment criteria. It is noted that these estimates are conservative, considering the highest contributions from the Project, and if Boral Quarries Seaham (Balickera) and Eagleton Quarry Project are operating at their maximum-approved production capacities.

Table 6.17. Estimated combined cumulative impacts, annually averaged PM_{10} compared to 25 µg/m^3 impact assessment criterion

Receptor	Project (most-affected stage) (µg/m^3)	Eagleton Quarry Project (µg/m^3)	Brandy Hill Quarry (µg/m^3)	Boral Quarries Seaham (Balickera) (µg/m^3)	Background (µg/m^3)	Combined cumulative impacts (µg/m^3)
R1 (R1)	0.2	0.3	<0.1	0.4	16	16.9
R5 (R38)	0.5	<0.1	<0.1	0.1		16.7
R18 (R70)	0.5	0.1	<0.1	0.1		16.7
R19 (R71)	0.2	0.2	<0.1	0.4		16.8
R20 (R69)	0.3	0.3	<0.1	0.7		17.3

Table 6.18. Estimated combined cumulative impacts, maximum 24-hour averaged PM_{10} compared to 50 µg/m^3 impact assessment criterion

Receptor	Project (most-affected stage) (µg/m^3)	Eagleton Quarry Project (µg/m^3)	Brandy Hill Quarry (µg/m^3)	Boral Quarries Seaham (Balickera) (µg/m^3)	Background (µg/m^3)	Combined cumulative impacts (µg/m^3)
R1 (R1)	2.5	4.9	<0.1	2.7	36	46.1
R5 (R38)	3.0	1.1	<0.1	1.3		41.4
R18 (R70)	7.2	2.0	<0.1	2.7		47.9

Receptor	Project (most-affected stage) (µg/m³)	Eagleton Quarry Project (µg/m³)	Brandy Hill Quarry (µg/m³)	Boral Quarries Seaham (Balickera) (µg/m³)	Background (µg/m³)	Combined cumulative impacts (µg/m³)
R19 (R71)	2.1	1.9	<0.1	4.0		44.0
R20 (R69)	3.3	2.9	<0.1	7.8		50.0

Table 6.19. Estimated combined cumulative impacts, annually averaged $PM_{2.5}$ compared to 8 µg/m³ impact assessment criterion

Receptor	Project (most-affected stage) (µg/m³)	Eagleton Quarry Project (µg/m³)	Brandy Hill Quarry (µg/m³)	Boral Quarries Seaham (Balickera) (µg/m³)	Background (µg/m³)	Combined cumulative impacts (µg/m³)
R1 (R1)	<0.1	0.1	<0.1	<0.1	5.9	6.0
R5 (R38)	0.1	<0.1	<0.1	<0.1		6.0
R18 (R70)	0.1	<0.1	<0.1	<0.1		6.0
R19 (R71)	<0.1	0.1	<0.1	<0.1		6.0
R20 (R69)	<0.1	0.1	<0.1	0.1		6.1

Table 6.20. Estimated combined cumulative impacts, maximum 24-hour averaged $PM_{2.5}$ compared to 25 µg/m³ impact assessment criterion

Receptor	Project (most-affected stage) (µg/m³)	Eagleton Quarry Project (µg/m³)	Brandy Hill Quarry (µg/m³)	Boral Quarries Seaham (Balickera) (µg/m³)	Background (µg/m³)	Combined cumulative impacts (µg/m³)
R1 (R1)	0.3	0.3	<0.1	0.3	19	19.9
R5 (R38)	0.4	<0.1	<0.1	<0.1		19.4
R18 (R70)	0.7	0.1	<0.1	0.3		20.1
R19 (R71)	0.2	0.2	<0.1	0.5		19.9
R20 (R69)	0.3	0.3	<0.1	1.0		20.6

Table 6.21. Estimated combined cumulative impacts, annually averaged TSP compared to 90 µg/m³ impact assessment criterion

Receptor	Project (most-affected stage) (µg/m³)	Eagleton Quarry Project (µg/m³)	Brandy Hill Quarry (µg/m³)	Boral Quarries Seaham (Balickera) (µg/m³)	Background (µg/m³)	Combined cumulative impacts (µg/m³)
R1 (R1)	0.3	0.3	<0.1	0.3	40	40.9
R5 (R38)	0.7	<0.1	<0.1	0.1		40.7
R18 (R70)	0.7	0.1	<0.1	0.2		41.0
R19 (R71)	0.3	0.2	<0.1	0.4		40.9
R20 (R69)	0.4	0.3	<0.1	0.7		41.4

Table 6.22. Estimated combined cumulative impacts, annually averaged deposited dust compared to 4 $g/m^2/month$ impact assessment criterion

Receptor	Project (most-affected stage) ($\mu g/m^3$)	Eagleton Quarry Project ($\mu g/m^3$)	Brandy Hill Quarry ($\mu g/m^3$)	Boral Quarries Seaham (Balickera) ($\mu g/m^3$)	Background ($\mu g/m^3$)	Combined cumulative impacts ($\mu g/m^3$)
R1 (R1)	0.1	0.3	<0.1	0.1	1.8	2.3
R5 (R38)	0.3	<0.1	<0.1	<0.1		2.1
R18 (R70)	0.2	0.1	<0.1	<0.1		2.1
R19 (R71)	<0.1	0.2	<0.1	0.1		2.1
R20 (R69)	0.1	0.3	<0.1	0.2		2.4

Regarding the potential for 'combined cumulative impacts' from crystalline silica was also considered. This was undertaken using the estimates for annually averaged $PM_{2.5}$ above and the methodology outlined in Section 5.6. Using this approach, the highest concentration predicted from the Project and the other surrounding developments was 0.2 $\mu g/m^3$; well below the VIC EPA's 3 $\mu g/m^3$ criterion. Given the extent of compliance predicted for the other pollutants assessed above including diesel exhaust post blast fume and odour, resulting 'combined cumulative impacts' are also expected to remain below the relevant impact assessment criteria.

7. Greenhouse Gas Assessment

7.1 Emissions

Table 7.1 shows the estimated emissions of greenhouse gases due to all identified GHG-generating activities over the life of the Project. Annual Scope 1 greenhouse gas emissions were predicted to range from 4,111 t CO_2-e/year (Year 17 to Year 22) to a maximum of 16,743 t CO_2-e/year in Year 1. Lost carbon sinks associated with vegetation clearing was the predominant source of Scope 1 emissions in Year 1 and Year 2. This, in combination with emissions from diesel use in plant and equipment were all significant contributors from Year 3 to Year 10 when most clearing is anticipated to be complete. The Scope 1 emissions associated with clearing do not take into consideration carbon sequestration associated with biodiversity gains in offset areas and, as such, are conservative. Scope 2 emissions from off-site electricity generation, remained a consistent source of emissions from Year 3 when on-site energy needs are planned to be transitioned from on-site generators to the grid. It is noted that the NGA Factors (DCCEEW, 2023) do not account for expected reductions in GHG intensity of electricity production with increased renewable supply, and as such associated estimates are conservative Appendix D provides more detailed breakdowns of the estimated emissions for each activity by year.

Table 7.1. Summary of estimated greenhouse gas emissions

Year	Emissions (t CO_2-e/year)								
	Diesel usage, plant, and equipment		Diesel usage, stationary engines		Blasting	Vegetation clearing	Electricity		Construction materials
	Scope 1	Scope 3	Scope 1	Scope 3	Scope 1	Scope 1	Scope 2	Scope 3	Scope 3
1	1,973	471	1,249	64	73	10,677	0	0	2,236
2	1,896	465	1,249	64	73	11,657	0	0	0
3	1,896	465	0	0	73	1,887	1,133	93	0
4	1,896	465	0	0	73	1,887	1,133	93	0
5	1,896	465	0	0	73	2,199	1,133	93	0
6	1,896	465	0	0	73	1,396	1,133	93	0
7	1,896	465	0	0	73	1,396	1,133	93	0
8	1,896	465	0	0	73	1,177	1,133	93	0
9	1,896	465	0	0	73	1,177	1,133	93	0
10	1,896	465	0	0	73	1,177	1,133	93	0
11	1,896	465	0	0	73	579	1,133	93	0
12	1,896	465	0	0	73	579	1,133	93	0
13	1,896	465	0	0	73	579	1,133	93	0
14	1,896	465	0	0	73	579	1,133	93	0
15	1,896	465	0	0	73	579	1,133	93	0
16	1,896	465	0	0	73	579	1,133	93	0
17	1,896	465	0	0	73	451	1,133	93	0
18	1,896	465	0	0	73	451	1,133	93	0
19	1,896	465	0	0	73	451	1,133	93	0
20	1,896	465	0	0	73	451	1,133	93	0
21	1,896	465	0	0	73	451	1,133	93	0
22	1,896	465	0	0	73	451	1,133	93	0
23	1,896	465	0	0	73	525	1,133	93	0
24	1,896	465	0	0	73	525	1,133	93	0
25	1,896	465	0	0	73	525	1,133	93	0
26	1,896	465	0	0	73	525	1,133	93	0
27	1,896	465	0	0	73	525	1,133	93	0

Year	Emissions (t CO_2-e/year)								
	Diesel usage, plant, and equipment		Diesel usage, stationary engines		Blasting	Vegetation clearing	Electricity		Construction materials
	Scope 1	Scope 3	Scope 1	Scope 3	Scope 1	Scope 1	Scope 2	Scope 3	Scope 3
28	1,896	465	0	0	71	586	1,133	93	0
29	1,896	465	0	0	71	586	1,133	93	0
30	1,896	465	0	0	71	586	1,133	93	0
Average	2,363		88		73	1,506	1,145		75
Annual average	5,250								
Annual average Scope 1 and 2	4,693								
Totals over life of Project									
Total	70,904		2,625		2,197	45,194	31,888		2,236
Scope 1	106,832								
Scope 2	31724								
Scope 3	18,924								
Total	157,480								

7.2 Impact and Context

The Commonwealth Department of Industry, Science, Energy and Resources (DISER) provides a National and State and Territory Greenhouse Gas Inventories, where statistics on emissions per annum are stored, and detailed analysis of sources can be determined. To develop the context for this assessment, the impacts of the emissions projected in this assessment have been compared with the latest emissions officially recorded on the National and State and Territory Greenhouse Gas Inventories (DISER, 2022a and 2022b). The latest available annual data through the inventories is from 2020.

Table 7.2 presents these national and State figures in context with the projected emissions from the Project. The estimated maximum (0.017 Mt CO_2-e) and average (0.0053 Mt CO_2-e) annual Scope 1, 2 and 3 emissions from the Project represent less than 0.0035% of Australia's and 0.013% of NSW's 2020 emissions respectively.

