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Lake Vermont Meadowbrook Project: Air Quality and Greenhouse Gas Assessment

Prepared for:

Bowen Basin Coal (BBC)

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Final

Prepared by:

Katestone Environmental Pty Ltd
ABN 92 097 270 276
Ground Floor, 16 Marie Street | PO Box 2217
Milton, Brisbane, Queensland, 4064, Australia

www.katestone.global
admin@katestone.com.au
Ph +61 7 3369 3699

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Prepared by:	Sarah Richardson, Sathya Roysmith and Lisa Smith
Reviewed by:	Rebecca Wilson
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Glossary

Term	Definition
µg/m^3	micrograms per cubic metre
µm	microns
AHD	Australian Height Datum
°C	degrees Celsius
GJ	gigajoule
ha	hectare
km	kilometre
km/h	kilometre per hour
kWh	kilowatt hour
m	metre
mg	milligram
m/s	metres per second
m^2	square metres
m^3	cubic metres
MJ	megajoule
kt CO2-e	kilotonnes of carbon dioxide equivalent
Mtpa	million tonnes per annum
TJ	terajoules
Nomenclature	**Definition**
CH_4	Methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
NO_x	oxides of nitrogen
N_2O	nitrous oxide
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
SO_2	sulfur dioxide
TSP	total suspended particulates
Abbreviations	**Definition**
AARC	Australasian Resource Consultants
Air EPP	*Environmental Protection (Air) Policy 2019*
Air NEPM	*National Environment Protection (Ambient Air Quality) Measure*
BBC	Bowen Basin Coal
BMA	Billiton Mitsubishi Alliance
CHPP	Coal Handling and Preparation Plant
DES	Department of Environment and Science
EA	Environmental Authority
EF	Emission Factor
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994*
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
ERF	Emissions Reduction Fund
GHG	Greenhouse gases
GWP	Global Warming Potential
LULUCF	Land use, land-use change and forestry
MDL	Mineral Development Licence
MIA	Mine Infrastructure Area
ML	Mining Lease

Term	Definition
NGER	National Greenhouse and Energy Reporting
NPI	National Pollutant Inventory database
OB	Overburden
PCI	Pulverised coal for injection
ROM	Run-of-mine
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by AARC Environmental Solutions (AARC), on behalf of Bowen Basin Coal Pty Ltd (Bowen Basin Coal, BBC), to complete an air quality and greenhouse gas (GHG) assessment of the Lake Vermont Meadowbrook Project (the Project), near Dysart in central Queensland.

The Project is an extension of the existing Lake Vermont Mine (open-cut) and addresses the forecast reduction in coal production that will occur at the Lake Vermont Mine, by combining output from the existing open cut operations and the Project extension. This will enable total coal product to be maintained at the currently approved output for an extended period (of approximately 20 years) while also increasing the existing mine life by approximately 35 years.

The Project involves the construction and operation of an underground multi-seam, longwall coal mine as well as an additional small-scale open-cut pit. Extraction rates are forecast to be up to 7 Mtpa of ROM coal, equivalent to approximately 5.5 Mtpa of metallurgical product coal. An infrastructure corridor will link the Project mining area to the Lake Vermont Mine processing area to utilise the existing processing plant and train loadout facility.

Air Quality

This air quality assessment has investigated the potential for the Project to affect air quality in the region. Two operational scenarios have been considered that represent the worst-case potential for dust emissions over the life of the Project, given the proposed mining schedule and proximity of sensitive receptors. The assessment has used site-specific meteorological data and industry standard dispersion modelling techniques to predict ground-level concentrations of particulate matter (TSP, PM_{10} and $PM_{2.5}$) and dust deposition rates due to the Project. The assessment has accounted for standard dust mitigation measures as well as reactive dust control strategies that are currently implemented, such as increased water application on haul roads, reducing haulage distances and altered truck dumping activities.

The air quality assessment has considered the potential impacts of the Project in isolation, the Project and the existing Lake Vermont open-cut coal mine (existing operations), as well as a cumulative assessment of the Project, existing operations, and ambient background levels.

Predicted ground-level concentrations have been compared to air quality objectives specified in the Environmental Protection (Air) Policy 2019 (Air EPP) for PM_{10}, $PM_{2.5}$, and TSP, as well as limits specified under the existing Environmental Authority (EA) No EPML00659513 for PM_{10} and dust deposition rates.

The results of the air quality assessment show:

For operations in Year 7:

- Predicted maximum monthly dust deposition rates comply with the EA limit at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted annual average concentrations of TSP comply with the Air EPP objective at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour and annual average concentrations of $PM_{2.5}$ comply with the relevant Air EPP objectives at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.

- Predicted 24-hour average concentrations of PM_{10} comply with the EA limit at all sensitive receptors for the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations. Additional dust mitigation measures have been applied that reflect current proactive management practices.
- Predicted annual average concentrations of PM_{10} comply with the Air EPP objective at all sensitive receptors for the Project in isolation, using standard mitigation measures for the Project and the existing operations.

For operations in Year 22:

- Predicted maximum monthly dust deposition rates comply with the EA limit at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted annual average concentrations of TSP comply with the Air EPP objective at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour and annual average concentrations of $PM_{2.5}$ comply with the relevant Air EPP objectives at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour average concentrations of PM_{10} comply with the EA limit at all sensitive receptors for the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations. Additional dust mitigation measures have been applied that reflect current proactive management practices.
- Predicted annual average concentrations of PM_{10} comply with the Air EPP objective at all sensitive receptors for the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.

Katestone recommends that BBC:

- Update the existing Air Quality Management Plan (AQMP) where necessary and include a range of available measures to be implemented as necessary to ensure compliance with approval conditions. Measures that would be considered for inclusion in the AQMP include:
  - Nomination of a range of measures which will be implemented following a complaint, for example:
    - Applying additional at-source dust controls
    - Increasing the intensity of dust controls
    - Modifying certain operations
    - Investigate if monitoring indicates unexpected exceedances of air quality objectives

Greenhouse Gas (GHG) Assessment

Scope 1, 2, and 3 GHG emissions have been estimated on an annual basis for the Project against the background of ongoing existing and approved Lake Vermont operations (existing operations). Annual GHG emissions have been expressed in 'tonnes CO_2 equivalent' (tCO_2-e) terms and compared to recent state and national greenhouse gas inventories.

Maximum annual GHG emissions (Scope 1 + Scope 2) associated with the Project are 884 $ktCO_2$-e nominally occurring in Year 6. In comparison to combined Lake Vermont mining operations (Lake Vermont Existing Operations + Project) the Project accounts for 49% of total mine emissions over the life of the Project.

Estimated annual Scope 3 GHG emissions associated with the Project are 7,956,355 tCO_2-e on average and account for approximately 40% of Scope 3 GHG emissions for Lake Vermont mining operations over the life of the Project.

Bowen Basin Coal would have ongoing NGER scheme reporting obligations associated with the Project including annual assessment of GHG emissions in line with the requirements of the NGER Scheme.

Bowen Basin Coal intends to implement the following initiatives where appropriate to help mitigate, reduce, control, or manage GHG emissions from the Project:

- Regular assessment, review, and evaluation of GHG reduction opportunities
- Regular maintenance of plant and equipment to minimise fuel consumption and associated emissions, including training staff on continuous improvement strategies regarding efficient use of plant and equipment
- Procurement policies that require the selection of energy efficient equipment and vehicles
- Monitoring and maintenance of equipment in accordance with manufacturer recommendations
- Optimisation of diesel consumption through logistics analysis and planning (e.g., review of the mine plan to optimise haul lengths, dump locations, and road gradients)
- Flaring of waste coal mine gas will occur as part of gas drainage and goaf gas recovery operations. Methane contained in ventilation stacks will be flared or combusted where practicable, to reduce CO2 emissions.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by AARC Environmental Solutions (AARC), on behalf of Bowen Basin Coal Pty Ltd (Bowen Basin Coal, BBC), to complete an Air Quality Assessment and Greenhouse Gas (GHG) Assessment of the Lake Vermont Meadowbrook Project (the Project), near Dysart in central Queensland.

1.1 Project overview

The Project is an extension of the existing Lake Vermont Mine open-cut and addresses the forecast reduction in coal production that will occur, by combining output from the existing open cut operations and the Proposed project extension. This will enable total coal production to be maintained a the currently approved output for an extended period (of approximately 20 years) while ultimately increasing the existing mine life by approximately 35 years.

The Project involves the construction and operation of an underground multi-seam, longwall coal mine as well as an additional open-cut pit. Extraction rates are forecast to be up to 7 Mtpa of ROM coal, equivalent to approximately 5.5 Mtpa of metallurgical product coal. An infrastructure corridor will link the Project mining area to the Lake Vermont Mine processing area to utilise the existing processing plant and train loadout facility.

The key objectives of the Project are to:

- Extend the life of the existing Lake Vermont Mine, at existing (approved) production levels of up to 12 Mtpa of ROM coal, by supplementing the future decline in production from the existing open-cut operation with output from an adjoining underground operation and open-cut pit.
- Operate profitable mining operations which provide high-quality hard coking coal and pulverized coal for injection (PCI) coal to the export and domestic market.
- Design, construct, and operate a project that minimises adverse impacts on the social and natural environments.
- Maximise recovery of economically minable coal resources within the BBC tenements.
- Maximise the use of BBC owned land and infrastructure at the Lake Vermont Mine to minimise the environmental impacts from additional infrastructure, and to provide project efficiencies.
- Comply with all relevant statutory obligations and continue to improve processes which enhance sound environmental management.

AARC submitted an initial advice statement for the Project to the Queensland Department of Environment and Science (DES) in support of an application to voluntarily prepare an Environmental Impact Statement (EIS) under the provisions of the *Environmental Protection Act 1994 (EP Act)*. The Project was also determined to be a controlled action under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)*. Accordingly, the Project's EIS will be assessed under the *EP* Act, in accordance with the bilateral agreement between the Commonwealth and State of Queensland.

1.2 Scope of work

The air quality and greenhouse gas assessment has addressed the following scope of works to satisfy the Project's Terms of Reference (ToR) for the EIS (Queensland Government, April 2020):

- Description of the existing air environment at the proposed project site and the surrounding region.
- Emissions inventory and a description of the characteristics of contaminants or materials that would be released from point and diffuse sources and fugitive emissions when carrying out the activity (point source and fugitive emissions), addressing the construction, commissioning, operation, upset conditions, and closure of the proposed project.
- Demonstration that the proposed project can meet the environmental objectives and performance outcomes in Schedule 8 of the EP Regulation.
- Predicted impact of the releases from the activity on environmental values of the receiving environment, demonstrated using established and accepted methods and in accordance with the EP Regulation, Environmental Protection (Air) Policy 2019 (EPP (Air)), and the latest version of the department's Air—EIS information guideline (DES 2020) and Applications for activities with impacts to air (ESR/2015/184020).
- Consideration of the sensitivity and assimilative capacity of the receiving environment and the practices and procedures that would be used to avoid or minimise impacts, along with the cumulative impact of any release with other known releases of contaminants, materials or wastes associated with existing development and possible future development (as described by approved plans and existing project approvals).
- Quantification of the human health risk and amenity impacts associated with emissions from the proposed project for all contaminants, whether or not they are covered by the National Environmental Protection (Ambient Air Quality) Measure or the EPP (Air).
- Description of the proposed mitigation measures to limit impacts from air emissions and how the proposed activity will be consistent with best practice environmental management, along with the compatibility of the proposed project's air emissions with existing or potential land uses in surrounding areas. Potential land uses have been gauged from the zonings of local planning schemes, State Development Areas, and other relevant planning frameworks.
- Description of how the proposed project's air emission objectives will be achieved, monitored, audited and reported, and how corrective actions will be managed for the life of the proposed project.
- Determination of the proponents' obligations under the Commonwealth National Greenhouse and Energy Reporting Act 2007 (NGER Act) and ensuring that information regarding greenhouse gas emissions and energy production and consumption provided in the EIS is consistent with requirements of the NGER Act and its subordinate legislation.
- Provision of an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO_2 equivalent' terms. Estimation of emissions from upstream activities associated with the proposed project, including estimates of coal seam methane to be released and/or flared as well as emissions resulting from such activities as transportation of products and consumables, and energy use at the proposed project site.
- Assessment of the potential impacts of operations within the proposed project area on the state and national greenhouse gas inventories and propose greenhouse gas abatement measures, including:

- A description of the proposed preferred and alternative measures to avoid and/or minimise greenhouse gas emissions directly resulting from activities of the proposed project, including such activities as transportation of products and consumables, and energy use by the proposed project
- An assessment of how the preferred measures minimise emissions and achieve energy efficiency
- A comparison of the preferred measures for emission controls and energy consumption with best practice environmental management in the relevant sector of industry
- A description of any opportunities for further offsetting of greenhouse gas emissions through indirect means.

- Assessment of the potential impacts of gas flare emissions, as a separate component of the Project's overall emissions.

2. DESCRIPTION OF OPERATIONS

The Lake Vermont Meadowbrook Project (the Project) is an extension of the existing Lake Vermont Mine, an open-cut coal mine operation located approximately 25 km northeast of Dysart and approximately 160 km southwest of Mackay, within central Queensland. The Lake Vermont Mine is an operation producing primarily hard coking coal and low volatile PCI coal.

The Project is located close to existing towns, rail, road, and power infrastructure and is approximately 320 km, 430 km, and 235 km from the Abbot Point Coal Terminal, RG Tanna Coal Terminal and Dalrymple Bay Coal Terminal, respectively. An existing rail loop connects the Lake Vermont Mine to the Aurizon heavy haul coal rail line, that will continue to provide a connection to export ports from the Lake Vermont Mine. Dysart is an established regional township serving both mining and pastoral industries.

The Bowen Basin contains numerous mining operations, with a number directly bordering the Project site. This includes BHP Mitsubishi Alliance's Saraji Mine to the west, the recently approved Pembroke Olive Downs Coking Coal Project to the north and east, Whitehaven Coal's Winchester South Project and Aquilla Resources Eagle Downs South Project both to the northeast, and the existing Lake Vermont Mine to the south.

BBC owns the Lake Vermont Mine on Mining Lease (ML) 70331, ML 70477, and ML 70528 under the Environmental Authority (EA) Permit No. EPML00659513. The proposed project lies on Mineral Development Licence (MDL) 303 and MDL 429.

The Project is proposed to include the development of a double-seam underground longwall coal mine, along with an adjacent small-scale open-cut pit, to the north of the existing Lake Vermont Mine. To support the operation of the proposed underground development, a new "satellite" surface Mine Infrastructure Area (MIA) will be constructed. A new infrastructure corridor will also be constructed, linking the new MIA to the existing infrastructure located at Lake Vermont Mine. This infrastructure corridor will enable the delivery of power and water, provide personnel and materials access, as well as facilitate the clearance of ROM coal to the existing CHPP. A conceptual layout is provided in Figure 1.

The Project is expected to produce up to 7 Mtpa of metallurgical product coal for the export and domestic market over a life of approximately 35 years. The output from the Project will supplement the scheduled decline in production from the existing open-cut operations, so that the total output from the Lake Vermont complex will be maintained within the existing EA limit of 12 Mtpa of ROM coal.

The proposed mine development will therefore be comprised of:

- Underground longwall mining of the Leichardt Seam.
- An open cut pit to mine the Vermont Seam, the Vermont Lower Seam, and the Leichardt Seam.
- Development of a new infrastructure corridor linking the new mining area to existing infrastructure at the Lake Vermont Mine.
- Development of a Mine infrastructure Area (MIA) which will include a surface ROM stockpile.
- Construction of a drift and shafts to provide access and ventilation to underground operations.
- Development of other supporting infrastructure and associated activities.

The Project will utilise much of the existing infrastructure located at the Lake Vermont Mine, including the CHPP and train load out facility. Coal will be transported from the underground ROM stockpile via a haul road within the proposed infrastructure corridor to the existing CHPP for processing. There is currently no CHPP upgrade proposed, with mining to continue within the current authorised limit of 12 Mtpa of ROM over an extended mine life of approximately 35 years.

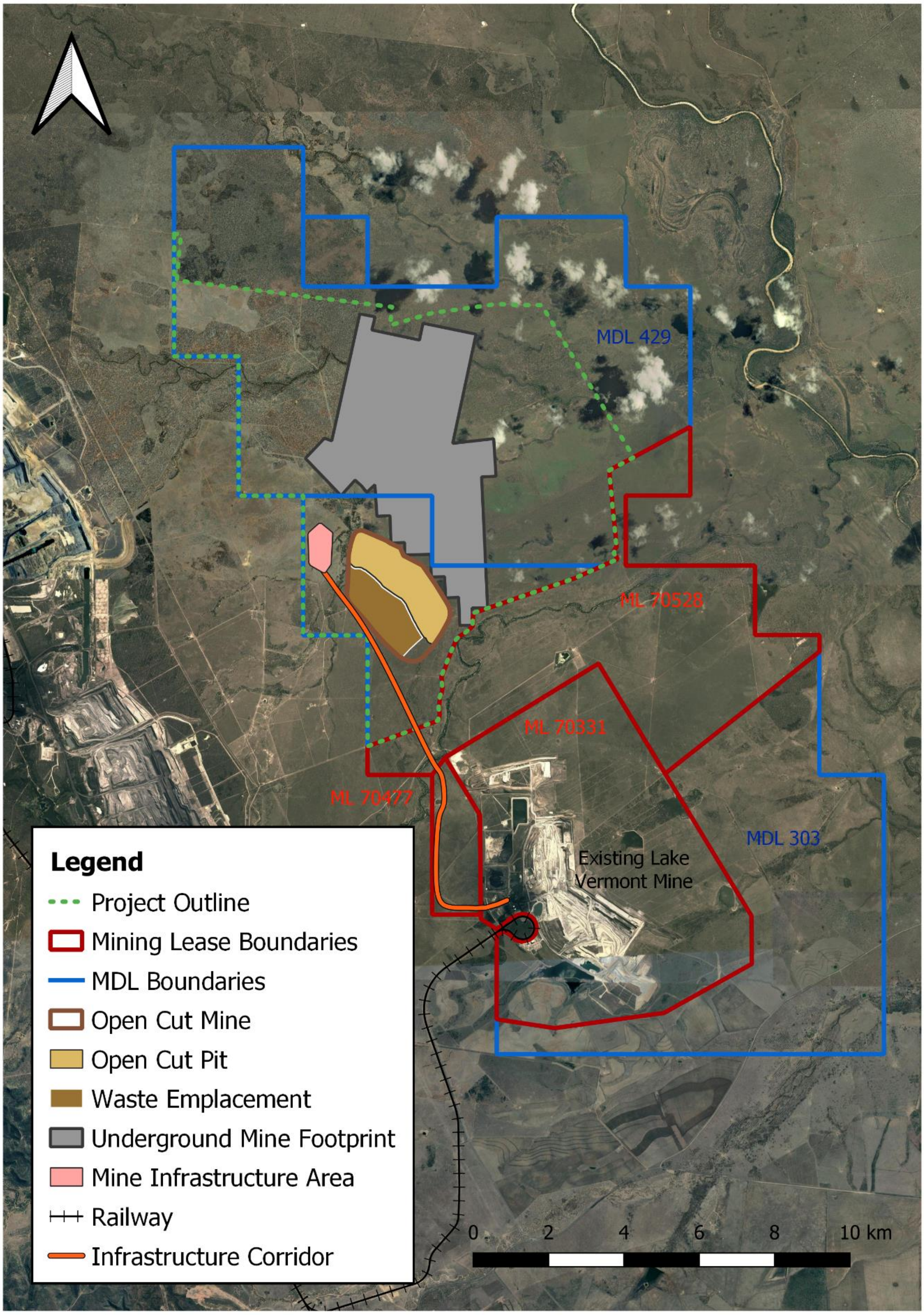

Figure 1 **Conceptual Project layout**

3. AIR QUALITY ASSESSMENT

3.1 Considerations for Assessing Air Quality

3.1.1 Pollutants

Particulate matter (i.e. dust) will be the key air pollutant generated by activities on the Project site. Particulate matter is discussed further in Section 3.1.2, and other potential pollutants are discussed in Section 3.1.3.

3.1.2 Particulate matter

Mining can give rise to dust that, in elevated concentrations has the potential to cause adverse impacts on the amenity and health of people living in the vicinity.

Dust can affect communities in various ways, depending upon the source and size of particles present. Dust typically emitted as a result of coal mining operations is assessed in terms of total suspended particulates (TSP), deposited dust, PM_{10} and $PM_{2.5}$.

Dust from mining consists primarily of larger particles generated through the handling of rock and soil, as well as through wind erosion of stockpiles and exposed ground. Larger particles (measured as dust deposition) are mostly associated with dust nuisance or amenity impacts in residential areas, through settling or deposition of the particles. Elevated dust deposition rates can reduce public amenity, through soiling of clothes, buildings and other surfaces in the area.

Smaller particles such as PM_{10} and $PM_{2.5}$ can also be generated through mining activities. Elevated levels of PM_{10} and $PM_{2.5}$ have the potential to affect human health as these particles can be trapped in the nose, mouth or throat, or be drawn into the lungs. Fine particles (i.e. $PM_{2.5}$) are typically generated through combustion processes.

3.1.3 Other pollutants

Quantities of other air pollutants such as oxides of nitrogen (NO_x), carbon monoxide (CO) and sulfur dioxide (SO_2), may also be emitted from vehicle traffic and blasting within the Project site. The emission rates of these air pollutants are low compared to the emission rates of particulate matter from mining activities. These air pollutants are transient in nature and are likely to have negligible impact outside of the roads and open-cut pits within the Project site. Hence, particulate matter is considered the critical air pollutant for this assessment.

Compliance with air quality objectives for particulate matter at the nearest sensitive receptors will, as a consequence, demonstrate compliance with air quality standards for NO_x, CO and SO_2. Therefore, these air pollutants do not require further assessment.

Spontaneous combustion is a possible source of odour from mining activities, although the potential for this is low. Odour can however be emitted from underground mining operations. Underground coal mines are ventilated to ensure that coal seam gases do not build up and become hazardous. At some coal mines in the Hunter Valley in New South Wales, the ventilation air from underground coal mines has been investigated as a possible source of odour annoyance at residential areas nearby. Sampling and analysis has been undertaken to quantify odour emission rates and odour concentrations. Detailed odour impact assessment studies (Holmes Air Sciences, 2003) have concluded that mine ventilation emissions are not likely to cause elevated odour levels. For these reasons, odour has not been assessed further in this assessment.

3.2 Legislative framework for air quality

3.2.1 Legislative Framework

3.2.1.1 Environmental Protection Act

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. The EP Act gives the Department of Environment and Science (DES) the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. Schedule 8 of the EP Act refers specifically to air, stating the Environmental Objective of activities being to "operate in a way that protects the environmental values of air". Performance outcomes are as follows:

1. *There is no discharge to air of contaminants that may cause an adverse effect on the environment from the operation of the activity.*
2. *All of the following—*
   a. *fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised;*
   b. *contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shut down and start up emissions of contaminants to air;*
   c. *releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values*

The Environmental Protection (Air) Policy (Air EPP) was made under the EP Act and gazetted in 1997; the Air EPP was revised and reissued in 2019.

The objective of the Air EPP is:

...to identify the environmental values of the air environment to be enhanced or protected and to achieve the objective of the Environmental Protection Act 1994, i.e. ecologically sustainable development.

The environmental values to be enhanced or protected under the Air EPP are the qualities of the environment that are conducive to:

- Protecting health and biodiversity of ecosystems
- Human health and wellbeing
- Protecting the aesthetics of the environment, including the appearance of building structures and other property
- Protecting agricultural use of the environment.

The administering authority must consider the requirements of the Air EPP when it decides an application for an environmental authority, amendment of a licence or approval of a draft environmental management plan. Schedule 1 of the Air EPP specifies air quality indicators and objectives for a number of contaminants that may be present in the air environment.

3.2.1.2 National Environment Protection (Ambient Air Quality) Measure

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) was established under the *National Environment Protection Act 1994* to provide a nationally consistent framework for monitoring and reporting on seven common ambient air pollutants. The standards contained in the Air NEPM informed the objectives specified in the Air EPP. An update to the Air NEPM was released in April 2021.

3.2.1.3 Environmental Authorities

BBC has approval to operate the Lake Vermont Mine under Environmental Authority (EA) No EPML00659513. There are two conditions related to air emissions contained in EPML00659513. These conditions are provided below.

Conditions B1 and B2 of EPML00659513 relate to air emissions and are reproduced below.

B1 *The environmental authority holder shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that the dust and particulate matter emissions generated by the mining activities do not cause exceedances of the following levels when measured at any sensitive or commercial place:*

a) Dust deposition of 120 milligrams per square metre per day, averaged over 1 month, when monitored in accordance with the most recent version of Australian Standard AS3580.10.1 Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.

b) A concentration of particulate matter with an aerodynamic diameter of less than 10 micrometers (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24-hour averaging time, for no more than 5 exceedances recorded each year, when monitored in accordance with the most recent version of either:

a. Australian Standard AS3580.9.6 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} high volume sampler with size-selective inlet – Gravimetric method; or

b. Australian Standard AS3580.9.9 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} low volume sampler – Gravimetric method.

Note: the five exceedances for the PM_{10} standard were introduced to account for the impact of bushfires, dust storms and fuel reduction for fire management purposes. The five exceedances are in essence arbitrary in that the number was chose as it is difficult to determine exactly the number of times these events may happen in any one year. More than five exceedances as a result of one or more of these events would not be considered to be a breach of condition.

c) A concentration of particulate matter suspected in the atmosphere of 90 micrograms per cubic metre of a 1 year averaging time, when monitored in accordance with the most recent version of AS/NZS3580.9.3:2003 Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – Total suspended particulate matter (TSP) - High volume sampler gravimetric method.

B2 *The release of dust and or particulate matter in accordance with the conditions of this environmental authority must not cause nuisance to any nuisance sensitive place or commercial place.*

3.2.2 Summary of air quality criteria

The relevant air quality objectives from the Air EPP, Air NEPM and the EA are presented in Table 1. The dispersion modelling results have been assessed against these objectives.

Table 1 Air quality objectives relevant to the Project

Pollutant	Environmental value	Averaging period	Air quality objective (µg/m³)	No. of allowable exceedance days	Source
TSP	Health and wellbeing	1-year	90	-	Air EPP, EPML00659513
PM_{10}	Health and wellbeing	24-hour	50	-	Air EPP, Air NEPM
		24-hour	50	5	EPML00659513
		1-year	25	-	Air EPP, Air NEPM
$PM_{2.5}$	Health and wellbeing	24-hour	25	-	Air EPP, Air NEPM
		1-year	8	-	Air EPP, Air NEPM
Dust deposition	Amenity	1-month	120 mg/m²/day	-	EPML00659513

Table note:

µg/m³= micrograms per cubic metre.
mg/m²/day = milligrams per square metre per day

3.3 Existing environment

3.3.1 Local terrain and land-use

The existing Lake Vermont Mine and proposed Meadowbrook Coal Mine are located in central Queensland, approximately 25 km northeast of the town of Dysart. Surrounding land use consists largely of grazing and cropping land. Several coal mines also operate in the Project's vicinity, being situated in a mining precinct. The closest mines are the BMA Saraji coal mine directly to the west, while to the northwest is the BMA Peak Downs coal mine.

Terrain in the immediate vicinity is relatively flat, with the Project area sitting around 155 Australian Height Datum (AHD) above sea level. Elevation gradually decreases to the east, while to the west beyond the Saraji mine lies hills reaching peak elevations of 470 AHD.

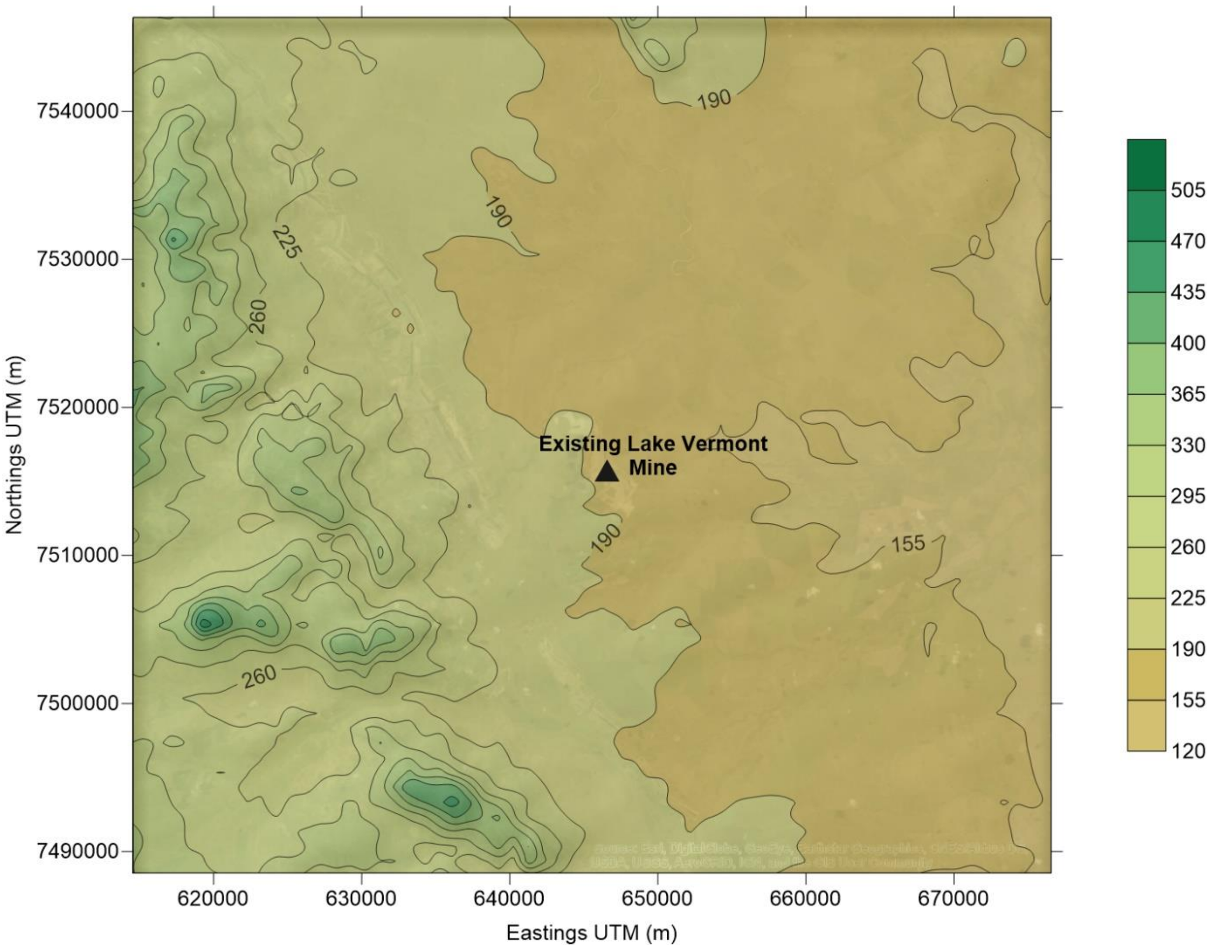

Figure 2 Surrounding terrain in the Project area

3.3.2 Nearby receptors

Receptors in the vicinity of the Project were identified and provided by AARC. These are shown in Table 2 and Figure 3.

Some receptors nearby the Project were not identified as sensitive receptors and are thus not included in the model for the following reasons:

- The potential Saraji East construction camp is proposed as a potential BHP Mitsubishi Alliance (BMA) option to house construction workers, if required, for the neighbouring Saraji East Project (immediately east and adjoining the existing BMA Saraji Coal Mine). BMA and Lake Vermont Resources Pty Ltd (LVR) have entered into an agreement that, amongst other things, provides:
    - BMA and LVR have reached agreement as to how the Saraji East Mining Lease (SEML) Project and the LVM Project may co-exist and how each party may assist, or at least not hinder, the development of the other party's project.
    - That BMA acknowledges and agrees that the SEML Project is adjacent to the LVM Project and LVR will be engaging in mining operations and/or associated activities in relation to the LVM Project.
    - BMA further expressly acknowledges and agrees that BMA shall make no objection or claim for compensation in relation to any nuisance to BMA's SEML Project (including, without limiting the generality of the foregoing, any accommodation, villages, or camps for BMA's workers) caused by LVR's mining operations and/or associated activities in relation to LVR's LVM Project (including, without limiting the generality of the foregoing, any noise, vibration, dust, or light).
    - BMA and LVR acknowledge and agree that they will each use their reasonable endeavours and negotiate in good faith to resolve any disputes which may arise between the parties in relation to the SEML Project and/or the LVM Project.

  As a result of the above, BMA has confirmed its position that no specific regulator assessment and/or conditioning is required in relation to the LVM Project Environmental Authority application and any LVM project interaction with the potential future Saraji East Project BMA village.

- The Lake Vermont and Meadowbrook receptors (R5 and R6) are both homesteads owned by BMA. Meadowbrook homestead is currently abandoned, and BMA has confirmed it will not be used as a residence in the future. The Lake Vermont homestead is currently occupied by a tenant of BMA, with appropriate agreements in place with the residents to acknowledge adjacent mining impacts. Hence, neither homestead was included as a sensitive receptor in the air quality assessment.