Table 7.2. Greenhouse gas emissions in the National and State context

Parameter	Value
National and State statistics	
2020 Total Australia GHG emissions (Mt CO2-e) (DISER, 2022a)	487.6
2020 Total NSW GHG emissions (Mt CO2-e) (DISER, 2022b)	132.4
Project statistics	
Average projected GHG emissions per year (Mt CO_2-e)	0.0053
Proportion of 2020 total Australia emissions (%)	0.0011
Proportion of 2020 total NSW emissions (%)	0.004
Maximum projected GHG emissions per year (Mt CO_2-e)	0.017
Proportion of 2020 total Australia emissions (%)	0.0034
Proportion of 2020 total NSW emissions (%)	0.013

In addition to the direct emissions associated with the Project, the following emissions sources are relevant to operations:

- Road transport of product to customers; and
- Product processing and usage by customers.

The indirect sources listed above have been classified as Scope 3 for the Project as the emissions, while a result of the activities, are from sources not owned or operated by ARDG. As noted in Section 3.2 the purpose of differentiating between the scopes of emissions is to avoid the potential for double counting, where two or more organisations assume responsibility for the same emissions. Still, Table 7.3 estimates the total greenhouse gas emissions from the combustion of diesel in customer trucks travelling along the quarry main access road before entering the public road network. This was estimated using TRAQ based on the annual number of truck movements.

Table 7.3. Estimated greenhouse gas emissions from customer truck movements along quarry main access road

Activity	Emissions (t CO_2-e over Project 30-year operational life)
Trucks receiving product from the Project travelling along the main access road before entering the public road network	4,074

Section 9 outlines the monitoring and management measures for the Project including those relevant to the minimisation of greenhouse gas emissions.

8. Monitoring and Management

8.1 Particulate Matter

The modelling presented above in Section 6.2 predicted that the change in dust concentrations and deposited dust levels due to the Project would not cause exceedances of the relevant EPA assessment criteria at the nearest sensitive receptors. These predictions considered the application of the following control measures, which should be implemented during operations:

Table 8.1. Emission management measures

Activity	Emission management measures	Assumed emission control (%) (NPI, 2012)
Drilling rock	Water sprays Minimising activities when excessive visible dust is generated	70%
Hauling on roads	Regular watering of unsealed haul routes / roads Restricting vehicle speeds to 20 kph Clearly marked haul routes	50%
Crushing (primary, secondary, and tertiary) and screening using fixed plant at central processing area	Partial enclosures around dust-generating components Water sprays	70%
Conveyors between process units at central processing area	Water sprays	50%
Wind erosion	Water sprays Minimising activities when excessive visible dust is generated Stabilising and minimising the extent of materials stored on-site Progressive rehabilitation of exposed areas	50 to 65%

The SEARs require that all reasonable and feasible measures to minimise dust are implemented, including consideration of real-time air quality monitoring. In-line with this requirement, the following standard measures are recommended:

- minimising the area of disturbed land at any one time, in line with the approved Quarry Operations Plan
- implementation of timely progressive rehabilitation
- adopting controls for haul road dust emissions
- review of meteorological conditions prior to blasting
- consideration of meteorological conditions in planning the loading and unloading of overburden and product materials
- applying water and using dust curtains when drilling overburden
- minimising fall distances during loading and unloading of materials
- utilising water sprays and water carts as needed on exposed areas and stockpiled materials
- maintaining the existing controls on fixed plant at processing area, including transfers
- routine inspection (and where necessary cleaning) of water tanks and solar cells at residents along Nine Mile Creek Road, Ferodale.

These as well as those listed in Table 8.1 and below in Section 8.3 should be included in a site Air Quality Management Plan.

As the modelling showed that the change in ambient air quality at the nearest private sensitive receptors would not lead to exceedances of criteria, real-time monitoring is not identified as a recommended measure. However, the data collected from a real-time monitoring system would inform whether further on-site controls are adequate or whether further measures are needed, so that any potential issues could be readily addressed.

Real-time monitoring involves the use of monitoring equipment capable of real-time (e.g., hourly, or better resolution) measurement and reporting (e.g., E-BAM) usually at the nearest sensitive receivers. Multiple monitors are often used and configured around key emission sources at suitable ‘upwind’ and ‘downwind’ locations based on prevailing local wind conditions. Considering the prevailing annual meteorological trends, the predicted results, and the locations of the nearest receptors, PM_{10} monitors placed at or in the corresponding directions near the boundary of the Project Area near receptors R18 or R19 to the west and receivers R5 or R6 to the east southeast would be most suitable. Locations would need to meet exposure guidelines from Australian Standards for siting air monitoring equipment. Suitable meteorological data would also be necessary for the interpretation of results.

Additionally, there are also various forecasting tools available that may assist with proactive management of dust emissions. These tools can be categorised into three main types:

- General weather information
- Regional wind predictions
- Site specific wind and dust predictions.

General weather forecasts and five to seven-day outlooks can assist with identifying potentially high-risk days for dust, based on consideration of expected hot, dry and / or windy conditions. These forecasts are available from the Bureau of Meteorology website (www.bom.gov.au).

Regional five-day wind predictions are also available. The predictions are typically based on extraction of synoptic-scale forecasts from the Global Forecast System for various regions. The predictions can assist with identifying potentially high-risk times of days for dust, based on consideration of expected wind conditions.

Finally, site-specific dust and meteorological forecasting systems exist which can use local information to identify times and locations of increased dust risk, based on automated, daily dispersion modelling of emissions from identified sources. The forecasts can be used for discussion at pre-shift meetings and to assist with planning of daily operations to proactively manage air quality. As the modelling showed that the change in ambient air quality at the nearest private sensitive receivers would not lead to exceedances of criteria, predictive air quality forecasting has not been identified as a recommended measure

Real-time monitoring and forecasting systems can allow emissions to air to be actively managed so that potential issues are identified early. Both methods form part of best practice approaches to minimise dust generation and potential impacts. However, these have specifically not been included as recommended measures since the modelling showed that predicted impacts from the Project at sensitive receivers are minimal and the change in ambient air quality at the nearest private sensitive receivers would not lead to exceedances of criteria. Accordingly, imposing proactive and reactive management measures is not considered necessary to ensure compliance with relevant assessment criteria.

8.2 Post-Blast Fume

Although the assessment determined that Project will not cause adverse blast fume impacts due to blasting, the following measure is recommended to ensure that this outcome is achieved:

- Development of a site Blast Management Plan to managing blasting activities during operations. It is expected that this plan would define the allowable times of the day when blasting can occur. The plan should also identify weather conditions that may lead to higher potential risks, and the process that would be implemented to avoid or otherwise effectively manage blasting during these conditions.
- Monitoring of NO_x emissions is not considered to be necessary given the very low risk of exceedance of relevant criteria.

8.3 Diesel Exhaust

Though diesel exhaust emissions from site operations were not determined to present an issue, the following recommendations should be applied:

- Servicing all machinery in accordance with maintenance contracts and adopting original equipment manufacturer recommendations for maintenance.
- Targeting the maintenance to ensure, as far as reasonably practical, equipment remains fit for purpose over its whole life cycle.
- Defining failure modes, effects and criticality which helps to minimise potential equipment failure.

These measures are consistent with the equipment maintenance and engine replacement strategies from the 'NSW Coal Mining Benchmarking Study: Best practice measures for reducing non-road diesel exhaust emissions', (EPA, 2014), understanding that the Project is not a coal development but that these measures are consistent with best practice.

The plant and equipment-related measures below in Section 8.4 to reduce greenhouse gas emissions would also reduce diesel exhaust emissions.

8.4 Greenhouse Gas Emissions

Mitigation of GHG emissions will be inherent in the development of the quarry development planning. For example, reducing fuel usage by mobile plant and equipment is good practice, and would be an objective of the quarry planning. Recommended measures to reduce the level of future greenhouse gas emissions from the Project which should be included in a Greenhouse Gas Management Plan (GHGMP) include:

- Improving the use of energy at the site and well as in associated supply chains: The assessment considers how electricity at the site would be provided by two diesel generators. It is expected that the GHGMP would include proactive transitional arrangements towards lower carbon energy supply options. Additionally, the GHGMP should include commitments to reduce emissions from plant and equipment. It is expected that this would include:
  - Strategies to ensure that mobile plant and equipment are maintained and operated in an efficient manner so that unnecessary fuel usage is avoided. This should include the shutting down of plant and equipment when they are not in-use and ensuring they are operated in the most efficient mode as relevant to the particular activity being performed.
  - Efficiency and greenhouse gas emissions (e.g., more fuel efficient and alternative fuels e.g., biodiesel and/or as electric/hybrid options rather than diesel) should also be considerations in the selection of plant, equipment and vehicles used at the site and for product transport.
- Minimising the extent of vegetation clearance and implementing revegetation and regeneration of completed areas (as appropriate) as soon as practicable.
- Designing future projects with consideration of energy efficiency and climate change risks.
- Raising awareness of climate change issues amongst all stakeholders.

Implementation of these measures as part of the GHGMP would demonstrate the Project's commitments towards minimising associated greenhouse gas emissions as well as the State government objectives of net-zero emissions by 2050.

9. Conclusions

This report has provided an assessment of the potential air quality and greenhouse gas impacts of the Stone Ridge Quarry Project. In summary, the air quality assessment involved identifying the key air quality issues, characterising the existing environment, quantifying emissions to air and modelling the potential impact of the Project on local air quality. The air dispersion modelling was carried out in accordance with the assessment procedures prescribed by the EPA. Greenhouse gas emissions were estimated in accordance with recognised methodologies.

The key air quality issue was identified as dust (particulates) during operations. This was the focus of the assessment, along with impacts from diesel exhaust emissions, NO_x and NO_2 emissions from blasting, impacts from associated road transport activities, the effects of crystalline silica and odour from the use of a mobile road chip precoating plant.

As part of the assessment, key features of the existing environment were identified including surrounding sensitive receptors, local meteorology, and background air quality. Aerial imagery was used to identify the location of surrounding receptors. Meteorological and ambient air quality data collected at monitors operated by DPE and BoM (Meteorology only) surrounding were reviewed to characterise existing local conditions. The following conclusions were made in relation to the existing environment:

- Meteorological conditions do not vary significantly from year to year, and conditions in 2021 were identified as most representative of the long term, local conditions.
- Air quality conditions are strongly correlated to the climatic conditions. For example, there was a deterioration in air quality conditions between 2017 and early 2020 that were heavily influenced by drought, dust storms and bushfires. These conditions were not unique to the Hunter region.

Air quality emission rates for key dust-generating activities associated with the proposed modification were estimated from local and international guidance. Modelling was then carried out with these emissions to predict potential changes to local air quality. The assessment determined that air quality impacts associated with the Project would meet the relevant requirements from the EPA's Approved Methods as well as the VLAMP. Specifically, it was predicted that:

- Construction and operational dust emissions due are not expected to cause adverse air quality impacts at the nearby sensitive receptors based on modelling which showed compliance with the EPA assessment criteria. No VLAMP mitigation or acquisition triggers were exceeded.
- No exceedances of the EPA's NO_2 criteria from diesel exhaust emissions or from blasting.
- Emissions from truck diesel exhausts travelling on public roads are not expected to result in any adverse air quality impacts based on modelling which showed that maximum kerbside concentrations would not exceed EPA criteria.
- Results from modelling suggest that the Project is not expected to cause adverse air quality impacts with respect to crystalline silica or odour.