Table 2 Nearest receptors to the Project

Receptor ID	Description	Easting (m)	Northing (m)	Distance and direction from the Project
R1	Pownalls	653,025	7,512,686	7.4 km southeast
R2	Seloh Nolem 1	652,696	7,532,404	17.7 km northeast
R3	Old Kyewong	646,743	7,509,949	6.6 km south
R4	Mockingbird Downs	652,135	7,513,934	6.2km east
R5	Meadowbrook Homestead	638,086	7,520,400	9.2 km northwest
R6	Lake Vermont Homestead	640,116	7,516,958	6.2 km west
R7	Willunga	666,958	7,529,954	25 km northeast
R8	Leichardt	656,328	7,515,670	10 km east
R9	Seloh Nolem 2	652,770	7,533,482	18.5 km northeast
R10	Old Bombandy	657,546	7,516,686	21 km east
R11	Vermont Park	647,231	7,537,824	21.8 km north
R12	Saraji Homestead 1	629,574	7,519,127	17 km west
R13	Saraji Homestead 3	630,689	7,522,987	17.5 km northwest
R14	BMA Saraji	631,500	7,520,239	15.2 km northwest
R15	Iffley	647,326	7,539,856	24 km north
R16	Tay Glen	635,322	7,509,101	12.8 km southwest
R17	Semple Residence	649,876	7,506,697	9.8 km south east
R18	Saraji Homestead 2	630,424	7,523,432	16.9 km northwest

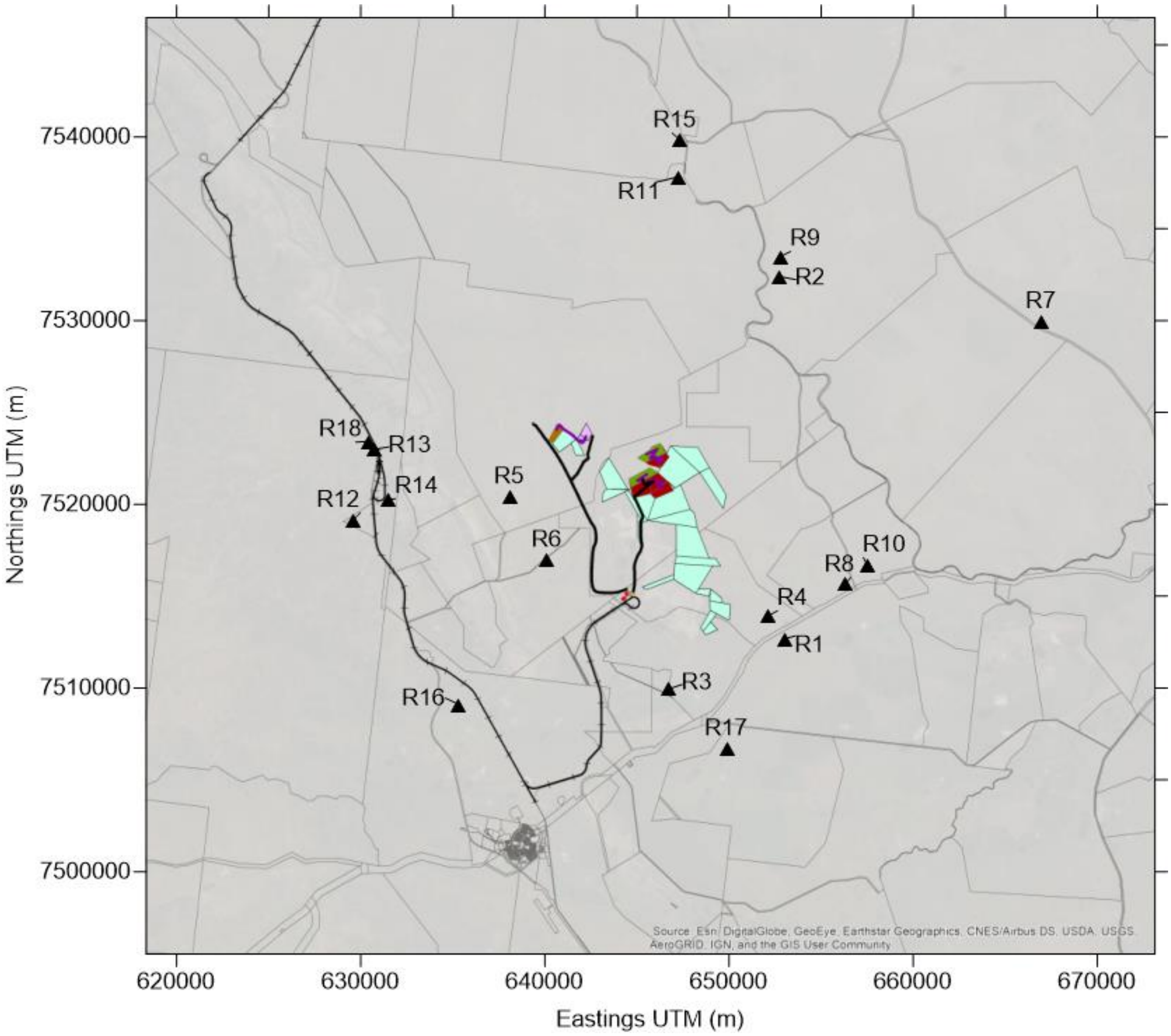

Figure 3 **Receptors in the Project vicinity**

3.3.3 Local meteorology

The following sections describe the meteorology at the Project site as used in the dispersion model. The meteorological data has been generated by the TAPM/CALMET models (as described in Appendix A1) for the 1 January 2018 to 31 December 2018 period.

The summary includes a description of the parameters that are important for the generation and dispersion of air pollutants such as dust, and a description of the wind speed, wind direction, atmospheric stability, and mixing height at the Project site. The dataset has been extracted from the CALMET model at a location indicative of the Project.

3.3.3.1 Wind speed and wind direction

The annual, seasonal and diurnal distribution of winds predicted by TAPM/CALMET for the Project site are presented in Figure 4, Figure 5 and Figure 6, respectively. The analysis of the wind speed and wind direction at the site shows that winds are predominantly light to moderate between 1 m/s and 7 m/s. Predicted mean wind speed is 2.8 m/s. Winds are predominantly from southeast quadrant, with minimal winds occurring from the northwest and southwest quadrants

The seasonal wind roses in Figure 5 show that during spring and summer, winds are predominantly from the east, shifting towards predominant southeast to south winds during autumn and winter. Wind speed is consistent showing little variation seasonally remaining around 3 m/s, with winter winds lowest at a mean speed of 2 m/s.

The diurnal wind roses in Figure 6 show that late evening and night-time winds (6pm to 6am) are predominantly light to moderate and from the northeast to southeast, reducing in strength during the early hours of the morning. Winds during the day (6am to 6pm) are predominantly from the east to southeast and between 2 m/s and 7 m/s, with the strongest winds occurring during the afternoon period.

Predicted wind characteristics are representative of conditions in the region as outlined in the validation comparison in Appendix A1.3. While the model does not account for calms very well, the difference between the modelled and observed calms is not substantial. Furthermore, while predicted wind speeds are comparatively lower than observed wind speeds, this allows for the model results to give conservative results. With lower wind speeds, less dispersion would be expected and hence higher ground level concentrations at receptors would occur.

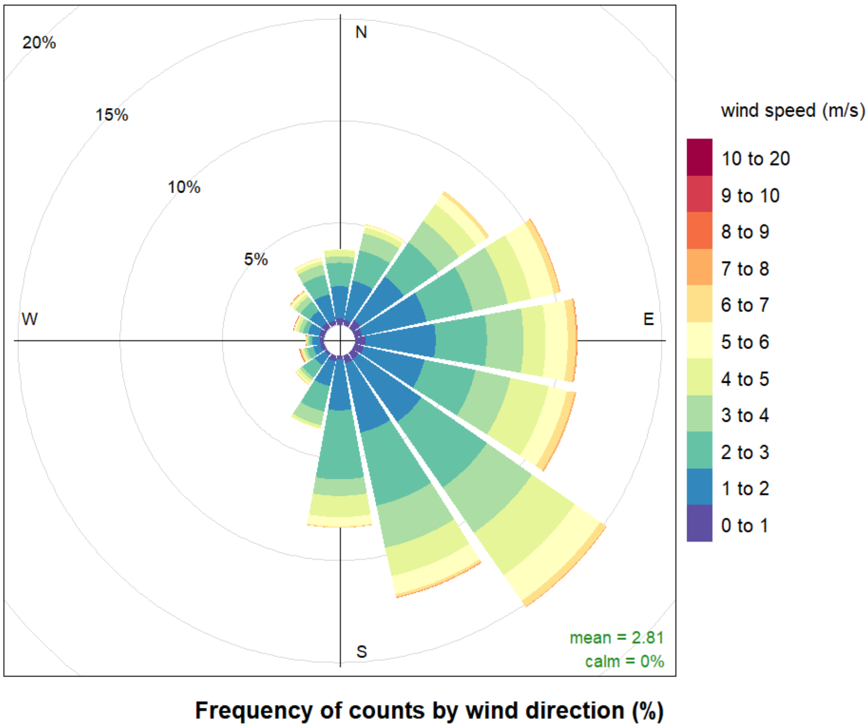

Figure 4 **Annual distribution of the TAPM/CALMET generated winds for the Project site**

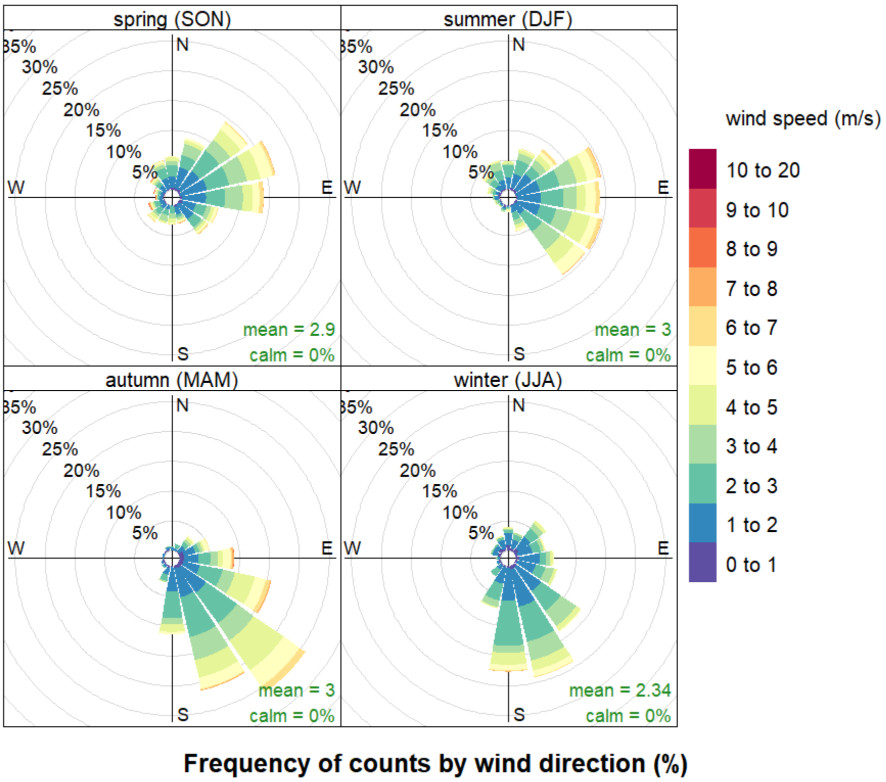

Figure 5 Seasonal distribution of the TAPM/CALMET generated winds for the Project site

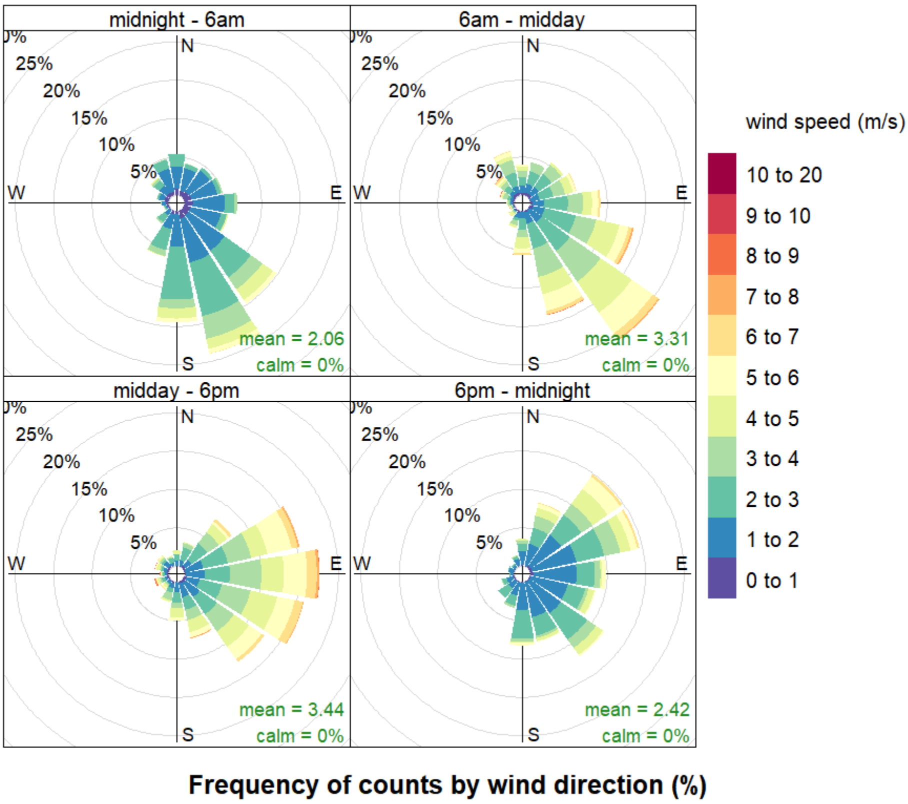

Figure 6 Diurnal distribution of the TAPM/CALMET generated winds for the Project site

3.3.3.2 Atmospheric stability

Atmospheric stability is classified under the Pasquil-Gifford scheme and ranges from Class A, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to Class F, which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (Class A-C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground, which usually results in material from a plume reaching the ground closer to the source than it does for neutral conditions or stable conditions.

This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for neutral conditions (Class D) are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface, such as terrain features and building structures. During night-time, the atmospheric conditions are generally neutral or stable (Class D, E and F) with cloud cover enhancing stability. Stability refers to the vertical movement of the atmosphere and is therefore an important factor in the dispersion and transport of a plume within the boundary layer.

Stability class is calculated by TAPM/CALMET and has been extracted at the Project site. Table 3 shows the distribution of stability classes for the site and Figure 7 shows the distribution of stability class predicted at the site by hour of day.

Table 3 Frequency distribution of surface atmospheric stability conditions at the Project site

Pasquil-Gifford Stability Class	Frequency (%)	Classification
A	1.4	Extremely unstable
B	6.5	Unstable
C	12.5	Slightly unstable
D	41.2	Neutral
E	9.8	Slightly stable
F	28.6	Stable

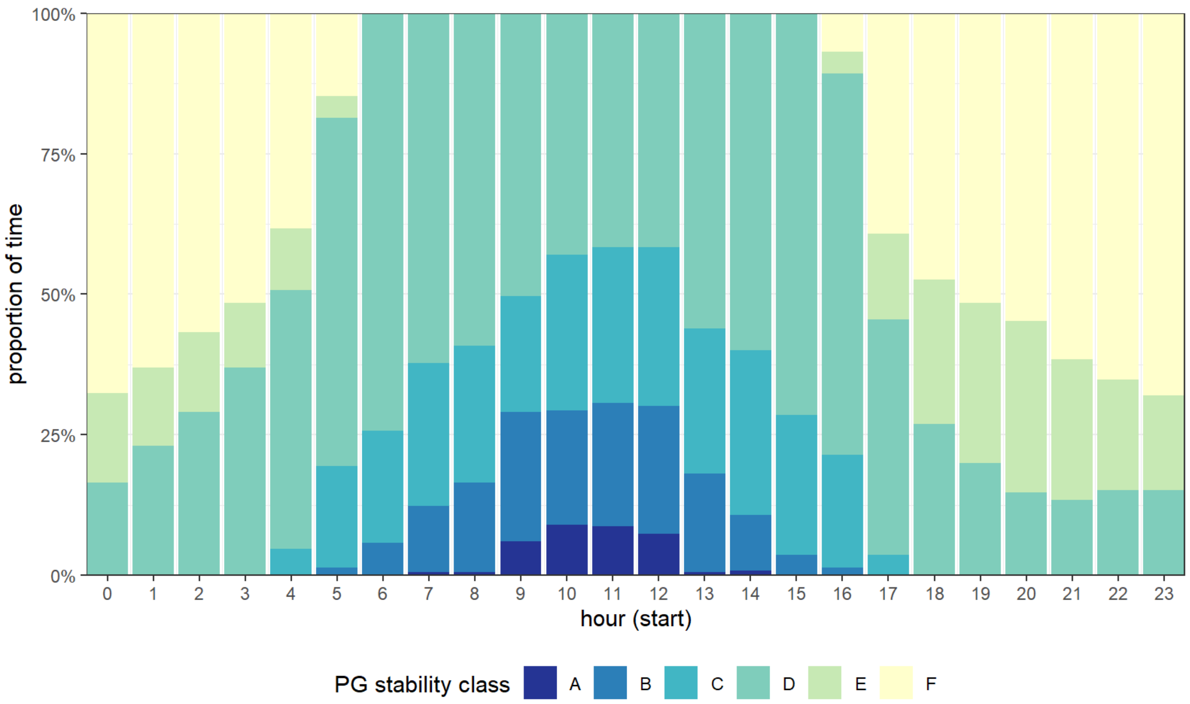

Figure 7 **Proportion of stability class predicted at the Project site by hour of day**

3.3.3.3 Mixing height

The mixing height defines the height of the mixed atmosphere above the ground (mixed layer), which varies diurnally. Air pollutants released at or near the ground will become dispersed within the mixed layer. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer. During the day, solar radiation heats the ground and causes the air above it to warm, resulting in convection and an increase to the mixing height. The growth of the mixing height is dependent on how well the warmer air from the ground can mix with the cooler upper-level air and, therefore, depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong winds, the air will be well mixed, resulting in an elevated mixing height.