An assessment of 'combined cumulative impacts' was also completed consistent with guidance presented in 'Cumulative Impact Assessment Guidelines for State Significant Projects' (DPIE, 2022). This assessment estimated that resulting air quality impacts from the Project, as well as from nearby existing and proposed developments (including background conditions) would not result in overall pollutant levels in excess of the relevant assessment criteria.

Regarding greenhouse gas emissions, an emissions inventory covering the life of operations was calculated in accordance with the principles of the GHG Protocol. This analysis estimated that the maximum (0.017 Mt CO2-e) and average (0.0053 Mt CO2-e) GHG emissions from the Project represent less than 0.0035% of Australia's 2020 emissions.

While this assessment has shown the Project is not expected to cause any adverse air quality impacts or State or nationally significant quantities of greenhouse gas emissions, A range of mitigation and management measures were recommended including a consideration of real-time air quality monitoring.

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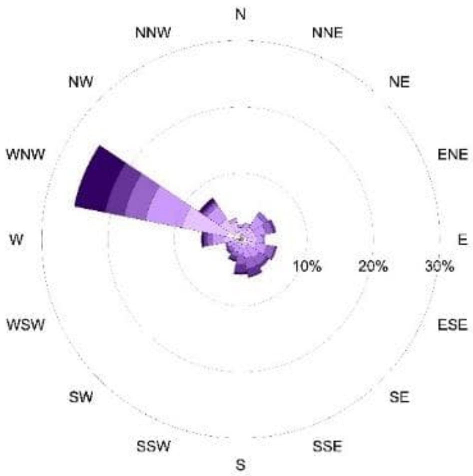
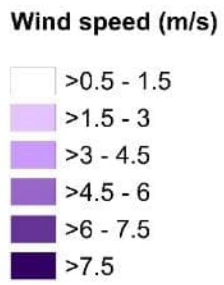
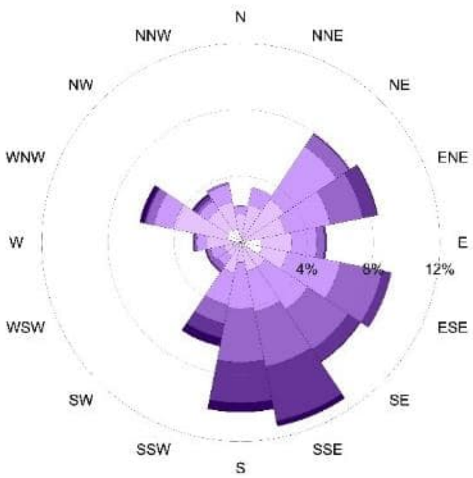
Appendix A. Wind-roses (CALMET site extract)

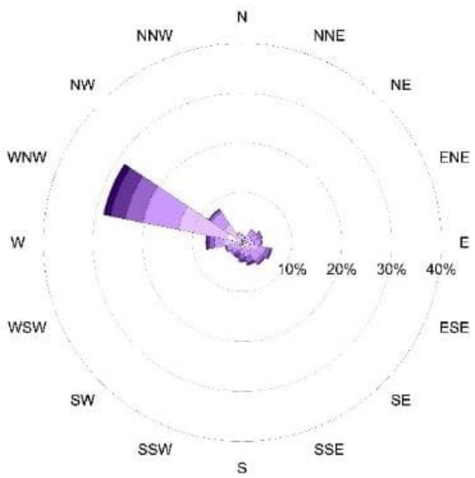


Annual
Calms = 8.4%

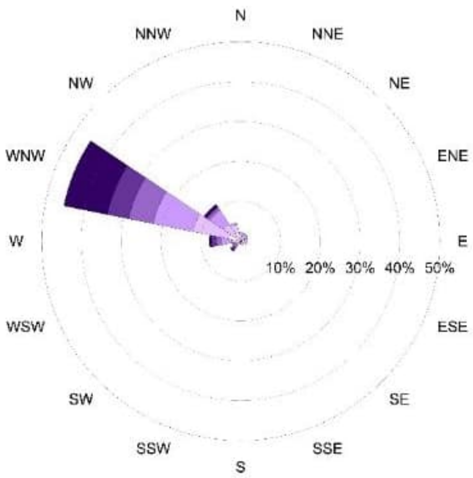




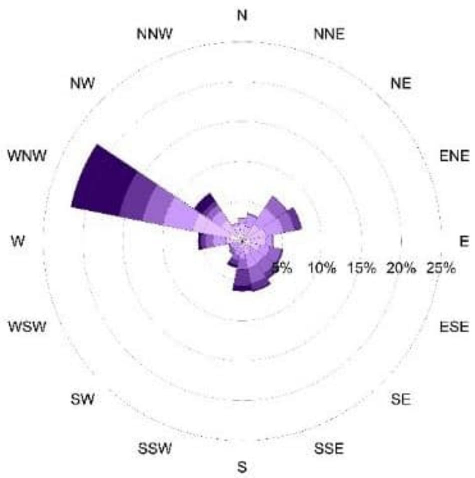
Summer
Calms = 6.3%



Autumn
Calms = 9.5%



Winter
Calms = 10.6%



Spring
Calms = 7.1%

Appendix B. Model settings

Geophysical

Figure B-10.1 shows the model grid, land-use and terrain information, as used by CALMET.

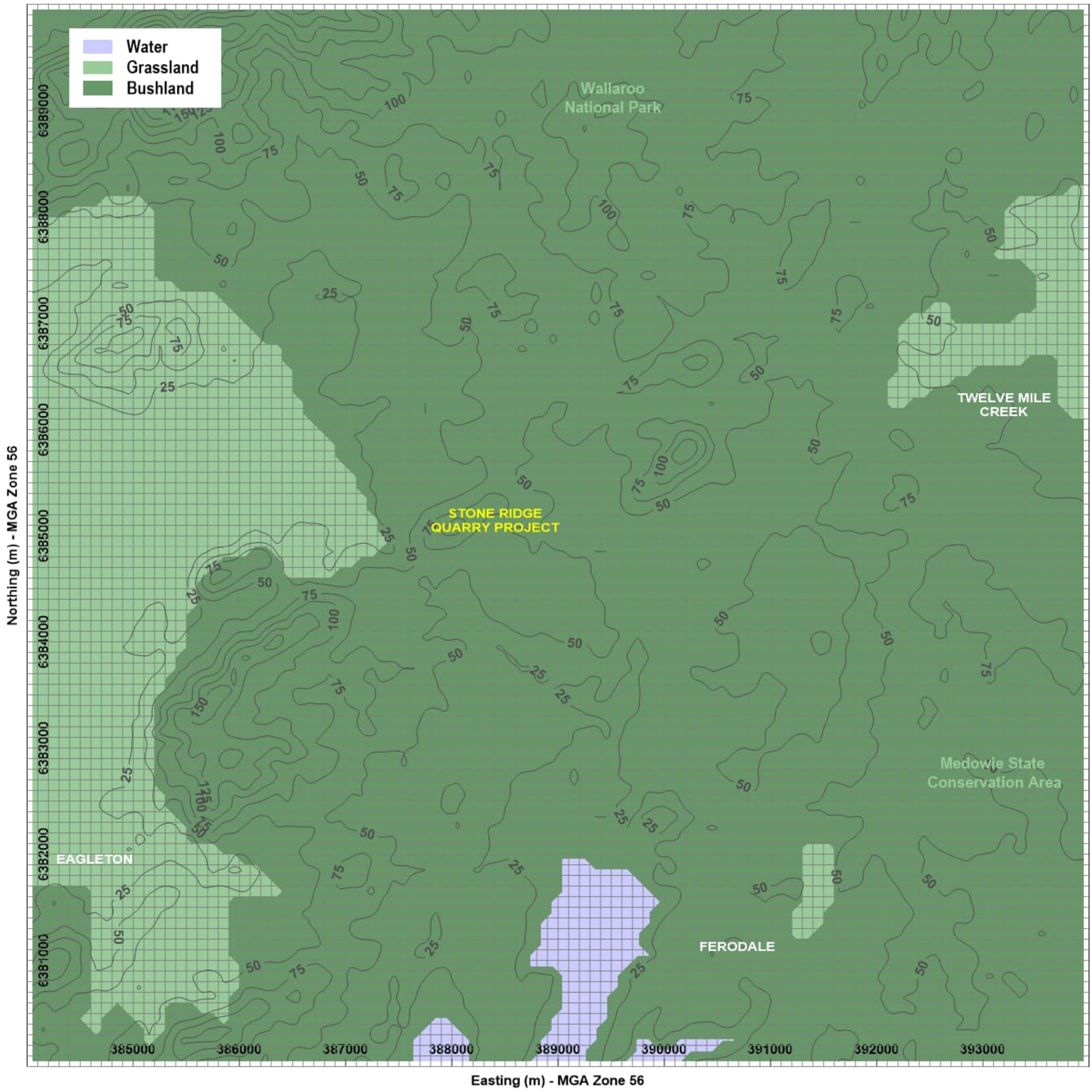


Figure B-10.1. Model domain, grid, land use and terrain information

Meteorology

The CALPUFF model, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The necessary upper air data for CALMET were generated by the CSIRO's prognostic model, TAPM, and the required surface observation data were sourced from local weather stations. CALMET was used to produce a year-long, three-dimensional output of meteorological conditions for input to the CALPUFF air dispersion model. The meteorological modelling followed the guidance of TRC (2011) and adopted the "observations" mode.

Table B-1. Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2021, with one "spin-up" day.
Centre of analysis	Stone Ridge Quarry (32°40' S, 151°49' E)
Terrain data source	90 m Shuttle Research Topography Mission (SRTM)
Land use data source	Default
Meteorological data assimilation	Beresfield and Williamtown meteorological stations. Radius of influence = 10 km. Number of vertical levels for assimilation = 4

Table B-10.1 lists the model settings and input data for CALMET.

Table B-10.1. Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	NASA SRTM 1 second 30 metre resolution dataset
Land use data source(s)	Digitised from aerial imagery
Meteorological grid domain	10 km x 10 km x 2km (vertically)
Meteorological grid resolution	0.1 km
Meteorological grid dimensions	100 x 100 x 9
Meteorological grid origin	384000 m E, 6380000 m S. MGA Zone 56
Surface meteorological stations	BoM Williamtown (observations of wind speed, wind direction, temperature and humidity. TAPM for ceiling height, cloud cover, air pressure) DPE Beresfield (observations of wind speed, wind direction, temperature, humidity and pressure. TAPM for ceiling height and cloud cover)
Upper air meteorological stations	Upper air data file for the location of BoM Williamtown and DPE Beresfield derived by TAPM. Biased towards surface observations (-1, -0.8, -0.6, -0.4, -0.2, 0, 0, 0, 0)
Simulation length	8760 hours (1 Jan 2021 to 31 Dec 2021)
R1, R2	0.5 km, 1 km
RMAX1, RMAX2	5 km, 20 km
TERRAD	5 km

Figure B-10.2 shows a snapshot of winds at 10 metres above ground-level as simulated by the CALMET model under stable conditions.

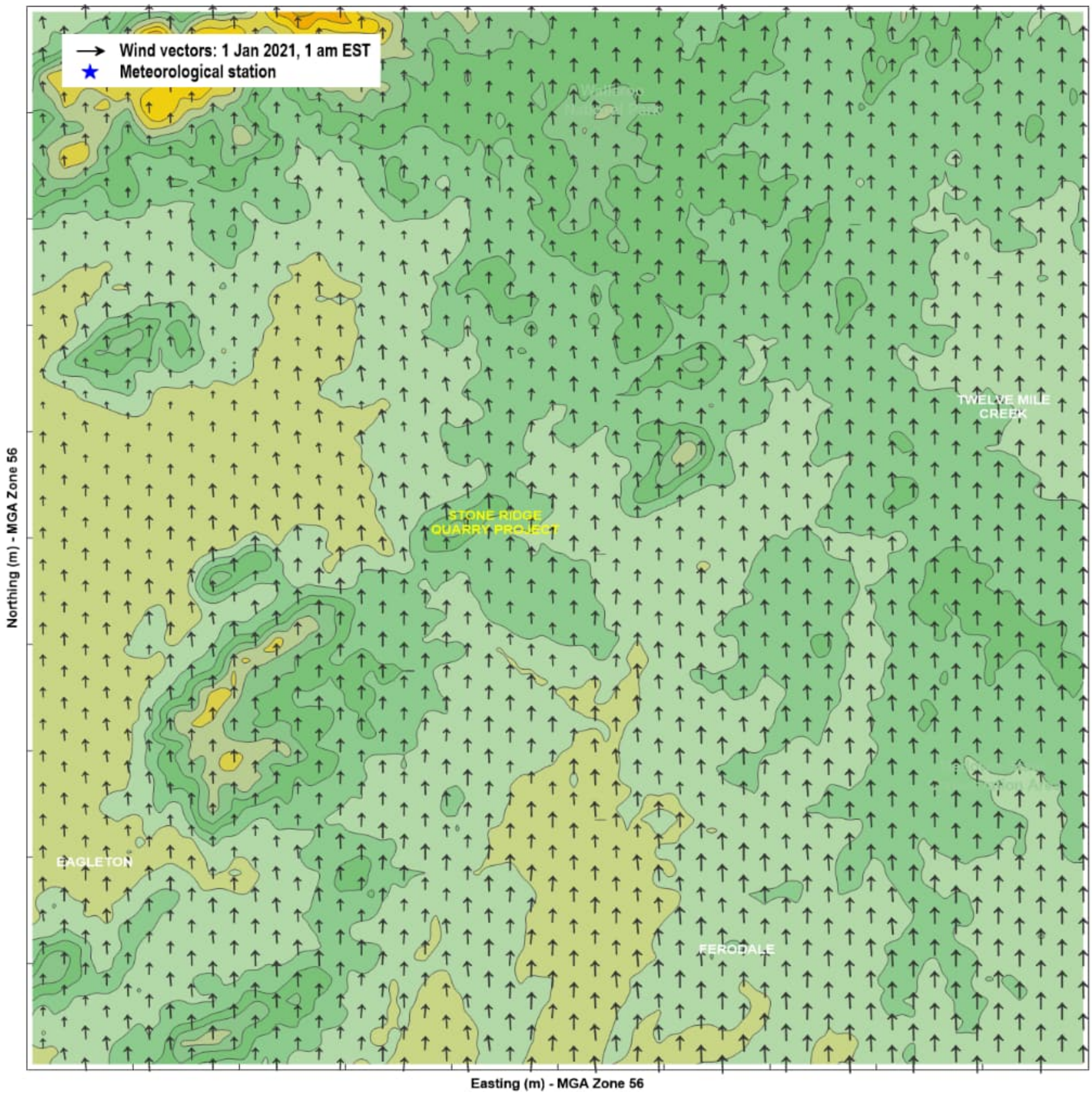


Figure B-10.2. Example of CALMET simulated ground-level wind flows

Receptors

Figure B-3, Figure B-4 and Figure B-5 shows the location of the model receptors for Stages 1, 5 and 9 respectively. These differ slightly, accounting for the different active footprint across the different stages. 1,072, 1,093 and 1116 CALPUFF discrete receptor locations were included for Stages 1, 5 and 9 respectively.