Mixing height information has been extracted from the TAPM/CALMET dataset at the Project site and is presented in Figure 8. The data shows that the mixing height develops at around 6am, increases to a peak around 2-3 pm before descending rapidly between 4-5 pm.

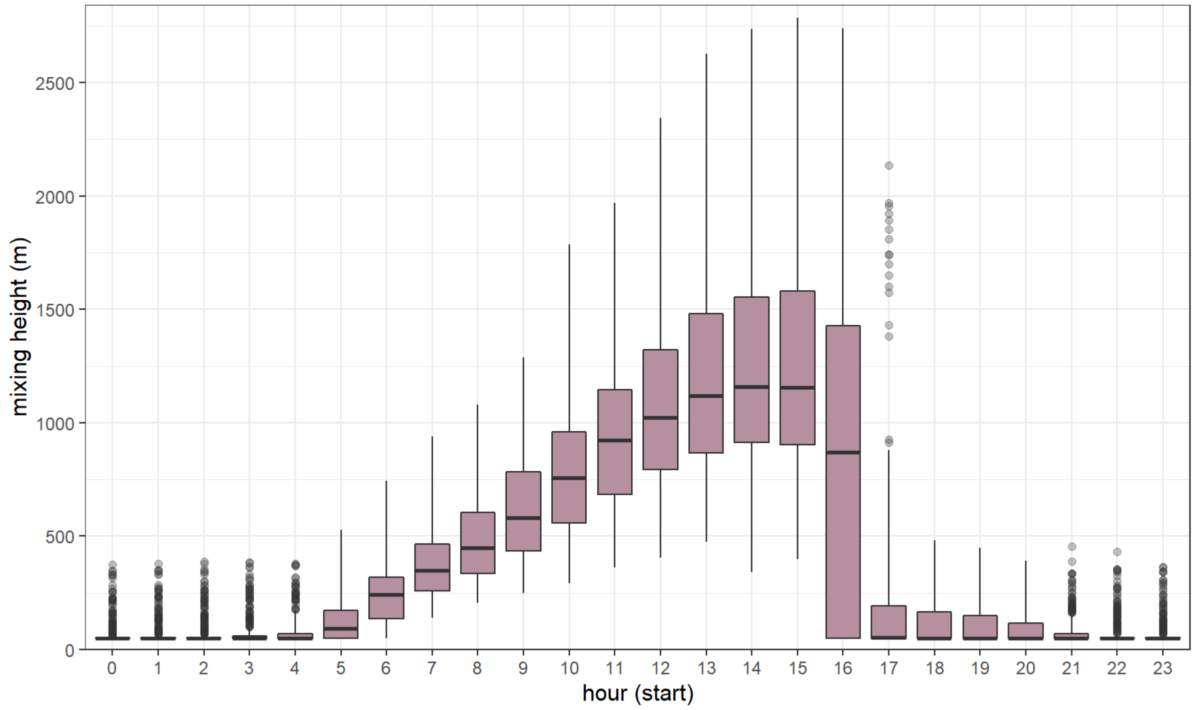

Figure 8 **Box and whisker plot of mixing height data extracted from TAPM/CALMET at the Project site by hour of day**

3.3.4 Existing air quality

There are several sources contributing to background levels of dust in the vicinity of the Project, including naturally generated dust in the environment such as pollen and grass seeds, dust from the use of dirt roads, agricultural activities, wind erosion of non-vegetated areas as well as contributions from a number of existing mines in the region.

The existing air quality has been characterised to indicate dust levels prior to the Project expansion, including the influence of natural dust sources and any dust arising from operations at the nearby mines. This has been characterised from a review of available information on dust emissions and representative ambient air quality monitoring data in the region.

3.3.4.1 Existing sources of emissions

The main sources of anthropogenic dust in the region most relevant to the Project are emissions from the existing Lake Vermont open cut coal mine and Saraji Mine. There are also a number of other coal mines in the surrounding region that may contribute to ambient dust concentrations.

Table 4 details the dust emissions (PM_{10} and $PM_{2.5}$) reported to the National Pollutant Inventory (NPI) database (NPI, 2020) for 2019/20 from identified industries in the Project region.

Table 4 Dust Emissions reported to NPI for 2019/2020

Facility Name	Main Activities	Approximate Distance and Direction from the Project Boundary	PM_{10} (tonnes/year)	$PM_{2.5}$ (tonnes/year)
Lake Vermont Mine	Coal Mining	6km south	9,921	663
Saraji Mine	Coal Mining	13 km west	8,218	167
South Walker Creek Mine	Coal Mining	20 km northwest	3,458	57
Peak Downs Mine	Coal Mining	27 km northwest	14,600	191
Poitrel Coal Mine	Coal Mining	42 km north	2,340	76
Daunia Mine	Coal Mining	42 km north	1,934	69
Caval Ridge Mine	Coal Mining	44 km northwest	7,588	109
Millennium Coal Mine	Coal Mining	45 km northwest	1,834	9
Carborough Downs Coal Mine	Coal Mining	45 km northwest	1,552	6
Moorvale Mine	Coal Mining	52.3 km north	4,693	72
Isaac Plains Coal Mine	Coal Mining	63.6 km northwest	2,982	48
Coppabella Coal Mine	Coal Mining	65.3 km northeast	7,351	73
Grosvenor	Coal Mining	68.2 km northwest	955	23

3.3.4.2 Existing ambient air quality

There is no ambient air quality monitoring at the Project site. Therefore, existing ambient air quality has been quantified through a summary of publicly available data.

3.3.4.2.1 PM_{10} and $PM_{2.5}$

Long-term continuous monitoring data for PM_{10} and $PM_{2.5}$ in the Project area is available from two DES monitoring stations located in the township of Moranbah (approximately 58 km north-west). A summary of the two stations is provided below in Table 5.

Table 5 Summary of DES Monitoring locations within 60km of Lake Vermont Mine

Monitoring Station	Monitoring Period	Parameters Monitored
Moranbah East (Utah Drive)	March 2011 - Current	PM_{10}, $PM_{2.5}$[1]
Moranbah West (Cunningham Way)	June 2020 – Current	PM_{10}, $PM_{2.5}$

Table notes:
[1] $PM_{2.5}$ monitoring at Moranbah East started in October 2019

As monitoring at Moranbah West (Cunningham Way) only commenced in June 2020, it has not been considered further. Relevant PM_{10} statistics from data measured from 2011 to 2021 at DES's Moranbah East (Utah Drive) site are presented in Table 6, while $PM_{2.5}$ statistics from data measured from 2019 to 2021 are presented in Table 7. (Queensland Data, 2019).

The Moranbah East PM_{10} data shows the following:

- The Moranbah monitoring station has recorded 109 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³ (Air EPP objective) over the 11 years of monitoring. In particular, 2012, 2018 and 2019 show a large number of PM_{10} concentrations greater than 50 µg/m³.
  - In 2012, there were 36 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that, for a period of 4 months, housing construction work was occurring within 100 metres of the monitoring station and was the likely cause of the elevated concentrations.
  - In 2017, there were 7 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that bushfires contributed to these elevated concentrations.
  - In 2018, there were 19 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that dust storms and bushfires contributed to these elevated concentrations.
  - In 2019, there were 32 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that a combination of emission sources including dust storms, bushfires, and hazard-reduction burning contributed to these elevated concentrations.
  - In 2020, there were 5 days when the 24-hour average concentration of PM_{10} was greater than 50 µg/m³. DES's monthly monitoring reports indicate that a combination of emissions sources including dust storms, smoke from bushfires and local dust sources contributed to these elevated concentrations
  - Annual average concentrations of PM_{10} at the Moranbah monitoring station were greater than the Air EPP objective of 25 µg/m³ for four of the nine years, 2012, 2017, 2018 and 2019.

When applying ambient background concentrations for cumulative air quality assessments, generally the highest representative concentration is used, in order to provide a conservative prediction of air quality impacts. For averaging periods of 24 hours or less, the 70th percentile is used, to reduce the influence of isolated extreme events on typical conditions. Excluding the years outlined above, 2016 showed the highest representative concentrations monitored at the Moranbah station, which were used in the assessment.

The Moranbah East $PM_{2.5}$ data shows the following:

- The Moranbah monitoring station has recorded 5 days when the 24-hour average concentration of $PM_{2.5}$ was greater than 25 µg/m³ (Air EPP objective) over the last ~2 years of monitoring.
  - From October onwards in 2019, there was 1 day when the 24-hour average concentration of $PM_{2.5}$ was greater than 25 µg/m³. DES's monthly monitoring reports indicate that a combination of smoke haze from bushfires and local dust sources contributed to this elevated concentration
  - In 2020, there were 4 days when the 24-hour average concentration of $PM_{2.5}$ was greater than 25 µg/m³. DES's monthly monitoring reports indicate that it is most likely that smoke and dust generated by vehicles on unsealed roads contributed to elevated concentrations on two of these exceedance days (which fell in May and July). These days are included in the average calculations presented in Table 7.

- Annual average concentrations of $PM_{2.5}$ at the Moranbah East monitoring station were greater than then Air EPP objective of 8 µg/m³ for the three-months of monitoring in 2019.

Of the available monitored concentrations of $PM_{2.5}$ at the Moranbah East monitoring station, only 2020 data is validated and complete. Hence, the 2020 dataset provides the most representative ambient $PM_{2.5}$ concentrations in the vicinity of the Project, and thus were used in the cumulative assessment.

Table 6 Concentrations of PM_{10} at Moranbah East (Utah Drive) monitoring station from 2011 to 2021

Year	PM_{10} (µg/m³)			
	24-hour average (Maximum)	No. days above 50 µg/m³	24-hour average (70th percentile)	Annual average
2011	67.6	5	23.4	20.3
2012	492.8	36	29.5	27.9
2013	99.9	1	26.5	22.4
2014	49.9	0	24.0	20.4
2015	91.9	4	25.3	21.3
2016	**49.5**	**0**	**27.2**	**22.1**
2017	68.8	7	29.6	26.1
2018	113.6	19	34.6	30.3
2019	217.8	32	35.5	31.2
2020	89.8	5	23.4	21.1
2021[1,2]	47.3	0	23.6	20.8
Objective	50	-	-	25

Table note:

[1] Eleven months of data in 2021 for Utah Drive

[2] Data downloaded from DES portal. Data was unvalidated at time of assessment.

Source: Queensland Data (2020).

Table 7 Concentrations of $PM_{2.5}$ at Moranbah East (Utah Drive) monitoring station from 2019 to 2021 inclusive

Year	$PM_{2.5}$ (µg/m³)			
	24-hour average (Maximum)	No. days above 25 µg/m³	24-hour average (70th percentile)	Annual average
2019[1]	26.1	1	13.6	11.7
2020	53.9	4	6.6	6.4
2021[2,3]	11.3	0	6.3	5.6
Objective	**25**	**-**	**-**	**8**

Table note:

[1] 2019 does not represents a full year of monitoring, it represents a period from October 2019

[2] Eleven months of data in 2021 for Utah Drive

[3] Data downloaded from DES portal. Data was unvalidated at time of assessment.

3.3.4.2.2 TSP

DES does not conduct monitoring for TSP at its Moranbah site. TSP has been calculated from DES Moranbah PM_{10} data, assuming TSP is twice the PM_{10}. This assumption is based on the TSP/PM_{10} ratios found in the NPI manual mining emission factors for fugitive dust that range from 25% to 52%.

3.3.4.2.3 Dust Deposition Rate

Dust deposition monitoring is not undertaken by BBC at Lake Vermont Mine. However, DES began monitoring dust deposition at its Moranbah stations in 2020. Moranbah East began monitoring in February 2020, while Moranbah West began in July 2020. Validated monthly maximum concentrations for both stations are available until July 2021 currently. As discussed in Section 3.2, the monthly maximum dust deposition rate is 120 mg/m^2/day, with an averaging period of one month. Moranbah West data was not considered due to having only 12 months of validated data compared to 18 months at Moranbah East. Rolling annual averages were calculated for data from Moranbah East, with the maximum rolling annual average being 79.4 mg/m^2/day.

3.3.4.3 Summary of background dust levels

Background levels of TSP, PM_{10}, $PM_{2.5}$ and dust deposition that have been derived from data presented in the previous sections and used in this assessment are summarised in Table 8.

Table 8 Ambient background concentrations used to assess cumulative impacts

Pollutant	Averaging Period	Concentration
TSP	Annual	44.2 µg/m^3
PM_{10}	24-hour, 70th percentile	27.2 µg/m^3
	Annual	22.1 µg/m^3
$PM_{2.5}$	24-hour, 70th percentile	6.6 µg/m^3
	Annual	6.4 µg/m^3
Dust deposition	Annual average	79.4 mg/m^2/day

3.4 Air quality assessment methodology

3.4.1 Emission rates

To assess potential air quality impacts due to the Project, potential dust emissions from individual mining activities for the modelling scenario were accounted for and have been explicitly modelled. Specific activity information used to calculate dust emission rates associated with individual mining activities were provided or confirmed by AARC, and are presented in Appendix B.

Dust emission rates were estimated using the base equation:

$$ER = A \times EF \times (1 - CF)$$

where:

ER	emission rate
A	activity / operations data
EF	emission factor
CF	reduction in emissions due to the implementation of control measures.

Emissions of TSP, PM_{10} and $PM_{2.5}$ from mining activities were estimated using recognised and accepted methods of dust emissions estimation. These include approximation of emission rates from NPI emissions estimation technique handbooks and the United States Environmental Protection Agency (US EPA) AP-42 emission handbooks (USEPA, 1998, USEPA, 2006a, USEPA, 2006b, USEPA, 2006c, USEPA, 2011).

The emissions estimation techniques applied in this assessment are based on standard methods that are applied throughout Australia and in the United States. These methods are consistent with those adopted for other air quality assessments conducted for other coal mines in Australia. The size distribution of dust particles was derived from the emission rates estimated for TSP, PM_{10}, and $PM_{2.5}$.

3.4.2 Meteorology

Site-specific meteorological data was generated by coupling the prognostic model TAPM (version 4.0.5) (The Air Pollution Model) with the diagnostic meteorological model CALMET (version 6.5.0). The coupled TAPM/CALMET modelling system was developed to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale, and local atmospheric conditions, detailed topographic and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models such as CALPUFF.

The assessment was conducted using the most recent versions of TAPM and CALMET available at the time of undertaking the study.

Technical details of the TAPM and CALMET model configurations are provided in Appendix A1, including a validation of the generated data whereby observed meteorological conditions at the Moranbah BoM weather station were statistically compared with the first-level TAPM output.

3.4.3 Dispersion modelling

Source characteristics and dust emission rates for each scenario were incorporated into a dispersion modelling study conducted using a standard and regulated model developed by Earth Tech, Inc., namely, the CALPUFF dispersion model (version 7.2.1).

CALPUFF is an advanced non-steady-state air quality modelling system. The meteorological data generated by TAPM/CALMET was used as input for CALPUFF in order to include all weather conditions likely to be experienced in the region during a typical year. This system has been used to predict ground-level particulate concentrations and dust deposition rates at nearby sensitive receptor locations and across a cartesian grid representing the region surrounding the Project.

Dust emissions have been modelled over a 365-day year, assuming 24-hour mine operation (noting there are two days per year which the mine does not operate), with the exception of drilling and blasting, which have been modelled as occurring during the daytime only.

Technical details of the CALPUFF model configuration are provided in Appendix A2.

3.4.4 Assessment scenarios

Two operational scenarios were modelled in this assessment. The Project Year 7 and Project Year 22 were chosen as being representative of the proposed mine activity, capturing both underground and open cut mining phases. Annual mining rates are displayed in Figure 9 below. It is noted that Project Year 22 captures both open-cut and underground activity. As such, the model results are considered indicative of worst-case impacts to air quality.

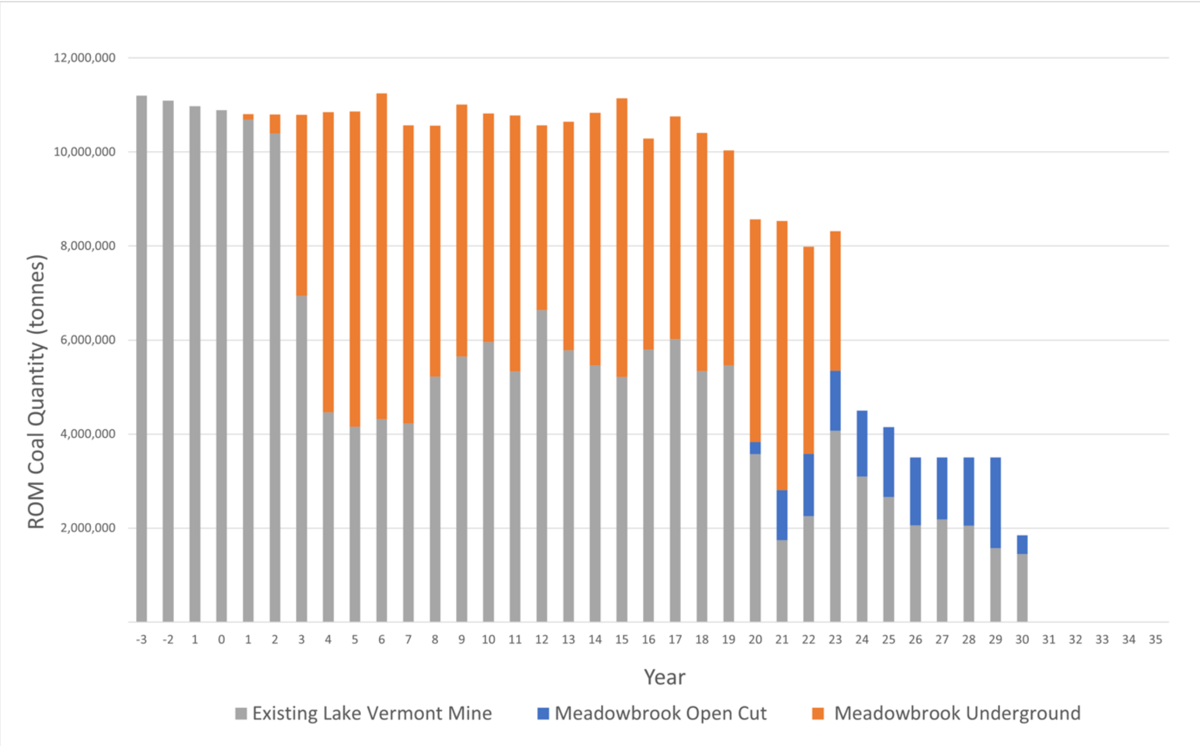

Figure 9 Projected ROM coal output from the Project and existing Lake Vermont mine

3.4.5 Cumulative impacts

Due to its close proximity to the Project, dust emissions from the existing Lake Vermont Mine were included in the dispersion modelling of the proposed underground and open-cut mines. It would also be expected that ambient concentrations of dust would be elevated due to the other mining operations in the vicinity of the Project. Hence, representative background levels of TSP, PM_{10}, $PM_{2.5}$, and dust deposition were acquired from monitoring in the area as outlined in Section 3.3.4, and have also been added to the results of the dispersion modelling to determine the complete potential impact of the Project.

Results have been presented as proposed results (Meadowbrook open cut/underground mines results), combined results (proposed operations plus the existing Lake Vermont mine operations), and cumulative results (combined results with ambient backgrounds added). These are shown in Section 3.6 in tabular format and as contour plots.

3.4.6 Limitations of dispersion modelling

A limitation of this study is that it relies on the accuracy of a number of data sets that feed into the dispersion model, such as:

- Meteorological monitoring observations from the Bureau of Meteorology Synoptic and surface information datasets from CSIRO
- Control efficiencies of mitigation measures
- Activity data and mining sequence
- Monitoring data from DES monitoring network.

It is also important to note that numerical models are based on an approximation of governing equations and will inherently be associated with some degree of uncertainty. The more complex the physical model, the greater the number of physical processes that must be included. There will be physical processes that are not explicitly accounted for in the model and, in general, these approximations tend to lead to an over prediction of air pollutant levels.

The dispersion model has been configured with worst case assumptions, namely the application of parameters to the model from the years of high production and activity. Therefore, the model is likely to overpredict potential impacts due to the Project.

3.5 Emissions to the atmosphere

The following sections provide a summary of dust emissions for the assessment scenarios and a description of dust mitigation measures currently implemented or proposed to be implemented by BBC.

3.5.1 Construction

Dust emissions from construction activities are predicted to be minimal compared to existing extraction operations. The bulk of the construction activity will be associated with the development of the proposed mine infrastructure area and the development of the proposed infrastructure corridor (see Figure 1). Best practices with regards to emission controls are already in place at the site, and they can be successfully applied to construction activities to further reduce dust emissions.

3.5.2 Operations

Activities that are associated with the most significant emissions of particulate matter from coal mines are the extraction of material (e.g. drilling and blasting), transfers and handling, haulage, stockpiles and wind erosion of exposed areas. Emissions of oxides of nitrogen, sulfur dioxide and carbon monoxide would also occur due to blasting activities and vehicle movements on site. However, these emissions are transient (contained within the infrastructure corridor and open-cut pits) and low in magnitude, thus their impact is likely to be negligible. Flaring of gas, as part of gas drainage of the underground coal seam, will occur where practicable; however, this is not expected to significantly contribute to the air quality of the area.

For the majority of activities, the emission rate of particulate matter is dependent on the wind speed with little or no emissions occurring for some activities (e.g. stockpiles) below a wind speed threshold. Other factors are also important such as coal type, coal moisture content, coal particle size distribution, rainfall and the mitigation measures that may be employed.

3.5.3 Mitigation measures - standard

Dust mitigation and operational controls have been included in the Project design to minimise dust emissions. This includes application of water to haul roads, handling activities and stockpiles as well as the sealing of the ROM haul road from the Project to the existing CHPP, Efficiency factors (reduction in dust emissions applied in this assessment) for these control measures are presented in Table 9.

Table 9 Standard dust control measures and relative reduction in emissions

Activity	Control measure	Reduction [a]
ROM coal haulage (unpaved, existing operations)	Watering	85%[b]
ROM coal haulage (unpaved)	Watering	85%[b]
Overburden waste haulage	Watering	85%[b]
Drilling	Drill dust suppression sprays	70%
Product stacking	Water sprays on stacker	50%
Train loading	Reclaim tunnel	70%
Wind erosion of recontoured / rehabilitated areas	Vegetation established but not demonstrated to be self-sustaining	40%

[a] Emissions reductions are based on values provided in the NPI EET Manual for Mining, unless otherwise specified.

[b] ACARP Development of Australia-Specific PM_{10} Emission Factors for Coal Mines

3.5.4 Mitigation measures – proactive

BBC currently implements additional emissions controls proactively when required for the existing Lake Vermont operations. BBC propose to continue the implementation of such measures as part of this Project. These controls typically are applied during periods where meteorological conditions promote an increase in dust generation. Proactive emission controls include:

- Additional road watering concentrated at problem areas.
- Speed restrictions imposed on haul trucks when dust is visible, which reduces the overall hauling capacity by ~20%.
- Re-routing of haul trucks to reduce waste haulage distances by up to 50%.
- Re-assignment of haulage location to areas experiencing less dust.

In consideration of the proactive emissions controls that are applied at the existing Lake Vermont operations, an additional control factor has been applied to existing overburden haul roads for 24 days of the year to reflect proactive dust controls, which impacts PM_{10} results.

3.5.5 Upset conditions

Upset conditions are defined as periods of excessive dust emissions. This may be due to an incident, inadequate or non-existent dust controls, or other initiating factor leading to elevated dust impacts. BBC currently has an existing AQMP in place for the existing Lake Vermont operations. This consists of a combination of standard mitigation measures (as outlined in Section 3.5.3) along with additional mitigation measures to control dust emissions when required (outlined in Section 3.5.4) to prevent upset conditions occurring.

3.5.6 Mine decommissioning and rehabilitation

As the project nears the end of its life, BBC will engage relevant stakeholders to undertake a decommissioning and rehabilitation process. Infrastructure assets will be either retained, sold, recycled, relocated, or disposed of as either general or regulated waste. Progressive rehabilitation will be undertaken at the existing Lake Vermont Mine as soon as practicable and will be underway during this project.

The Progressive Rehabilitation and Closure Plan will detail the milestones and schedule for the project decommissioning, but it is expected that decommissioning of the proposed project will proceed in a similar way to the process implemented at the existing Lake Vermont Mine. Emissions from rehabilitated areas are expected to be less than operational emissions.

3.5.7 Emissions Inventory

3.5.7.1 Year 7

A summary of emission rates from the Project during Year 7 are provided in Table 10. These inventories include the emissions associated with the Project as well as the existing Lake Vermont open-cut mine operations. Emissions have been estimated as described in Section 3.4.1 and Appendix B. Schematics illustrating the location of emission sources is presented in Figure 10.

Table 10 Year 2032 - Summary of emissions

Mine/Activity	TSP	PM_{10}	$PM_{2.5}$
Meadowbrook Underground Mine			
Handling / Transfers - ROM	0.07	0.03	0.005
Haulage – ROM (paved)	35.1	6.7	1.6
Wind erosion - ROM stockpile	0.07	0.04	0.01
Subtotal	**35.2**	**6.8**	**1.6**
Meadowbrook Open Cut Mine	No open cut mining for Meadowbrook for this year		
Extraction / Handling / Transfers of ROM/OB			
Haulage – ROM			
Haulage – OB			
Grading - OB			
Wind Erosion - OB dump / Stockpile			
Subtotal	**0.0**	**0.0**	**0.0**
Existing Lake Vermont Mine			
Extraction / Handling / Transfers of ROM/OB	7.7	3.8	0.7
Haulage - ROM	5.3	1.3	0.1
Haulage - OB	53.7	13.6	1.4
Grading - ROM	1.0	0.3	0.03
Grading - OB	0.9	0.3	0.03
CHPP (all mines)	5.3	2.0	0.2
Wind Erosion - OB dump / Stockpiles	41.1	20.5	3.1
Subtotal	**114.9**	**41.8**	**5.5**
Total	**150.18**	**48.57**	**7.16**

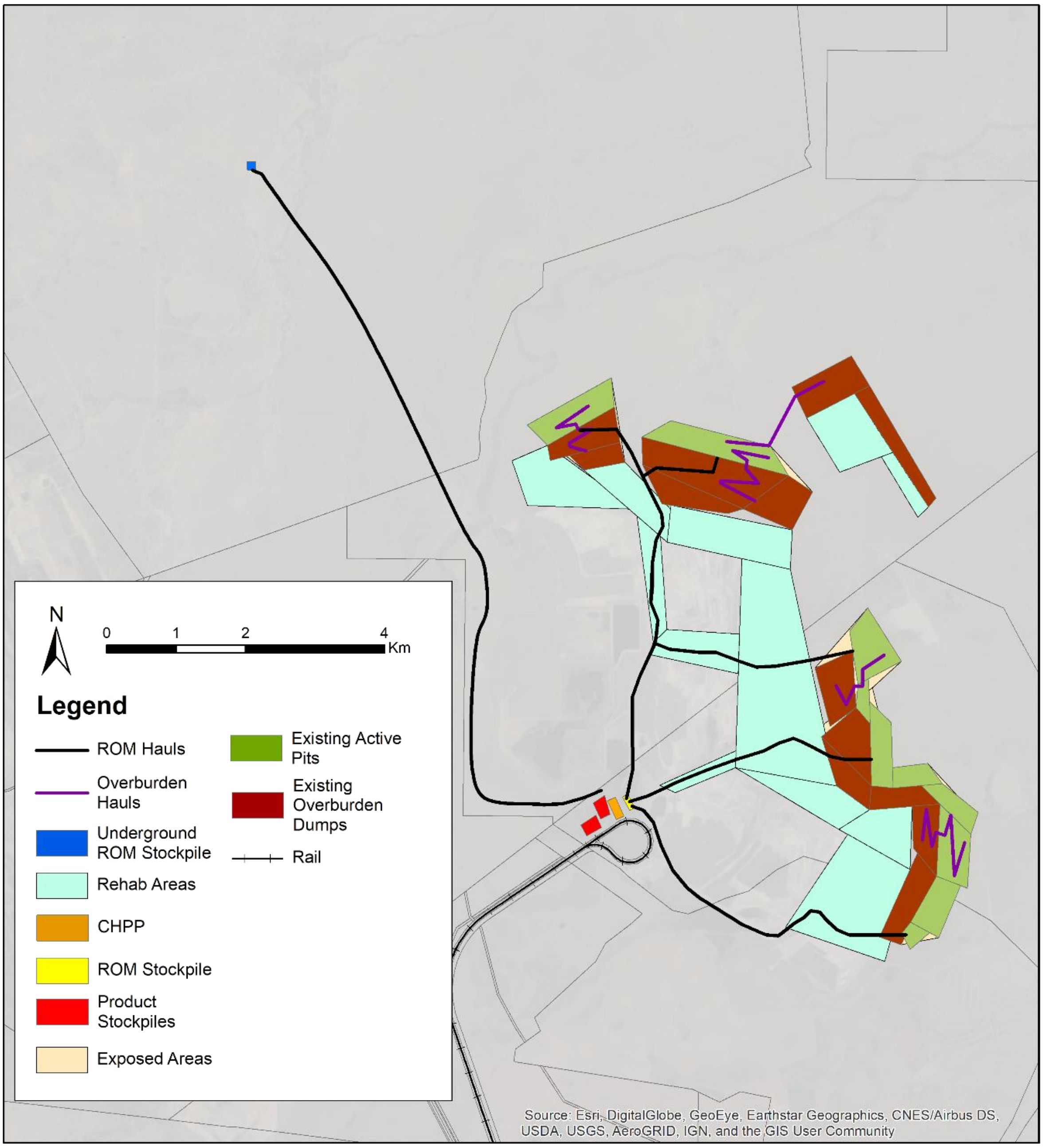

Figure 10 **Year 7 – Location of dust emissions source for the Project and existing Lake Vermont operations**

3.5.7.2 Year 22

A summary of emission rates from the Project during Year 22 are provided in Table 11. These inventories include the emissions associated with the Project as well as the existing Lake Vermont open-cut mine operations. Emissions have been estimated as described in Section 3.4.1 and Appendix B. Schematics illustrating the location of emission sources is presented in Figure 11.

Table 11 **Year 22 - Summary of emissions**

Mine/Activity	TSP	PM_{10}	$PM_{2.5}$
Meadowbrook Underground Mine			

Handling / Transfers - ROM	0.05	0.02	0.003
Haulage – ROM (paved)	24.4	4.7	1.1
Wind erosion - ROM stockpile	0.1	0.04	0.01
Subtotal	**24.5**	**4.7**	**1.1**
Meadowbrook Open Cut Mine			
Extraction / Handling / Transfers of ROM/OB	2.7	1.3	0.3
Haulage – ROM (paved + unpaved)	6.8	1.4	0.3
Haulage – OB	17.8	4.5	0.4
Grading - OB	0.001	<0.001	<0.001
Wind Erosion - OB dump / Stockpile	4.0	2.0	0.3
Subtotal	**31.4**	**9.2**	**1.3**
Existing Lake Vermont Mine			
Extraction / Handling / Transfers of ROM/OB	6.6	3.3	0.6
Haulage - ROM	4.0	1.0	0.1
Haulage - OB	69.0	17.4	1.7
Grading - ROM	1.0	0.3	0.03
Grading - OB	0.9	0.3	0.03
CHPP (all mines)	4.1	1.5	0.1
Wind Erosion - OB dump / Stockpiles	43.2	21.6	3.2
Subtotal	**128.8**	**45.4**	**5.9**
Total	**184.72**	**59.37**	**8.35**