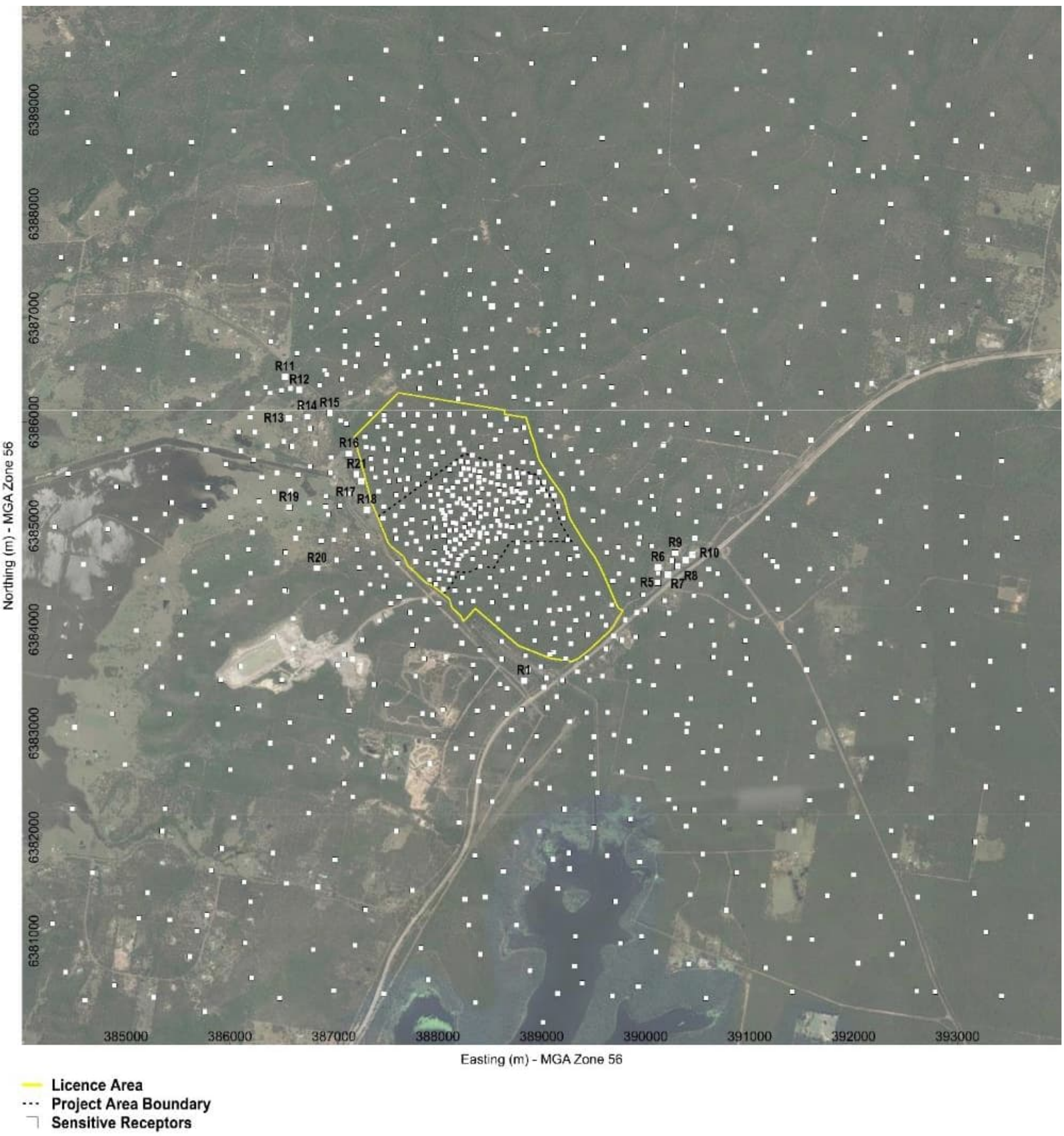


Figure B-3. Model receptors, Stage 1

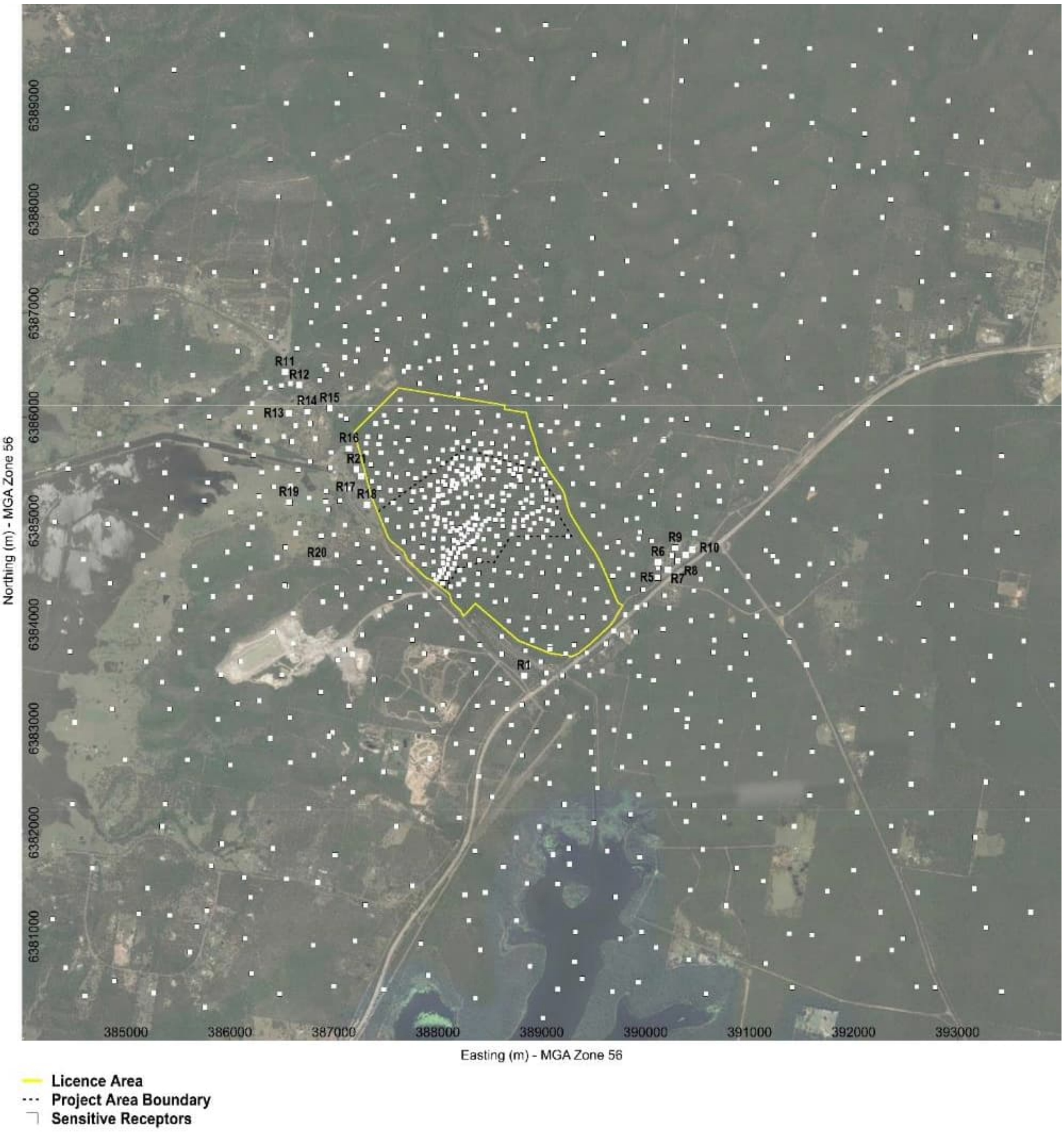


Figure B-4. Model receptors, Stage 5

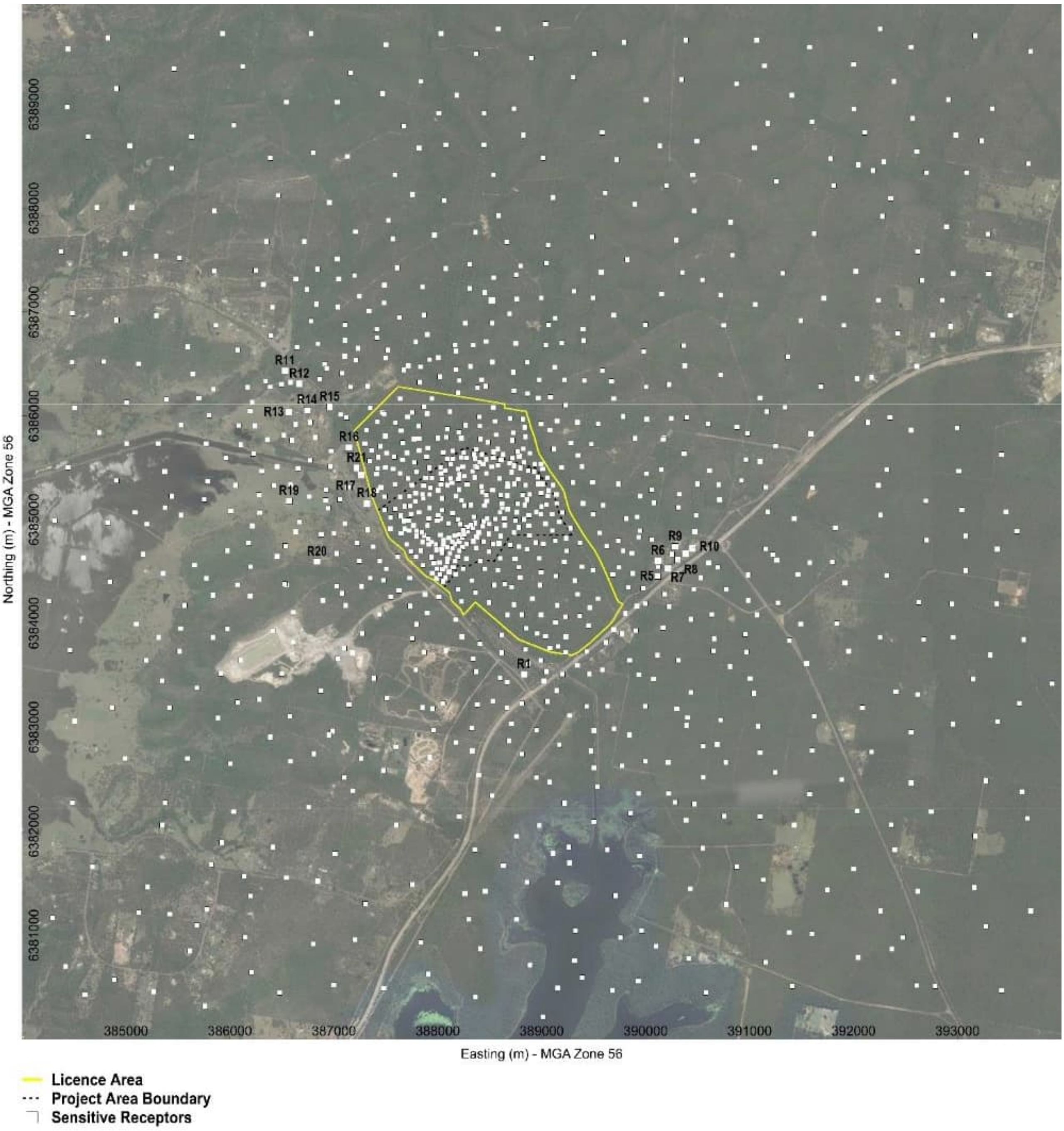


Figure B-5. Model receptors, Stage 9

Ground-level concentration and deposition levels due to the emission sources have been predicted using the air dispersion model known as CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and AERMOD) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. CALPUFF can model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping. CALPUFF is an air dispersion model which has been approved by the EPA for these types of assessments (EPA, 2016).

Key model settings and inputs for CALPUFF are provided in Table . These settings have been chosen for consistency with the recommendations of TRC (2011).

Table B-3. Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
Computational grid domain	100 x 100 grid points
Chemical transformation	None
Dry deposition	Yes
Wind speed profile	ISC rural
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Number of volume sources	163, 173 and 199 for Stages 1, 5 and 9. Height = 5 m, SY = 20 m, SZ = 10 m.
Number of discrete receptors	1,072, 1,093 and 1116 CALPUFF discrete receptor locations were included for Stages 1, 5 and 9 (See **Figure B-3** to **Figure B-5** above)

Appendix C. Emission calculations

Stage 1: Source locations

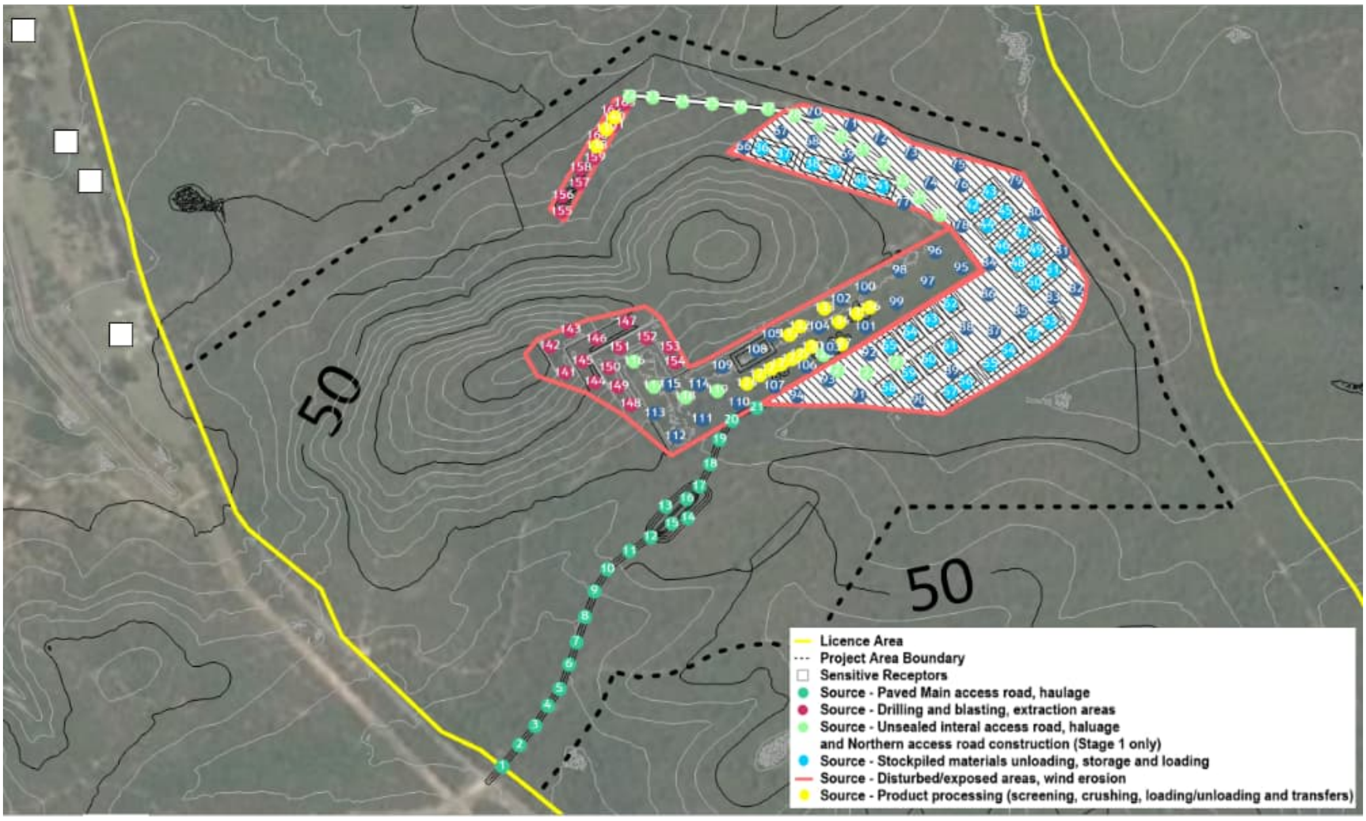


Figure C-1. Stage 1 Source locations

Stage 1: Sources, activities, and calculations

Emission calculations																			
Stone Ridge Quarry Stage 1																			
	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables						
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	(ws/2.2)^1.3	Moisture (%)	t/truck	km/trip	Silt (%)	Silt load (g/m2)	Reference
Dozer - Construction of Northern Haul Road	269	58	28	0	40	h/y	6.7	kg/h	1.45486	kg/h	0.705	kg/h	-	3.4	-	-	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.5, Equations 16 and 17
Grader - Construction of Northern Haul Road	38	17	2	0	200	VKT/y	0.19007	kg/VKT	0.085	kg/VKT	0.0095	kg/VKT	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.14)
Drilling rock - Northern Quarry Pit	35	18	2	70	198	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.8, Default values)
Blasting rock - Northern Quarry Pit	8	4	0	0	1	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.9, Equation 19)
Loading to Crusher (Primary) - Northern Quarry Pit	13	5	1	0	92842	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Crushing (Primary) - Northern Quarry Pit	928	371	46	0	92842	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Loading to Screening - Northern Quarry Pit	13	5	1	0	92852	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Screening - Northern Quarry Pit	1161	399	58	0	92842	t/y	0.0125	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-02, 03', screening uncontrolled (crushed stone Processing) (US EPA)
Loading Product to Trucks - Northern Quarry Pit	12	4	1	0	83557.8	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling Product to Stockpiling Area from Northern Quarry Pit (Unsealed)	4655	1324	66	50	1724.20857	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	110.18	1.3	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Product from Northern Quarry Pit trucks at Stockpiling Area	2	1	0	0	83558	t/y	0.00002	kg/t	8E-06	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-31', unloading crushed stone product from trucks (US EPA)
Placement of Product into Stockpiles	278	131	14	0	83558	t/y	0.00332	kg/t	0.00157	kg/t	0.000	kg/t	2.05	1.6	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Overburden from Northern Quarry Pit - Load to Trucks	5	2	0	0	4561	t/y	0.00116	kg/t	0.00055	kg/t	0.000	kg/t	2.05	3.4	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Haulling Overburden from Northern Quarry Pit to Stockpiling Area	254	72	4	50	94.115873	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	110.18	1.3	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Overburden from Northern Quarry Pit at Stockpiling Area	55	20	3	0	4561	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Drilling rock - Main Quarry Pit	592	311	30	70	3344	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.8, Default values)
Blasting rock - Main Quarry Pit	138	71	7	0	20	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.9, Equation 19)
Loading rock to Trucks	5228	2473	261	0	1573825	t/y	0.00332	kg/t	0.00157	kg/t	0.0002	kg/t	2.05	1.6	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Hauling rock to Central Processing Plant	40471	11508	575	50	14988.8095	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	110.18	0.6	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading from Trucks to Central Processing Plant	222	79	11	0	1573825	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Crushing (Primary) - Central Processing Area	4721	1889	236	70	1573825	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Conveyors to Secondary Crushing	1180	433	59	50	1573825	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Crushing (Secondary) - Central Processing Area	14164	5666	708	70	1573825	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Conveyors to Tertiary Crushing	1180	433	59	50	1573825	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Crushing (Tertiary) - Central Processing Area	1275	567	64	70	1573825	t/y	0.0027	kg/t	0.0012	kg/t	0.000	kg/t	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-050030-03' (US EPA)
Conveyors to Screening	1180	433	59	50	1573825	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Screening - Central Processing Area	5902	2030	295	70	1573825	t/y	0.0125	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-02, 03', screening uncontrolled (crushed stone Processing) (US EPA)
Unloading Product to Trucks	199	71	10	0	1416443	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling Product from Main Quarry Pit (Central Processing Area) to Stockpiling Area	24282	6905	345	50	8993.28571	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	110.18	0.4	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Product from Main Quarry Pit (Central Processing Area) Trucks at Stockpiling Are	32	11	2	0	1416443	t/y	0.00002	kg/t	8E-06	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-31', unloading crushed stone product from trucks (US EPA)
Placement of Product into Stockpiles	4705	2225	235	0	1416443	t/y	0.00332	kg/t	0.00157	kg/t	0.000	kg/t	2.05	1.6	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Overburden from Main Quarry Pit - Load to Trucks	74	35	4	0	63840	t/y	0.00116	kg/t	0.00055	kg/t	0.000	kg/t	2.05	3.4	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Hauling Overburden from Main Quarry Pit to Stockpiling Area	2189	622	31	50	810.666667	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	110.18	0.8	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Overburden from Main Quarry Pit at Stockpiling Area	773	275	39	0	63840	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Loading product to trucks	211	75	11	0	1500000	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling product off-site (paved)	29949	5749	1197	50	79688	VKT/y	0.75	kg/VKT	0.14	kg/VKT	0.03	kg/VKT	-	-	32	1.7	-	8.2	AP42-13.2. 1, Equation 1 (US EPA)
Wind erosion from Product stockpiles - >5mm Aggregates	0	0	0	0	1.37	ha	0.0	kg/ha/y	0.0	kg/ha/y	0.0	kg/ha/y	-	-	-	-	-	-	Inert, no fines, limited dispersivity
Wind erosion from Product stockpiles - <5mm Crusher dust	342	171	17	65	0.74	ha	1328.5	kg/ha/y	664.2	kg/ha/y	66.4	kg/ha/y	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from Product stockpiles - Blended Road Base	2380	1190	119	65	2.10	ha	3238.1	kg/ha/y	1619.1	kg/ha/y	161.9	kg/ha/y	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from exposed areas - Northern Quarry Pit	1226	613	61	50	0.7	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Main Quarry Pit	7884	3942	394	50	4.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Stockpile Area (exc Product Stockpiles)	12509	6255	625	65	10.2	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Central processing area	6794	3397	340	65	5.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Overburden external to pits - Loading to Trucks	34	16	2	0	29010	t/y	0.00116	kg/t	0.00055	kg/t	0.0001	kg/t	2.05	3.4	-	-	-	-	EETM Mining (2012), Section 1.1.2, AP42-13.2.4
Overburden external to pits - Hauling to Stockpiling Area	746	212	11	50	276.285714	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	110.18	0.6	8.3	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Overburden external to pits - Unloading from Trucks	351	125	18	0	29010	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Total	**178662**	**60213**	**6051**																