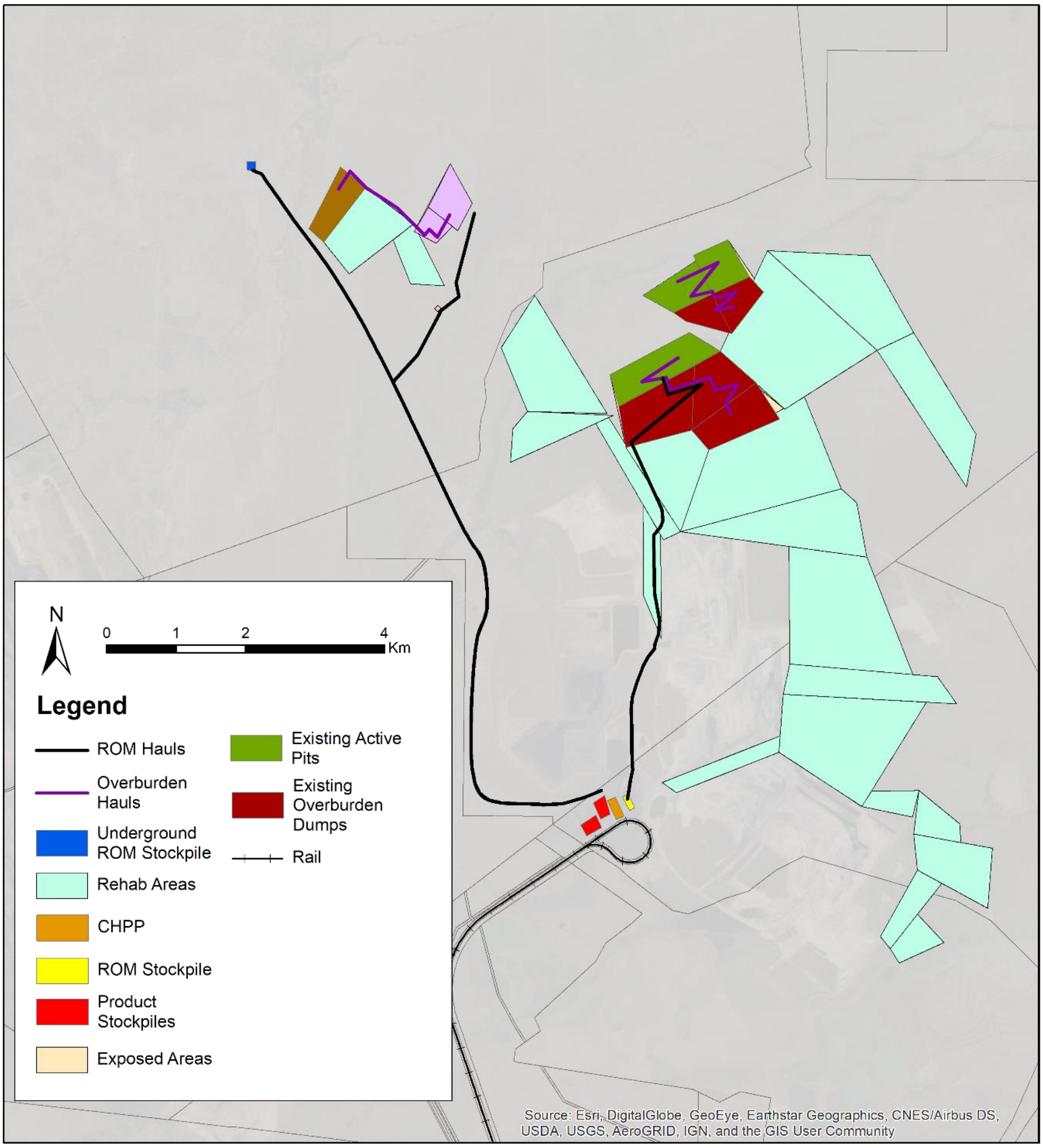

Figure 11 Year 22 – Location of dust emissions source for the Project and existing Lake Vermont operations

3.6 Results

This section presents the results of the dispersion modelling assessment of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rates in tabular format and as contour plots. Modelling results associated with each scenario have been presented as ground-level concentrations or dust deposition rates at sensitive receptors as well as contours across the modelling domain.

Background dust levels have been added to the incremental model predictions in order to obtain an estimate of the potential cumulative impacts of the Project. Results have been assessed by comparing the predicted concentrations and dust deposition rates with the relevant air quality objectives.

When considering the results, it is important to note the 24-hour average dispersion modelling results are based on the concentration of each pollutant predicted at the receptors over the one-year period and thus represent a peak-impact scenario. The contour plots are constructed such that the highest value is obtained and stored from each point in the modelled domain. As these values may occur at different times at different grid points, these figures do not represent a single snapshot of conditions at any given time. Gridded residual results inclusive of the dust control measures have been presented for both scenarios.

3.6.1 Year 7

Predicted ground-level concentrations of TSP and dust deposition rates for Project Year 7 are presented in Table 12. Predicted ground-level concentrations of $PM_{2.5}$ and PM_{10} are presented in Table 13. Results have been presented as:

- Proposed – Meadowbrook underground mine operations in isolation
- Combined – Meadowbrook underground mine operations and existing Lake Vermont mine operations in isolation
- Cumulative – Meadowbrook underground mine and Lake Vermont Mine with ambient backgrounds included.

The results of the cumulative assessment are also presented as contour plots in Plate 1 to Plate 7.

The results show that:

- Predicted annual average concentrations of TSP ***comply*** with the Air EPP objective at all sensitive receptors due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted maximum monthly dust deposition rates ***comply*** with the EA limit at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour average concentrations of $PM_{2.5}$ ***comply*** with the Air EPP objective at all sensitive receptors due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted annual average concentrations of $PM_{2.5}$ ***comply*** with the Air EPP objective at all sensitive receptors due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour average concentrations of PM_{10} ***comply*** with the EA limit at all sensitive receptors for the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations. Additional dust mitigation measures have been applied that reflect current proactive management practices.

- Predicted annual average concentrations of PM_{10} ***comply*** with the Air EPP objective at all sensitive receptors for the Project in isolation, using standard mitigation measures for the Project and the existing operations.

Table 12 Year 7 – Predicted annual average TSP and dust deposition rates

Receptors		TSP (µg/m³)			Dust deposition (mg/m²/day)		
		Annual			Max monthly		
		Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG
R1	Pownalls	0.1	0.7	44.9	0.2	3.0	82.4
R2	Seloh Nolem 1	0.1	0.5	44.7	0.1	0.6	80.0
R3	Old Kyewong	0.2	3.0	47.2	0.5	5.2	84.6
R4	Mockingbird Downs	0.1	1.5	45.7	0.2	7.6	87.0
R7	Willunga	0.01	0.1	44.3	0.04	0.5	79.9
R8	Leichardt	0.03	0.3	44.5	0.1	2.0	81.4
R9	Seloh Nolem 2	0.1	0.4	44.6	0.1	0.6	80.0
R10	Old Bombandy	0.02	0.2	44.4	0.1	1.8	81.2
R11	Vermont Park	0.1	0.8	45.0	0.1	0.9	80.3
R12	Saraji Homestead 1	0.4	1.0	45.2	0.8	3.9	83.3
R13	Saraji Homestead 3	0.5	1.3	45.5	1.2	4.7	84.1
R14	BMA Saraji	0.6	1.5	45.7	1.3	5.1	84.5
R15	Iffley	0.1	0.6	44.8	0.1	0.7	80.1
R16	Tay Glen	0.4	1.4	45.6	1.2	6.1	85.5
R17	Semple Residence	0.1	1.0	45.2	0.3	1.2	80.6
R18	Saraji Homestead 2	0.5	1.2	45.4	1.1	4.3	83.7
Air EPP Objective		**90 µg/m³ (Air EPP)**			**120 mg/m²/day (EA limit)**		

Table 13 Year 7 - Predicted 24-hour and annual average $PM_{2.5}$ and PM_{10}

Receptors		$PM_{2.5}$ (µg/m³)						PM_{10} (µg/m³)								
		24-hour			Annual			24-hour Maximum [a]			24-hour 6th Highest [a]			Annual		
		Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG
R1	Pownalls	0.9	4.1	10.7	0.02	0.1	6.5	2.1	15.3	42.5	0.6	6.1	33.3	0.04	0.5	22.6
R2	Seloh Nolem 1	0.7	2.0	8.6	0.03	0.1	6.5	1.6	8.6	35.8	1.3	6.6	33.8	0.1	0.4	22.5
R3	Old Kyewong	1.6	4.9	11.5	0.1	0.6	7.0	3.5	17.8	45.0	2.2	13.3	40.5	0.2	2.5	24.6
R4	Mockingbird Downs	1.5	5.3	11.9	0.03	0.2	6.6	3.5	18.7	45.9	1.1	14.1	41.3	0.1	1.1	23.2
R7	Willunga	0.2	0.6	7.2	0.004	0.02	6.4	0.5	2.8	30.0	0.2	1.4	28.6	0.01	0.1	22.2
R8	Leichardt	1.0	3.1	9.7	0.01	0.05	6.4	2.4	9.3	36.5	0.3	3.6	30.8	0.02	0.2	22.3
R9	Seloh Nolem 2	0.7	1.8	8.4	0.03	0.1	6.5	1.7	8.6	35.8	1.1	6.6	33.8	0.1	0.4	22.5
R10	Old Bombandy	0.7	2.2	8.8	0.01	0.04	6.4	1.45	7.7	34.9	0.4	3.2	30.4	0.02	0.2	22.3
R11	Vermont Park	1.1	2.5	9.1	0.04	0.2	6.6	3.0	10.4	37.6	1.7	8.0	35.2	0.1	0.7	22.8
R12	Saraji Homestead 1	1.0	2.1	8.7	0.1	0.3	6.7	2.0	4.5	31.7	1.6	3.7	30.9	0.3	0.8	22.9
R13	Saraji Homestead 3	1.4	2.4	9.0	0.2	0.4	6.8	2.9	5.8	33.0	2.2	5.2	32.4	0.5	1.1	23.2
R14	BMA Saraji	1.4	2.5	9.1	0.2	0.4	6.8	3.0	7.0	34.2	2.5	5.5	32.7	0.5	1.3	23.4
R15	Iffley	0.9	2.3	8.9	0.04	0.1	6.5	2.4	9.5	36.7	1.4	5.8	33.0	0.1	0.5	22.6

Receptors		PM2.5 (µg/m³)						PM10 (µg/m³)								
		24-hour			Annual			24-hour Maximum [a]			24-hour 6th Highest [a]			Annual		
		Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG
R16	Tay Glen	1.6	3.4	10.0	0.1	0.4	6.8	3.6	9.0	36.2	2.0	5.7	32.9	0.3	1.2	23.3
R17	Semple Residence	1.1	5.1	11.7	0.03	0.2	6.6	2.6	13.9	41.1	1.4	9.5	36.7	0.1	0.9	23.0
R18	Saraji Homestead 2	1.4	2.4	9.0	0.20	0.4	6.8	2.8	5.8	33.0	2.1	5.1	32.3	0.4	1.0	23.1
Objective		**25 µg/m³**			**8 µg/m³**			**50 µg/m³**						**25 µg/m³**		

Table note:

[a] An additional 50% control factor has been applied to existing overburden haul roads for 24 days of the year to reflect proactive dust controls

3.6.2 Year 22

Predicted ground-level concentrations of TSP and dust deposition rates for Year 22 are presented in Table 14. Predicted ground-level concentrations of $PM_{2.5}$ and PM_{10} are presented in Table 15. Results have been presented as:

- Proposed – Meadowbrook underground mine operations and Meadowbrook open cut mine operations in isolation
- Combined – Meadowbrook underground mine operations, open cut mine operations and existing Lake Vermont mine operations in isolation
- Cumulative – Meadowbrook underground mine, open cut mine and Lake Vermont Mine with ambient backgrounds included

The results of the cumulative assessment are also presented as contour plates in Plate 8 to Plate 14.

The results show that:

- Predicted annual average concentrations of TSP ***comply*** with the Air EPP objective at all sensitive receptors due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted maximum monthly dust deposition rates ***comply*** with the EA limit at all sensitive receptors, due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour average concentrations of $PM_{2.5}$ ***comply*** with the Air EPP objective at all sensitive receptors due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted annual average concentrations of $PM_{2.5}$ ***comply*** with the Air EPP objective at all sensitive receptors due to the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.
- Predicted 24-hour average concentrations of PM_{10} ***comply*** with the EA limit at all sensitive receptors for the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations. Additional dust mitigation measures have been applied that reflect current proactive management practices.
- Predicted annual average concentrations of PM_{10} ***comply*** with the Air EPP objective at all sensitive receptors for the Project in isolation and cumulatively, using standard mitigation measures for the Project and the existing operations.

Table 14 Year 22 – Predicted annual average TSP and dust deposition rates

Receptors		TSP (µg/m³)			Dust deposition (mg/m²/day)		
		Annual			Max monthly		
		Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG
R1	Pownalls	0.1	0.4	44.6	0.2	1.5	80.9
R2	Seloh Nolem 1	0.1	0.6	44.8	0.3	0.8	80.2
R3	Old Kyewong	0.3	1.3	45.5	0.6	1.9	81.3
R4	Mockingbird Downs	0.1	0.7	44.9	0.3	2.8	82.2
R7	Willunga	0.02	0.1	44.3	0.1	0.6	80.0
R8	Leichardt	0.05	0.3	44.5	0.1	1.3	80.7
R9	Seloh Nolem 2	0.1	0.5	44.7	0.2	0.6	80.0
R10	Old Bombandy	0.04	0.2	44.4	0.1	1.2	80.6
R11	Vermont Park	0.2	1.0	45.2	0.2	1.4	80.8
R12	Saraji Homestead 1	0.6	1.3	45.5	1.8	4.4	83.8
R13	Saraji Homestead 3	0.9	1.9	46.1	2.0	6.2	85.6
R14	BMA Saraji	1.0	2.0	46.2	2.6	5.8	85.2
R15	Iffley	0.2	0.8	45.0	0.2	1.0	80.4
R16	Tay Glen	0.5	1.3	45.5	1.3	4.9	84.3
R17	Semple Residence	0.1	0.6	44.8	0.3	0.8	80.2
R18	Saraji Homestead 2	0.9	1.9	46.1	1.9	5.8	85.2
Air EPP Objective		**90 µg/m³**			**120 mg/m²/day (EA limit)**		

Table 15 Year 22 - Predicted 24-hour and annual average $PM_{2.5}$ and PM_{10}

Receptors		$PM_{2.5}$ (µg/m³)						PM_{10} (µg/m³)								
		24-hour			Annual			24-hour Maximum [a]			24-hour 6th Highest [a]			Annual		
		Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG
R1	Pownalls	0.96	3.0	9.6	0.02	0.1	6.5	2.4	9.1	36.3	1.3	5.1	32.3	0.1	0.4	22.5
R2	Seloh Nolem 1	1.39	3.2	9.8	0.04	0.1	6.5	4.4	10.4	37.6	2.3	7.6	34.8	0.1	0.5	22.6
R3	Old Kyewong	2.36	7.4	14.0	0.09	0.3	6.7	5.9	17.0	44.2	2.9	12.7	39.9	0.2	1.2	23.3
R4	Mockingbird Downs	1.53	4.4	11.0	0.03	0.1	6.5	3.5	13.8	41.0	1.9	8.8	36.0	0.1	0.6	22.7
R7	Willunga	0.31	1.0	7.6	0.01	0.02	6.4	0.7	4.2	31.4	0.3	1.4	28.6	0.01	0.1	22.2
R8	Leichardt	1.12	2.8	9.4	0.01	0.1	6.5	2.7	9.9	37.1	0.6	4.1	31.3	0.04	0.2	22.3
R9	Seloh Nolem 2	1.15	3.9	10.5	0.03	0.1	6.5	3.5	11.4	38.6	2.0	6.3	33.5	0.11	0.5	22.6
R10	Old Bombandy	0.89	3.0	9.6	0.01	0.04	6.4	2.1	11.9	39.1	0.4	2.3	29.5	0.03	0.2	22.3
R11	Vermont Park	1.49	7.2	13.8	0.06	0.2	6.6	5.3	20.7	47.9	3.8	10.9	38.1	0.20	1.0	23.1
R12	Saraji Homestead 1	1.36	2.8	9.4	0.17	0.3	6.7	3.7	6.9	34.1	2.5	5.5	32.7	0.5	1.1	23.2
R13	Saraji Homestead 3	2.03	3.6	10.2	0.27	0.5	6.9	5.7	9.8	37.0	3.9	8.0	35.2	0.8	1.6	23.7
R14	BMA Saraji	1.96	3.8	10.4	0.28	0.5	6.9	5.5	9.7	36.9	4.6	8.8	36.0	0.8	1.7	23.8
R15	Iffley	1.41	5.6	12.2	0.05	0.2	6.6	4.2	16.9	44.1	2.7	8.4	35.6	0.2	0.7	22.8

Receptors		PM2.5 (µg/m³)						PM10 (µg/m³)								
		24-hour			Annual			24-hour Maximum [a]			24-hour 6th Highest [a]			Annual		
		Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG	Proposed	Combined	Combined + BG
R16	Tay Glen	1.55	2.9	9.5	0.16	0.3	6.7	3.7	9.6	36.8	2.5	7.8	35.0	0.4	1.1	23.2
R17	Semple Residence	1.07	4.9	11.5	0.04	0.2	6.6	2.6	16.9	44.1	1.5	5.5	32.7	0.1	0.5	22.6
R18	Saraji Homestead 2	2.13	3.6	10.2	0.27	0.5	6.9	6.1	9.2	36.4	3.9	8.0	35.2	0.8	1.6	23.7
Objective		**25 µg/m³**			**8 µg/m³**			**50 µg/m³**						**25 µg/m³**		

Table note:

[a] An additional 50% control factor applied to existing overburden haul roads for 24 days of the year

3.7 Monitoring and Mitigation

BBC currently has an existing AQMP in place for the existing Lake Vermont operations. This consists of a combination of standard mitigation measures (as outlined in Section 3.5.3) along with additional mitigation measures to control dust emissions when required (outlined in Section 3.5.4). BBC plans to continue to operate the existing operations and proposed operations with both the standard and proactive dust mitigation measures in place.

It is recommended that BBC also implement the following measures:

- Update the existing Air Quality Management Plan (AQMP) where necessary and include a range of available measures to be implemented as necessary to ensure compliance with approval conditions. Measures that would be considered for inclusion in the AQMP include:
  - Nomination of a range of measures which will be implemented following a complaint, for example:
    - Applying additional at-source dust controls.
    - Increasing the intensity of dust controls.
    - Modifying certain operations.
    - Investigate if monitoring indicates unexpected exceedances of air quality objectives.

4. GREENHOUSE GAS ASSESSMENT

4.1 Background

The term GHG (greenhouse gas) comes from the ‘greenhouse effect’, which refers to the natural process that warms the Earth’s surface. GHG in the atmosphere absorb the longwave solar radiation (heat) emitted by the Earth’s surface, warming the atmosphere, and then re-emits the radiation in turn, some of which goes back towards the ground, increasing the surface temperature. Human activity, especially burning fossil fuels and deforestation, is increasing the concentration of GHG in the atmosphere and hence increasing the capacity of the atmosphere to absorb outgoing radiative heat. Even a small increase in long-term average surface temperatures has numerous direct and indirect consequences for climate.

Australia is a signatory to United Nations Framework Convention on Climate Change (UNFCCC), the associated Kyoto Protocol signalling its commitment to reducing GHG emissions at a national level. Under the Paris Agreement, the most recent progression of the UNFCCC, Australia has set a target to reduce emissions by 26 -28% below 2005 levels by 2030, building on the 2020 target of reducing emissions by 5% below 2000 levels.

The main GHG associated with the Project is carbon dioxide (CO_2), with smaller contributions from methane (CH_4) and nitrous oxide (N_2O). These gases vary in effect and atmospheric lifetime, however a parameter referred to as the Global Warming Potential (GWP) allows each gas to be described in terms of CO_2 (the most prevalent GHG). Thus, a given quantity of CH_4 or N_2O can be expressed in terms of carbon dioxide equivalents (CO_2-e). A unit of one tonne of CO_2-e (tCO_2-e) is the basic unit used in carbon accounting. In simple terms, the GHG emissions associated with the Project can be expressed as the sum of the emission rate of each GHG multiplied by its associated GWP (denoted in squares). For example:

$$\text{tonnes } \mathbf{CO_2\text{-e}} = \text{tonnes } \mathbf{CO_2} \times \boxed{1} + \text{tonnes } \mathbf{CH_4} \times \boxed{28} + \text{tonnes } \mathbf{N_2O} \times \boxed{265}$$

While few, if any, individual Projects would make a noticeable change to the Earth’s climate, the summation of human activities increasing the concentrations of GHG in the atmosphere does. Climate change is an environmental concern at a global level. Governments and the global scientific community have established conventions for accounting for GHG emissions to enable the transparent and verifiable assessment of GHG emissions among all global jurisdictions. This assessment employs these established conventions so that the relative impact of the Project can be assessed and understood.

4.2 Regulatory Framework for Greenhouse Gas Emissions

4.2.1 National policy

Australia will seek to meet its emissions targets through the Government’s Direct Action Plan. The Emissions Reduction Fund (ERF) is a central component of the Direct Action policies, and comprises emission reduction credits, a fund to purchase emission reductions, and a Safeguard Mechanism.

The Safeguard Mechanism has been put in place to ensure that emission reductions purchased by the Government through the ERF are not offset by significant increases in emissions by large emitters elsewhere in the economy. The Safeguard Mechanism commenced on 1 July 2016 and requires Australia’s largest emitters to keep net emissions within baseline levels. It applies to around 140 large businesses that have facilities with direct emissions (Scope 1 emissions) of more than 100,000 tonnes of carbon dioxide equivalent (t CO_2-e) a year and is expected to cover approximately half of Australia’s emissions.

Direct emissions associated with the Project are anticipated to exceed 100,000 t CO_2-e for all years of the existing and proposed operations. As a result, the Project will be subject to the requirements of the Safeguard Mechanism.

4.2.2 National Greenhouse and Energy Reporting (NGER)

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) established a national framework for corporations to report GHG emissions and energy consumption.

The *National Greenhouse and Energy Reporting Regulations 2008* recognises Scope 1 and Scope 2 emissions as follows:

- Scope 1 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.
- Scope 2 emissions – in relation to a facility, means the release of GHG into the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility.

A third category of GHG emissions, namely Scope 3 emissions, are defined as indirect GHG emissions other than Scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business. Some examples are production and manufacture of purchased materials, transportation of products, use of sold products and services, and flying on a commercial airline by a person from another business. Due to the potential for double-counting of GHG emissions, Scope 3 emissions are not included in NGER reporting. Despite this, potential Scope 3 emissions have been considered as part of this assessment.

NGER registration and reporting are mandatory for corporations that have energy production, energy use or GHG emissions that exceed specified thresholds. GHG emission thresholds include Scope 1 and Scope 2 emissions. NGER reporting thresholds are summarised in Table 16.

Table 16 NGER annual reporting thresholds – greenhouse gas emissions and energy use

Threshold level	Threshold type	
	GHG (kt CO_2-e)	Energy production and/or consumption (TJ)
Facility	25	100
Corporate	50	200

Note:
kt CO_2-e = kilotonnes of carbon dioxide equivalent. TJ = terajoules.

4.3 Existing NGER Data

GHG emissions associated with the Project will contribute to State and National GHG inventories. A summary of Queensland's and Australia's most recently published GHG emissions inventories are provided in Table 17 (Australian Government Department of Industry, Science, Energy and Resources, 2021). Total emissions presented are excluding those from land use and land use change.

Bowen Basin Coal have ongoing reporting obligation under the NGER scheme. Table 18 provides a summary of recent NGER reporting for Bowen Basin Coal's activities.

Table 17 Annual GHG emissions for Australia and Queensland – 2019

Category	Australia	Queensland	
	Emissions (Mt CO_2-e)	Emissions (Mt CO_2-e)	Contribution to national emissions
Inventory total*	554.36	148.21	27%

Notes: * National and State GHG emissions excluding Land Use and Land Use Change.
Mt CO_2-e = million tonnes of carbon dioxide equivalent.

Table 18 Summary of recent National Greenhouse and Energy Reporting for Bowen Basin Coal Lake Vermont operations

Reporting period	Scope 1 Emissions (t CO_2-e / year)	Scope 2 Emissions (t CO_2-e / year)	Total Emissions (t CO_2-e / year)
2017	210,118	50,207	260,325
2018	278,642	58,058	336,700
2019	247,922	54,058	301,980
2020	300,794	57,566	358,360
2021	393,671	62,012	455,683

4.4 GHG assessment methodology

4.4.1 Overview

Pollutants of importance to climate change associated with the Project include CO_2, CH_4 and N_2O. This study has assessed the emissions of GHGs from the Project during the construction and operation phases of the existing and approved Lake Vermont operations, and from the proposed Meadowbrook open-cut and underground operations. GHG emissions have been based on activity data representative of the existing and proposed activities and the methods described in the following resources:

- Australian National Greenhouse Accounts, National Greenhouse Accounts Factors, August 2021 (Australian Government, Department of Industry, Science, Energy and Resources, 2021)
- *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulations)
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Australian Government,* Department of Industry, Science, Energy and Resources, 2021)
- The Greenhouse Gas Protocol (WRI/WBCSD,2004)

Scope 1, 2 and 3 GHG emissions have been estimated on an annual basis for the Project against the background of ongoing existing and approved Lake Vermont operations (Lake Vermont Existing Operations) and for the proposed Project. This includes potential emissions from:

Scope 1 GHG emissions:

- Diesel combustion:
  - heavy machinery and equipment
  - haulage vehicles

- Fugitive emissions from mining of coal
- Combustion of fugitive methane through flaring
- Explosives use.

Scope 2 GHG Emissions:

- Electricity usage:
    - conveyors
    - underground operations
    - coal processing plant
    - amenities.

Scope 3 GHG Emissions:

- Transport of coal:
    - rail transport to coal terminal
    - shipping to international customers.
- Use of coal:
    - thermal application.
- Electricity distribution losses.
- Diesel extraction and processing.

Table 19 provides a summary of the energy content and emissions factors for emissions sources associated with the existing and proposed operations at the facility.

Table 19 Summary of energy content and emissions factors

Emission source	Energy content	Units	Emission factor			Units
			Scope 1	Scope 2	Scope 3	
Diesel	38.6	GJ/kL	70.4		3.6	kg CO_2-e/GJ [1]
Fugitive methane (Qld – open cut)	37.7 x 10^{-3}	GJ/t	0.023			t CO_2-e/tROM [1]
Explosives (Ammonium Nitrate Fuel Oil - ANFO)	2.4	GJ/t	0.17			t CO_2-e/tANFO [2]
Electricity (Queensland)	3.6	MJ/kWh		0.80	0.12	kg CO_2-e/kWh [1]
Coking coal	30	GJ/t			92.03	kg CO_2-e/GJ [1]
Thermal coal	22 – 24	GJ/t			90.24	kg CO_2-e/GJ [1,5]
Forest clearing	29.83	tC/ha	109			t CO_2-e/ha [3]
Shipping – bulk carrier					0.00354	kg CO_2-e/ tonne.km [4]
Table notes:						

[1]*National Greenhouse and Energy Reporting (Measurement) Determination 2008*, as amended in June 2021, and *National Greenhouse Accounts Factors* (Australian Government, Department of Industry, Science, Energy and Resources, 2021) [2]*National Greenhouse Accounts (NGA) Factors* (Department of Climate Change, 2008) [3]Fullcam model, based on 100% conversion of C to CO2, Latitude: -25.5N, Longitude: 148.6E, 50% Acacia Shrubland +50% Agricultural annual grass [4]*UK Government GHG Conversion Factors for Company Reporting* (DEFRA, 2021). [5]Industrial coal as defined in the EIS has been approximate as thermal coal for the purposes of estimating GHG emissions GJ/kL = gigajoules per kilolitre, kg CO_2-e/GJ = kilograms of carbon dioxide equivalent per gigajoule, GJ/t = gigajoules per tonne, t CO_2-e/tROM = tonnes of carbon dioxide equivalent per tonne of ROM coal, t CO_2-e/tANFO = tonnes of carbon dioxide equivalent per tonne of ANFO, MJ/kWh = megajoules per kilowatt hour, kg CO_2-e/kWh = kilograms of carbon dioxide equivalent per kilowatt hour and kg CO_2-e/t.km = kilograms of carbon dioxide equivalent per tonne per kilometre, tC/ha = tonnes of carbon per hectare of clearing.

GHG emissions associated with land clearing are not covered by the NGER scheme. Furthermore, as mining operations progress, spent pits and waste emplacement landforms will be progressively rehabilitated with the aim of offsetting any previous GHG emissions from land clearing. Additionally, GHG emissions originating from land clearing are not expected to be significant compared to the annual Scope 1 and Scope 2 GHG emissions associated with the existing and proposed operations, with GHG emissions from land clearing estimated to account for approximately 1% of the overall annual GHG emissions of the Project.

4.4.2 Coal distribution and use

It is intended that coal produced by the Project will be railed along the existing Lake Vermont spur line that connects to the Aurizon Goonyella rail system for shipment to the Abbott Point Coal Terminal in Bowen. Product coal would also be railed to the RG Tanna Coal Terminal in Gladstone, and potentially to the Dalrymple Bay Coal Terminal in Mackay. The coal product will then subsequently be shipped to international customers located in Japan, Korea, Taiwan, China, Vietnam, Indonesia, Brazil, Argentina, Germany, South Africa, and India. A small proportion will be transported to local customers within Australia (currently around 2% of all product).

A summary of key parameters used in the quantification of potential Scope 3 emissions associated with coal transportation is provided in Table 20. Rail transport distance is to the RG Tanna Coal Terminal, the furthest of the three coal terminals from the Project. Shipping distance has been calculated based on the distance to each destination coal terminal and the proportion of sale product shipped to each during the 2021/2022 period. Shipping distance calculations are provided in Appendix C.

Table 20 Coal transportation – Scope 3 GHG Parameters

Parameter	Estimated quantity	Units
Rail transport distance	430 [1]	km
Emissions factor for freight trains	0.028 [2]	kg CO_2e/tonne.km
Shipping distance	10,276	km

Table notes:
[1] Maximum distance to available coal terminals (Abbott Point, RG Tanna, and Dalrymple Bay), as referenced in project ToR (BBC, 2020)
[2]*UK Government GHG Conversion Factors for Company Reporting* (Department for Environment, Food and Rural Affairs, 2021).
[3] Calculated based on distance from Abbott Point Coal Terminal to destination ports in Japan, Korea, Taiwan, China, Vietnam, Indonesia, Brazil, Argentina, Germany, South Africa, and India, and the proportion of sale product shipped to each destination during the 2021/2022 period. Details provided in Appendix C.

Lake Vermont Mine is a metalliferous coal operation producing both hard coking coal and PCI product streams for the export market. The coal preparation plant consists of two identical modules both of which produce the two product streams. In 2016 analysis of the plant reject stream identified that a scalping reprocess of the rejects could yield additional volumes of a higher ash industrial coal thereby reducing the volume of reject material and maximising overall resource recovery and value. In 2017 a third plant module was constructed and retrofitted to the existing plant which has enabled a third product stream of industrial coal to be scalped. The additional industrial coal retrieved equates to approximately 10 to 15% of the total product coal produced. Product coal has been classified as either coking coal of industrial coal. GHG emission associated with industrial coal have been estimated based on thermal coal properties.

4.5 Emissions

4.5.1 Scopes 1 and 2

The Project has been assessed against the background of Lake Vermont Existing Operations. The proposed phases of the Project are:

- Meadowbrook proposed underground operations undergoing construction (Year -1 and 0)
- Meadowbrook proposed underground operations commencing Year 1 (indicatively 2026) and extending through to Year 23.
- Meadowbrook proposed open-cut operations commencing Year 20 and extending through to final rehabilitation and closure in Year 35.

GHG emissions associated with the Project and Lake Vermont Existing Operations have been considered and estimated separately and on an annual basis for the life of the Project. The cumulative annual emissions associated with the operation of both the Lake Vermont and Meadowbrook operations have also been considered:

- A summary of the estimated Scope 1 and Scope 2 emissions associated with the Project, is presented in Table 21.
- A summary of the contribution of the Project to annual GHG emissions associated with Lake Vermont mining operations is presented in Table 23.

Maximum annual GHG emissions (Scope 1 + Scope 2) associated with the Project are 884 ktCO_2-e nominally occurring in Year 6.

Average annual GHG emissions (Scope 1 + Scope 2) associated with the Project are:

- 348,469 tCO_2-e (including land use, land use change, and forestry (LULUCF) emissions).
- 346,461 tCO_2-e (excluding LULUCF).

In comparison to combined Lake Vermont mining operations (Lake Vermont Existing Operations + Project) the Project accounts for 49% of total mine emissions over the life of the Project.

Further details of Scope 1 and Scope 2 emissions calculations are provided in Appendix C.