Figure C-2. Stage 1 Sources, activities, and calculations

Stage 5: Source locations

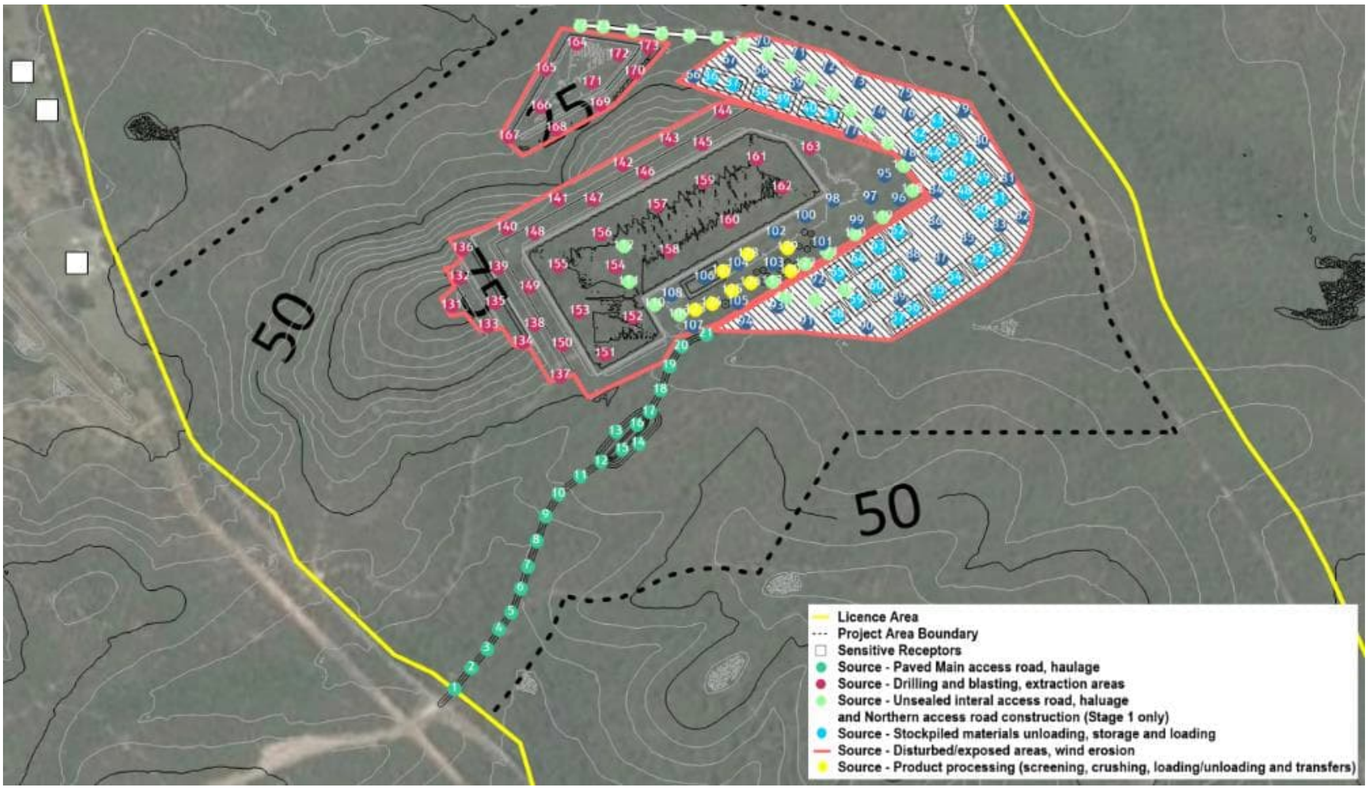


Figure C-3. Stage 5 Source locations

Stage 5: Sources, activities, and calculations

Emission calculations																							
Stone Ridge Quarry Stage 5																							
	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables										
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)	Silt load (g/m2)	Reference
Northern Quarry Pit																							
Drilling rock - Northern Quarry Pit	61	32	3	70	346	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.8, Default values)
Blasting rock - Northern Quarry Pit	14	7	1	0	2	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.9, Equation 19)
Loading rock to Trucks	670	317	34	0	201703	t/y	0.00332	kg/t	0.00157	kg/t	0.0002	kg/t	-	2.05	1.6	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Hauling rock to Central Processing Plant	17289	4916	246	50	6403.26984	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	2.0	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading from Trucks to Central Processing Plant	28	10	1	0	201703	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Overburden from Northern Quarry Pit - Load to Trucks	0	0	0	0	0	t/y	0.00116	kg/t	0.00055	kg/t	0.000	kg/t	-	2.05	3.4	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Haulling Overburden from Northern Quarry Pit to Stockpiling Area	0	0	0	50	0	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	1.3	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Overburden from Northern Quarry Pit at Stockpiling Area	0	0	0	0	0	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Main Quarry Pit																							
Drilling rock - Main Quarry Pit	566	297	28	70	3196	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.8, Default values)
Blasting rock - Main Quarry Pit	132	68	7	0	19	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.9, Equation 19)
Loading rock to Trucks	4866	2302	243	0	1464964	t/y	0.00332	kg/t	0.00157	kg/t	0.0002	kg/t	-	2.05	1.6	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Hauling rock to Processing Plant	62785	17854	893	50	23253.3968	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	1.0	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading from Trucks to Processing Plant	206	73	10	0	1464964	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Primary crushing - Central Processing Area	5000	2000	250	70	1666667	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Conveyors to Secondary Crushing	1250	458	63	50	1666667	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Secondary crushing - Central Processing Area	15000	6000	750	70	1666667	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Conveyors to Tertiary Crushing	1250	458	63	50	1666667	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Tertiary crushing - Central Processing Area	1350	600	68	70	1666667	t/y	0.0027	kg/t	0.0012	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-050030-03' (US EPA)
Conveyors to Screening	1250	458	63	50	1666667	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Screening - Central Processing Area	6250	2150	313	70	1666667	t/y	0.0125	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-02, 03', screening uncontrolled (crushed stone Processing) (US EPA)
Unloading Product to Trucks	211	75	11	0	1500000	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling Product from Main Quarry Pit (Central Processing Area) to Stockpiling Area	25715	7312	366	50	9523.81143	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	0.4	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Product from Main Quarry Pit (Central Processing Area) trucks at Stockpiling Area	34	12	2	0	1500000	t/y	0.00002	kg/t	8E-06	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-31', unloading crushed stone product from trucks (US EPA)
Placement of Product into Stockpiles	4983	2357	249	0	1500000	t/y	0.00332	kg/t	0.00157	kg/t	0.000	kg/t	-	2.05	1.6	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Overburden from Main Quarry Pit - Load to Trucks	34	16	2	0	29496	t/y	0.00116	kg/t	0.00055	kg/t	0.000	kg/t	-	2.05	3.4	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Haulling Overburden from Main Quarry Pit to Stockpiling Area	1264	359	18	50	468.190476	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	1.0	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Overburden from Main Quarry Pit at Stockpiling Area	357	127	18	0	29496	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Export of Product																							
Loading product to trucks	211	75	11	0	1500000	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling product off-site (paved)	29949	5749	1197	50	79688	VKT/y	0.75	kg/VKT	0.14	kg/VKT	0.03	kg/VKT	-	-	-	-	-	32	1.7	-	-	8.2	AP42-13.2. 1, Equation 1 (US EPA)
Wind erosion																							
Wind erosion from Product stockpiles - >5mm Aggregates	0	0	0	0	1.37	ha	0.0	kg/ha/y	0.0	kg/ha/y	0.0	kg/ha/y	-	-	-	-	-	-	-	-	-	-	Inert, no fines, limited dispersivity
Wind erosion from Product stockpiles - <5mm Crusher dust	342	171	17	65	0.74	ha	1328.5	kg/ha/y	664.2	kg/ha/y	66.4	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from Product stockpiles - Blended Road Base	2380	1190	119	65	2.10	ha	3238.1	kg/ha/y	1619.1	kg/ha/y	161.9	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from exposed areas - Northern Quarry Pit	5782	2891	289	50	3.3	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Main Quarry Pit	30660	15330	1533	50	17.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Stockpile Area (exc Product Stockpiles)	12509	6255	625	65	10.2	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Central processing area	6794	3397	340	65	5.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Overburden external to pits																							
Overburden external to pits - Loading to Trucks	0	0	0	0	0	t/y	0.00116	kg/t	0.00055	kg/t	0.0001	kg/t	-	2.05	3.4	-	-	-	-	-	-	-	EETM Mining (2012), Section 1.1.2, AP42-13.2.4
Overburden external to pits - Hauling to Stockpiling Area	0	0	0	50	0	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	0.6	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Overburden external to pits - Unloading from Trucks	0	0	0	0	0	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Total	**239194**	**83318**	**7829**																				

Figure C-4. Stage 5 Sources, activities, and calculations

Stage 9: Source locations

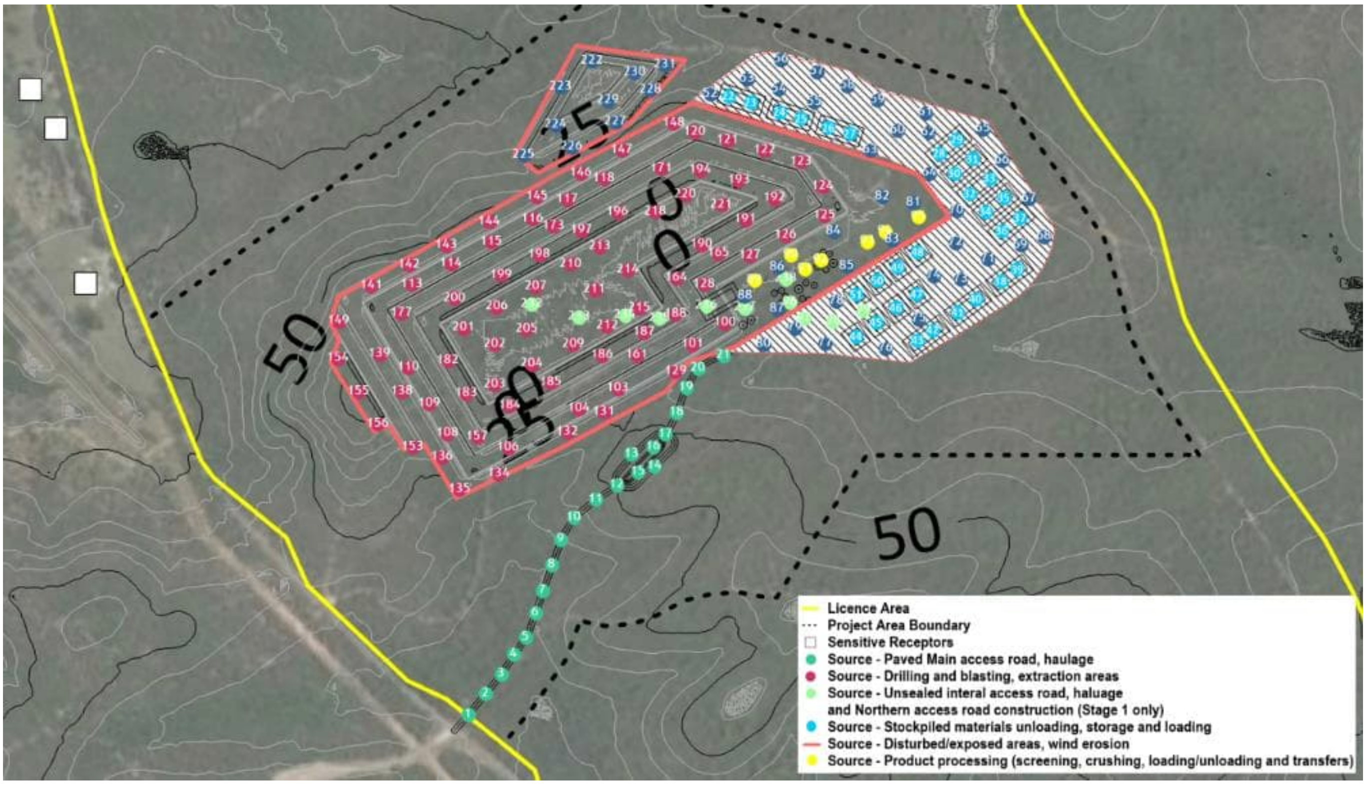


Figure C-5. Stage 9 Source locations

Stage 9: Sources, activities, and calculations

Emission calculations																							
Stone Ridge Quarry Stage 9																							
	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables										
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	Speed (km/h)	Silt load (g/m2)	Reference
Drilling rock - Main Quarry Pit	985	518	49	70	5567	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.8, Default values)
Blasting rock - Main Quarry Pit	146	76	7	0	21	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.9, Equation 19)
Loading rock to Trucks	5536	2619	277	0	1666667	t/y	0.00332	kg/t	0.00157	kg/t	0.0002	kg/t	-	2.05	1.6	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Hauling rock to Processing Plant	92859	26406	1320	50	34391.5413	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	1.3	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading from Trucks to Processing Plant	235	83	12	0	1666667	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Primary crushing - Central Processing Area	5000	2000	250	70	1666667	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Conveyors to Secondary Crushing	1250	458	63	50	1666667	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Secondary crushing - Central Processing Area	15000	6000	750	70	1666667	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 5.2.2, Table 3, default value for high-moisture material)
Conveyors to Tertiary Crushing	1250	458	63	50	1666667	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Tertiary crushing - Central Processing Area	1350	600	68	70	1666667	t/y	0.0027	kg/t	0.0012	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-050030-03' (US EPA)
Conveyors to Screening	1250	458	63	50	1666667	t/y	0.00150	kg/t	0.00055	kg/t	0.0001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-06', conveying crushed stone (US EPA)
Screening - Central Processing Area	6250	2150	313	70	1666667	t/y	0.0125	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-	-	AP42-11.19.2-1, value for activity 'SCC 3-05-020-02, 03', screening uncontrolled (crushed stone Processing) (US EPA)
Unloading Product to Trucks	211	75	11	0	1500000	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling Product from Main Quarry Pit (Central Processing Area) to Stockpiling Area	25715	7312	366	50	9523.80952	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	0.4	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Product from Main Quarry Pit (Central Processing Area) trucks at Stockpiling Area	34	12	2	0	1500000	t/y	0.00002	kg/t	8E-06	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-31', unloading crushed stone product from trucks (US EPA)
Placement of Product into Stockpiles	4983	2357	249	0	1500000	t/y	0.00332	kg/t	0.00157	kg/t	0.000	kg/t	-	2.05	1.6	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Overburden from Main Quarry Pit - Load to Trucks	17	8	1	0	14688	t/y	0.00116	kg/t	0.00055	kg/t	0.000	kg/t	-	2.05	3.4	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.2, Equations 10 and 11)
Haulling Overburden from Main Quarry Pit to Stockpiling Area	629	179	9	50	233.142857	VKT/y	5.40010	kg/VKT	1.53559	kg/VKT	0.077	kg/VKT	-	-	-	-	-	110.18	1.0	8.3	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.11)
Unloading Overburden from Main Quarry Pit at Stockpiling Area	178	63	9	0	14688	t/y	0.01211	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-	-	-	-		NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.6, Default values)
Loading product to trucks	211	75	11	0	1500000	t/y	0.00014	kg/t	0.00005	kg/t	0.000	kg/t	-	-	-	-	-	-	-	-	-		AP42-11.19.2-1, value for activity 'SCC 3-05-020-32', loading crushed stone product to trucks from processing (US EPA)
Hauling product off-site (paved)	29949	5749	1197	50	79688	VKT/y	0.75	kg/VKT	0.14	kg/VKT	0.03	kg/VKT	-	-	-	-	-	32	1.7	-	-	8.2	AP42-13.2. 1, Equation 1 (US EPA)
Wind erosion from Product stockpiles - >5mm Aggregates	0	0	0	0	1.37	ha	0.0	kg/ha/y	0.0	kg/ha/y	0.0	kg/ha/y	-	-	-	-	-	-	-	-	-	-	Inert, no fines, limited dispersivity
Wind erosion from Product stockpiles - <5mm Crusher dust	342	171	17	65	0.74	ha	1328.5	kg/ha/y	664.2	kg/ha/y	66.4	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from Product stockpiles - Blended Road Base	2380	1190	119	65	2.10	ha	3238.1	kg/ha/y	1619.1	kg/ha/y	161.9	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from exposed areas - Northern Quarry Pit	959	479	48	65	3.3	ha	830.3	kg/ha/y	415.1	kg/ha/y	41.5	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Equation 17)
Wind erosion from exposed areas - Main Quarry Pit	58867	29434	2943	50	33.6	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Stockpile Area (exc Product Stockpiles)	12509	6255	625	65	10.2	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Wind erosion from exposed areas - Central processing area	4783	2391	239	65	3.9	ha	3504.0	kg/ha/y	1752.0	kg/ha/y	175.2	kg/ha/y	-	-	-	-	-	-	-	-	-	-	NPI EETM Mining V3.1 (DSEWPaC, 2012, Section 1.1.18, Default values)
Total	**272879**	**97576**	**9079**																				

Figure C-6. Stage 9 Sources, activities, and calculations

Appendix D. Greenhouse gas emissions by activity

Diesel usage, mobile plant, and equipment

Diesel usage, Mobile plant and vehicles									
			Emission factor (kg CO2-e/kL)			Emissions (t CO2-e/year)			
Year	Production (t)	Usage (kL)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total
2023	1,666,667	697	2721.3	0	667.78	1,973	-	471	2,444
2024	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2025	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2026	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2027	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2028	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2029	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2030	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2031	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2032	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2033	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2034	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2035	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2036	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2037	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2038	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2039	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2040	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2041	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2042	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2043	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2044	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2045	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2046	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2047	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2048	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2049	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2050	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2051	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
2052	1,666,667	697	2721.3	0	667.78	1,896	-	465	2,361
Note #1 Year 2023 includes 77t and 6t of Scope 1 and 3 emissions estimated for construction plant and equipment using Carbon Gauge								**Average**	**2,363**
Note# 2 Scope 1 emission factor from Table 7, NGAF (DCCEEW, 2022)								**Total**	**70,904**
Note# 3 Scope 3 emission factor from Table 7, NGAF (DCCEEW, 2022)									

Figure D-1. GHG calculations, Diesel usage, mobile plant, and equipment

Diesel usage, stationary engines

Diesel usage, Stationary Engines									
			Emission factor (kg CO2-e/kL)			Emissions (t CO2-e/year)			
Year	Production (t)	Usage (kL)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total
2023	1,666,667	461	2709.72	0	138.96	1,249	-	64	1,313
2024	1,666,667	461	2709.72	0	138.96	1,249	-	64	1,313
2025	1,666,667	-	2709.72	0	138.96	-	-	-	-
2026	1,666,667	-	2709.72	0	138.96	-	-	-	-
2027	1,666,667	-	2709.72	0	138.96	-	-	-	-
2028	1,666,667	-	2709.72	0	138.96	-	-	-	-
2029	1,666,667	-	2709.72	0	138.96	-	-	-	-
2030	1,666,667	-	2709.72	0	138.96	-	-	-	-
2031	1,666,667	-	2709.72	0	138.96	-	-	-	-
2032	1,666,667	-	2709.72	0	138.96	-	-	-	-
2033	1,666,667	-	2709.72	0	138.96	-	-	-	-
2034	1,666,667	-	2709.72	0	138.96	-	-	-	-
2035	1,666,667	-	2709.72	0	138.96	-	-	-	-
2036	1,666,667	-	2709.72	0	138.96	-	-	-	-
2037	1,666,667	-	2709.72	0	138.96	-	-	-	-
2038	1,666,667	-	2709.72	0	138.96	-	-	-	-
2039	1,666,667	-	2709.72	0	138.96	-	-	-	-
2040	1,666,667	-	2709.72	0	138.96	-	-	-	-
2041	1,666,667	-	2709.72	0	138.96	-	-	-	-
2042	1,666,667	-	2709.72	0	138.96	-	-	-	-
2043	1,666,667	-	2709.72	0	138.96	-	-	-	-
2044	1,666,667	-	2709.72	0	138.96	-	-	-	-
2045	1,666,667	-	2709.72	0	138.96	-	-	-	-
2046	1,666,667	-	2709.72	0	138.96	-	-	-	-
2047	1,666,667	-	2709.72	0	138.96	-	-	-	-
2048	1,666,667	-	2709.72	0	138.96	-	-	-	-
2049	1,666,667	-	2709.72	0	138.96	-	-	-	-
2050	1,666,667	-	2709.72	0	138.96	-	-	-	-
2051	1,666,667	-	2709.72	0	138.96	-	-	-	-
2052	1,666,667	-	2709.72	0	138.96	-	-	-	-
Note #1 On-iste power planned to be sourced from grid from 2025								Average	88
Note# 2 Scope 1 emission factor from Table 6, NGAF (DCCEEW, 2022)								Total	2,625
Note# 3 Scope 3 emission factor from Table 6, NGAF (DCCEEW, 2022)									

Figure D-2. GHG calculations, Diesel usage, stationary engines

Blasting

Blasting emissions									
			Emission factor (t CO2-e/t Explosives)			Emissions (t CO2-e/year)			
Year	Production (t)	Explosives (t)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total
2023	1,666,667	432	0.17	0	0	73	-	-	73
2024	1,666,667	432	0.17	0	0	73	-	-	73
2025	1,666,667	432	0.17	0	0	73	-	-	73
2026	1,666,667	432	0.17	0	0	73	-	-	73
2027	1,666,667	432	0.17	0	0	73	-	-	73
2028	1,666,667	432	0.17	0	0	73	-	-	73
2029	1,666,667	432	0.17	0	0	73	-	-	73
2030	1,666,667	432	0.17	0	0	73	-	-	73
2031	1,666,667	432	0.17	0	0	73	-	-	73
2032	1,666,667	432	0.17	0	0	73	-	-	73
2033	1,666,667	432	0.17	0	0	73	-	-	73
2034	1,666,667	432	0.17	0	0	73	-	-	73
2035	1,666,667	432	0.17	0	0	73	-	-	73
2036	1,666,667	432	0.17	0	0	73	-	-	73
2037	1,666,667	432	0.17	0	0	73	-	-	73
2038	1,666,667	432	0.17	0	0	73	-	-	73
2039	1,666,667	432	0.17	0	0	73	-	-	73
2040	1,666,667	432	0.17	0	0	73	-	-	73
2041	1,666,667	432	0.17	0	0	73	-	-	73
2042	1,666,667	432	0.17	0	0	73	-	-	73
2043	1,666,667	432	0.17	0	0	73	-	-	73
2044	1,666,667	432	0.17	0	0	73	-	-	73
2045	1,666,667	432	0.17	0	0	73	-	-	73
2046	1,666,667	432	0.17	0	0	73	-	-	73
2047	1,666,667	432	0.17	0	0	73	-	-	73
2048	1,666,667	432	0.17	0	0	73	-	-	73
2049	1,666,667	432	0.17	0	0	73	-	-	73
2050	1,666,667	418	0.17	0	0	71	-	-	71
2051	1,666,667	418	0.17	0	0	71	-	-	71
2052	1,666,667	418	0.17	0	0	71	-	-	71
Note #1 Emission factors from NGA Factors (DCC, 2008)								**Average**	**73**
								Total	**2,197**

Figure D-3. GHG calculations, Blasting

Vegetation clearing (Carbon sink loss)

Vegetation clearing (Carbon sink loss)									
			Emission factor (t CO2-e/ha)			Emissions (t CO2-e/year)			
Year	**Production (t)**	**Clearing (ha)**	**Scope 1**	**Scope 2**	**Scope 3**	**Scope 1**	**Scope 2**	**Scope 3**	**Total**
2023	1,666,667	14.9	718	0	0	10,677	-	-	10,677
2024	1,666,667	16.2	718	0	0	11,657	-	-	11,657
2025	1,666,667	2.6	718	0	0	1,887	-	-	1,887
2026	1,666,667	2.6	718	0	0	1,887	-	-	1,887
2027	1,666,667	3.1	718	0	0	2,199	-	-	2,199
2028	1,666,667	1.9	718	0	0	1,396	-	-	1,396
2029	1,666,667	1.9	718	0	0	1,396	-	-	1,396
2030	1,666,667	1.6	718	0	0	1,177	-	-	1,177
2031	1,666,667	1.6	718	0	0	1,177	-	-	1,177
2032	1,666,667	1.6	718	0	0	1,177	-	-	1,177
2033	1,666,667	0.8	718	0	0	579	-	-	579
2034	1,666,667	0.8	718	0	0	579	-	-	579
2035	1,666,667	0.8	718	0	0	579	-	-	579
2036	1,666,667	0.8	718	0	0	579	-	-	579
2037	1,666,667	0.8	718	0	0	579	-	-	579
2038	1,666,667	0.8	718	0	0	579	-	-	579
2039	1,666,667	0.6	718	0	0	451	-	-	451
2040	1,666,667	0.6	718	0	0	451	-	-	451
2041	1,666,667	0.6	718	0	0	451	-	-	451
2042	1,666,667	0.6	718	0	0	451	-	-	451
2043	1,666,667	0.6	718	0	0	451	-	-	451
2044	1,666,667	0.6	718	0	0	451	-	-	451
2045	1,666,667	0.7	718	0	0	525	-	-	525
2046	1,666,667	0.7	718	0	0	525	-	-	525
2047	1,666,667	0.7	718	0	0	525	-	-	525
2048	1,666,667	0.7	718	0	0	525	-	-	525
2049	1,666,667	0.7	718	0	0	525	-	-	525
2050	1,666,667	0.8	718	0	0	586	-	-	586
2051	1,666,667	0.8	718	0	0	586	-	-	586
2052	1,666,667	0.8	718	0	0	586	-	-	586
Note #1 Class 5:250-350 based on 'Maximum Potential Biomasses Classes - NSW Figure 1' (GHD, 2012) and Vegetation Class 'C' based								**Average**	**1,506**
on EPBC Referral (sclerophyll forest types)								**Total**	**45,194**

Figure D-4. GHG calculations, vegetation clearing (Carbon sink loss)

Electricity usage (Grid)

Electricity usage (Grid)									
			Emission factor (kg CO2-e/kWh)			Emissions (t CO2-e/year)			
Year	Production (t)	Usage (kWh)	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total
2023	1,666,667	-	0	0.73	0.06	-	-	-	-
2024	1,666,667	-	0	0.73	0.06	-	-	-	-
2025	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2026	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2027	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2028	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2029	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2030	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2031	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2032	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2033	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2034	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2035	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2036	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2037	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2038	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2039	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2040	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2041	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2042	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2043	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2044	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2045	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2046	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2047	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2048	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2049	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2050	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2051	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
2052	1,666,667	1,552,500	0	0.73	0.06	-	1,133	93	1,226
Note #1 On-site power planned to be sourced from grid from 2025								Average	1,145
Note# 2 Scope 1 emission factor from Table 1, NGAF (DCCEEW, 2022)								Total	31,888
Note# 2 Scope 3 emission factor from Table 1, NGAF (DCCEEW, 2022)									

Figure D-5. GHG calculations, electricity usage (grid)