Table 21 Summary of estimated annual Scope 1 and Scope 2 GHG emissions (tCO_2-e) and energy use (GJ) for the Project

Project Year	Energy	Scope 1					Scope 2	TOTAL (Scope 1 + Scope 2)	
		Diesel (mining)	Fugitive gas	Blasting	Land clearing	Total	Electricity	Including LULUCF	Excluding LULUCF
	GJ	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e
-1	118,320	3,261	-	-	4,813	8,074	16,000	24,074	19,261
0	154,320	3,261	-	-	4,813	8,074	24,000	32,074	27,261
1	186,250	4,242	31,000	-	-	35,242	28,000	63,242	63,242
2	246,070	4,651	31,579	-	-	36,230	40,000	76,230	76,230
3	382,729	10,075	99,304	-	-	109,379	53,250	162,628	162,628
4	591,803	13,695	426,096	-	-	439,791	88,283	528,074	528,074
5	618,018	14,149	352,765	-	-	366,914	92,676	459,590	459,590
6	636,233	14,464	370,895	-	-	385,359	95,728	481,087	481,087
7	587,712	13,624	392,269	-	-	405,893	87,598	493,491	493,491
8	504,994	12,192	422,742	-	-	434,934	73,737	508,671	508,671
9	506,621	12,220	583,656	-	-	595,876	74,010	669,886	669,886
10	466,334	11,522	685,045	-	-	696,567	67,259	763,826	763,826
11	514,017	12,348	560,605	-	-	572,953	75,249	648,202	648,202
12	389,094	10,185	819,188	-	-	829,373	54,317	883,689	883,689
13	465,775	11,513	803,976	-	-	815,489	67,165	882,654	882,654
14	508,288	12,249	620,041	-	-	632,290	74,289	706,579	706,579
15	546,846	12,538	522,341	-	-	534,879	81,946	616,824	616,824
16	428,017	10,480	593,650	-	-	604,130	62,034	666,164	666,164
17	448,553	10,836	563,348	-	-	574,184	65,475	639,659	639,659
18	475,492	11,302	403,183	-	-	414,485	69,989	484,474	484,474
19	435,212	10,604	361,806	-	-	372,410	63,240	435,650	435,650
20	1,025,839	50,097	316,206	1,403	14,013	381,720	65,401	447,121	433,108

Project Year	Energy	Scope 1					Scope 2	TOTAL (Scope 1 + Scope 2)	
		Diesel (mining)	Fugitive gas	Blasting	Land clearing	Total	Electricity	Including LULUCF	Excluding LULUCF
	GJ	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e
21	1,278,079	63,262	390,607	1,655	10,671	466,195	79,102	545,297	534,626
22	1,207,708	63,893	336,511	1,823	8,350	410,577	60,942	471,519	463,170
23	1,048,397	58,998	276,185	1,827	4,857	341,868	40,978	382,845	377,988
24	736,950	50,111	238,641	1,771	4,586	295,108	-	295,108	290,522
25	775,915	52,836	34,228	1,789	11,788	100,640	-	100,640	88,852
26	841,312	57,379	33,187	1,849	3,233	95,648	-	95,648	92,415
27	768,371	52,245	30,286	1,848	3,486	87,866	-	87,866	84,380
28	731,586	49,730	33,375	1,774	2,890	87,768	-	87,768	84,878
29	589,690	40,191	44,264	1,323	806	86,585	-	86,585	85,779
30	67,951	4,669	9,100	115	-	13,884	-	13,884	13,884
31	171,963	12,106	-	-	-	12,106	-	12,106	12,106
32	196,130	13,808	-	-	-	13,808	-	13,808	13,808
33	191,070	13,451	-	-	-	13,451	-	13,451	13,451
34	160,640	11,309	-	-	-	11,309	-	11,309	11,309
35	23,352	1,644	-	-	-	1,644	-	1,644	1,644
TOTAL	**19,025,652**	**815,136**	**10,386,080**	**17,178**	**74,305**	**11,292,698**	**1,600,669**	**12,893,367**	**12,819,063**
Average	**514,207**	**22,031**	**280,705**	**464**	**2,008**	**305,208**	**43,261**	**348,469**	**346,461**
%	Scope 1	7%	92%	0.2%	0.7%	100%	-	-	-
	Scope 1 + 2	6%	81%	0.1%	0.6%	88%	12%	100%	-

Table 22 Summary of estimated annual Scope 1 and Scope 2 GHG emissions (tCO_2-e) (excluding LULUCF) for Lake Vermont Existing Operations and the Project

Mine Year	Project			Lake Vermont Existing Operations			Lake Vermont Mine (TOTAL)			Project (%)
	Scope 1	Scope 2	Scope 1 + 2	Scope 1	Scope 2	Scope 1 + 2	Scope 1	Scope 2	Scope 1 & 2	Scope 1 + 2
-3	-	-	-	517,075	59,200	576,275	517,075	59,200	576,275	0%
-2	-	-	-	524,312	59,200	583,512	524,312	59,200	583,512	0%
-1	3,261	16,000	19,261	527,175	59,200	586,375	530,436	75,200	605,636	3%
0	3,261	24,000	27,261	524,506	59,200	583,706	527,767	83,200	610,967	4%
1	35,242	28,000	63,242	519,845	59,200	579,045	555,087	87,200	642,287	10%
2	36,230	40,000	76,230	516,697	59,200	575,897	552,928	99,200	652,128	12%
3	109,379	53,250	162,628	337,012	59,200	396,212	446,391	112,450	558,840	29%
4	439,791	88,283	528,074	219,367	59,200	278,567	659,157	147,483	806,641	65%
5	366,914	92,676	459,590	206,143	59,200	265,343	573,056	151,876	724,932	63%
6	385,359	95,728	481,087	210,411	59,200	269,611	595,770	154,928	750,698	64%
7	405,893	87,598	493,491	252,404	59,200	311,604	658,297	146,798	805,095	61%
8	434,934	73,737	508,671	280,527	59,200	339,727	715,461	132,937	848,398	60%
9	595,876	74,010	669,886	288,677	59,200	347,877	884,553	133,210	1,017,763	66%
10	696,567	67,259	763,826	297,446	59,200	356,646	994,013	126,459	1,120,472	68%
11	572,953	75,249	648,202	323,913	59,200	383,113	896,865	134,449	1,031,314	63%
12	829,373	54,317	883,689	357,657	59,200	416,857	1,187,029	113,517	1,300,546	68%
13	815,489	67,165	882,654	340,845	59,200	400,045	1,156,333	126,365	1,282,699	69%
14	632,290	74,289	706,579	335,608	59,200	394,808	967,897	133,489	1,101,386	64%
15	534,879	81,946	616,824	330,099	59,200	389,299	864,977	141,146	1,006,123	61%
16	604,130	62,034	666,164	354,521	59,200	413,721	958,651	121,234	1,079,885	62%
17	574,184	65,475	639,659	359,899	59,200	419,099	934,083	124,675	1,058,758	60%
18	414,485	69,989	484,474	334,187	59,200	393,387	748,672	129,189	877,862	55%
19	372,410	63,240	435,650	333,869	59,200	393,069	706,280	122,440	828,720	53%
20	367,706	65,401	433,108	243,394	59,200	302,594	611,100	124,601	735,701	59%

Mine Year	Project			Lake Vermont Existing Operations			Lake Vermont Mine (TOTAL)			Project (%)
	Scope 1	Scope 2	Scope 1 + 2	Scope 1	Scope 2	Scope 1 + 2	Scope 1	Scope 2	Scope 1 & 2	Scope 1 + 2
21	455,524	79,102	534,626	184,206	59,200	243,406	639,730	138,302	778,032	69%
22	402,227	60,942	463,170	211,389	59,200	270,589	613,616	120,142	733,759	63%
23	337,011	40,978	377,988	257,758	59,200	316,958	594,769	100,178	694,946	54%
24	290,522	-	290,522	183,411	59,200	242,611	473,933	59,200	533,133	54%
25	88,852	-	88,852	170,256	59,200	229,456	259,108	59,200	318,308	28%
26	92,415	-	92,415	163,121	59,200	222,321	255,536	59,200	314,736	29%
27	84,380	-	84,380	170,667	59,200	229,867	255,047	59,200	314,247	27%
28	84,878	-	84,878	159,206	59,200	218,406	244,084	59,200	303,284	28%
29	85,779	-	85,779	124,849	59,200	184,049	210,628	59,200	269,828	32%
30	13,884	-	13,884	154,994	59,200	214,194	168,878	59,200	228,078	6%
31	12,106	-	12,106	110,856	59,200	170,056	122,962	59,200	182,162	7%
32	13,808	-	13,808	108,225	59,200	167,425	122,033	59,200	181,233	8%
33	13,451	-	13,451	108,225	59,200	167,425	121,677	59,200	180,877	7%
34	11,309	-	11,309	102,964	59,200	162,164	114,273	59,200	173,473	7%
35	1,644	-	1,644	94,602	59,200	153,802	96,246	59,200	155,446	1%
36	-	-	-	52,411	59,200	111,611	52,411	59,200	111,611	0%
TOTAL	**11,218,393**	**1,600,669**	**12,819,063**	**10,892,729**	**2,368,000**	**13,260,729**	**22,111,122**	**3,968,669**	**26,079,792**	**49%**
Average	**303,200**	**43,261**	**346,461**	**272,318**	**59,200**	**331,518**	**552,778**	**99,217**	**651,995**	**-**

GHG emissions from the Project would contribute to Australia's and Queensland's annual GHG emissions inventories. A summary of the impact of the maximum estimated annual (Scopes 1 and 2) GHG emissions from the Lake Vermont and Meadowbrook operations at a State and National scale is provided in Table 23.

Table 23 Comparison of estimated annual GHG emissions (t CO_2-e) for the Project to State and National emissions

Category	Project[1]	Australia[2]		Queensland[2]	
	Emissions (Mt CO_2-e)	Emissions (Mt CO_2-e)	Project %	Emissions (Mt CO_2-e)	Project %
Inventory total	0.88	554.36	0.16%	148.22	0.60%

Notes: [1]Estimated maximum annual GHG emissions [2] National Greenhouse Gas Inventory – Paris Agreement Inventory 2019 (Australian Government Department of Industry, Science, Energy and Resources, 2021), GHG emissions excluding Land Use and Land Use Change.

4.5.2 Scope 3

Scope 3 GHG emissions associated with the Lake Vermont Existing Operations and for the Project have been estimated on an annual basis for the life of the Project. Estimated Scope 3 GHG emissions are summarised in the following tables:

- Table 24- Estimated annual Scope 3 GHG emissions associated with the Project
- Table 25 – Estimated annual Scope 3 GHG emissions for Lake Vermont mining operations (Lake Vermont Existing Operations + Project), including the contribution of the Project to the Scope 3 GHG emissions associated with Lake Vermont mining activities.

Estimated annual Scope 3 GHG emissions associated with the Project are 7,956,355 tCO2-e on average and account for approximately 35% of Scope 3 GHG emissions for Lake Vermont mining operations over the life of the Project.

Table 24 Summary of estimated annual Scope 3 GHG emissions in t CO_2-e for the Project

Year	Diesel + Electricity*	Rail transport of coal	Shipping of coal	End use of product coal (industrial)**	End use of product coal (coking)	Total
	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
-1	2,567	-	-	-	-	2,567
0	3,767	-	-	-	-	3,767
1	4,417	1,262	3,813	19,616	270,473	299,582
2	6,238	4,492	13,573	91,434	941,797	1,057,534
3	8,503	40,981	123,821	744,445	8,678,345	9,596,095
4	13,943	69,034	208,579	1,162,571	14,707,230	16,161,358
5	14,625	72,917	220,311	1,030,639	15,725,036	17,063,527
6	15,099	75,058	226,781	934,922	16,308,542	17,560,401
7	13,836	68,486	206,924	1,134,502	14,608,679	16,032,427
8	11,684	56,892	171,894	1,030,474	12,050,555	13,321,499
9	11,726	53,797	162,543	2,531,788	9,890,728	12,650,583
10	10,678	48,871	147,659	2,382,754	8,905,005	11,494,967
11	11,919	54,166	163,658	2,906,402	9,613,455	12,749,600
12	8,668	39,519	119,404	2,153,689	6,981,842	9,303,123
13	10,664	49,466	149,458	2,236,872	9,182,465	11,628,924
14	11,770	54,650	165,118	2,218,323	10,388,948	12,838,809
15	12,933	60,794	183,683	2,277,474	11,740,799	14,275,684
16	9,841	47,300	142,912	771,356	10,101,275	11,072,684
17	10,375	50,340	152,099	781,098	10,789,088	11,783,000
18	11,076	53,679	162,187	789,334	11,546,825	12,563,102
19	10,028	48,243	145,763	699,927	10,386,649	11,290,611
20	12,372	51,601	155,908	1,105,101	10,765,268	12,090,251
21	15,100	68,207	206,080	1,792,235	13,909,326	15,990,947

Year	Diesel + Electricity*	Rail transport of coal	Shipping of coal	End use of product coal (industrial)**	End use of product coal (coking)	Total
	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
22	12,409	56,187	169,764	1,808,150	11,137,762	13,184,272
23	9,164	40,770	123,183	1,363,065	8,032,394	9,568,576
24	2,562	13,679	41,328	650,215	2,508,567	3,216,351
25	2,702	13,933	42,097	843,073	2,380,612	3,282,416
26	2,934	12,453	37,627	1,016,774	1,873,561	2,943,350
27	2,672	11,522	34,813	821,851	1,848,310	2,719,168
28	2,543	13,832	41,792	785,014	2,413,544	3,256,725
29	2,055	18,990	57,376	880,600	3,504,000	4,463,022
30	239	3,906	11,800	175,731	725,851	917,527
31	619	-	-	-	-	619
32	706	-	-	-	-	706
33	688	-	-	-	-	688
34	578	-	-	-	-	578
35	84	-	-	-	-	84
TOTAL	**281,784**	**1,255,030**	**3,791,950**	**37,139,429**	**251,916,930**	**294,385,123**
Average	**7,616**	**33,920**	**102,485**	**1,003,768**	**6,808,566**	**7,956,355**
%	0.10%	0.43%	1.29%	12.62%	85.57%	100.00%
Notes: *Full fuel cycle GHG emissions including production and distribution related emissions, **Industrial coal approximated as thermal coal						

Table 25 Summary of cumulative annual Scope 3 GHG emissions in t CO_2-e for Lake Vermont Existing Operations and the Project

Year	Project	Lake Vermont Existing Operations	Lake Vermont Mine (TOTAL)	Project (%)
-3	-	25,699,136	25,699,136	0%
-2	-	25,533,027	25,533,027	0%
-1	2,567	25,056,273	25,058,840	0%
0	3,767	25,001,723	25,005,490	0%
1	299,582	24,390,742	24,690,324	1%
2	1,057,534	23,589,833	24,647,368	4%
3	9,596,095	15,499,017	25,095,111	38%
4	16,161,358	9,954,128	26,115,486	62%
5	17,063,527	9,297,920	26,361,447	65%
6	17,560,401	9,658,496	27,218,897	65%
7	16,032,427	9,436,074	25,468,501	63%
8	13,321,499	11,626,065	24,947,564	53%
9	12,650,583	12,578,891	25,229,475	50%
10	11,494,967	13,260,776	24,755,743	46%
11	12,749,600	11,965,738	24,715,338	52%
12	9,303,123	14,937,182	24,240,305	38%
13	11,628,924	12,952,231	24,581,156	47%
14	12,838,809	12,087,524	24,926,332	52%
15	14,275,684	11,678,302	25,953,985	55%
16	11,072,684	13,150,507	24,223,191	46%
17	11,783,000	13,760,400	25,543,400	46%
18	12,563,102	12,229,574	24,792,676	51%
19	11,290,611	12,476,792	23,767,404	48%
20	12,090,251	8,244,451	20,334,702	59%
21	15,990,947	4,027,851	20,018,798	80%
22	13,184,272	5,189,311	18,373,583	72%
23	9,568,576	9,312,600	18,881,176	51%
24	3,216,351	7,144,168	10,360,519	31%
25	3,282,416	6,147,419	9,429,836	35%
26	2,943,350	4,765,127	7,708,477	38%
27	2,719,168	5,031,049	7,750,217	35%
28	3,256,725	4,723,225	7,979,950	41%
29	4,463,022	3,664,685	8,127,707	55%
30	917,527	5,106,984	6,024,511	15%
31	619	3,411,568	3,412,187	0%
32	706	3,184,956	3,185,662	0%
33	688	3,184,956	3,185,644	0%
34	578	2,731,733	2,732,311	0%
35	84	2,505,124	2,505,209	0%
36	-	1,925,048	1,925,048	0%

Year	Project	Lake Vermont Existing Operations	Lake Vermont Mine (TOTAL)	Project (%)
TOTAL	**294,385,123**	**436,120,610**	**730,505,733**	**40%**
Average	7,956,355	10,903,015	18,262,643	

4.6 Regulatory Obligations – NGER and the Safeguard Mechanism

Cumulative annual GHG emissions (Scope 1 + Scope 2, excluding LULUCF) for the combined Lake Vermont Existing Operations and the Project (see Table 21 and Table 22), over the life of the Project, range from:

- Scope 1: 2 – 829 ktCO_2-e/y
- Scope 2: 16 – 95 ktCO_2-e/y
- Total: 2 – 884 ktCO_2-e/y.

Based on the NGER Reporting thresholds detailed in Table 16, Bowen Basin Coal would have ongoing reporting obligations associated with the Project including annual assessment of GHG emissions in line with the requirements of the NGER Scheme.

In all years of operation, for Lake Vermont Mine (including existing operations), estimated Scope 1 emissions (excluding LULUCF) exceed the reporting threshold of 100 kt CO_2-e/y. Under the current Safeguard Mechanism, facilities with Scope 1 emissions of more than 100 kt CO_2-e/y are required to keep their emissions within baseline levels. This Safeguard Mechanism would apply to the Project; however, the exact implications of this would need to be reviewed on an annual basis in communication with the Clean Energy Regulator.

4.7 GHG Mitigation and Management

Bowen Basin Coal intends to implement the following initiatives where appropriate to help mitigate, reduce, control or manage GHG emissions from the Project:

- Regular maintenance of plant and equipment to minimise fuel consumption and associated emissions, including training staff on continuous improvement strategies regarding efficient use of plant and equipment
- Regular assessment, review, and evaluation of GHG reduction opportunities
- Procurement policies that require the selection of energy efficient equipment and vehicles
- Monitoring and maintenance of equipment in accordance with manufacturer recommendations
- Optimisation of diesel consumption through logistics analysis and planning (e.g., review of the mine plan to optimise haul lengths, dump locations, and road gradients).

Flaring of waste coal mine gas will occur as part of gas drainage activities, where practicable, to reduce equivalent CO_2 emissions. Bowen Basin Coal considered the potential use of carbon capture and sequestration of GHG emissions; however, it has been determined that these measures are not viable at this stage.

5. REFERENCES

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6. CONTOUR PLOTS

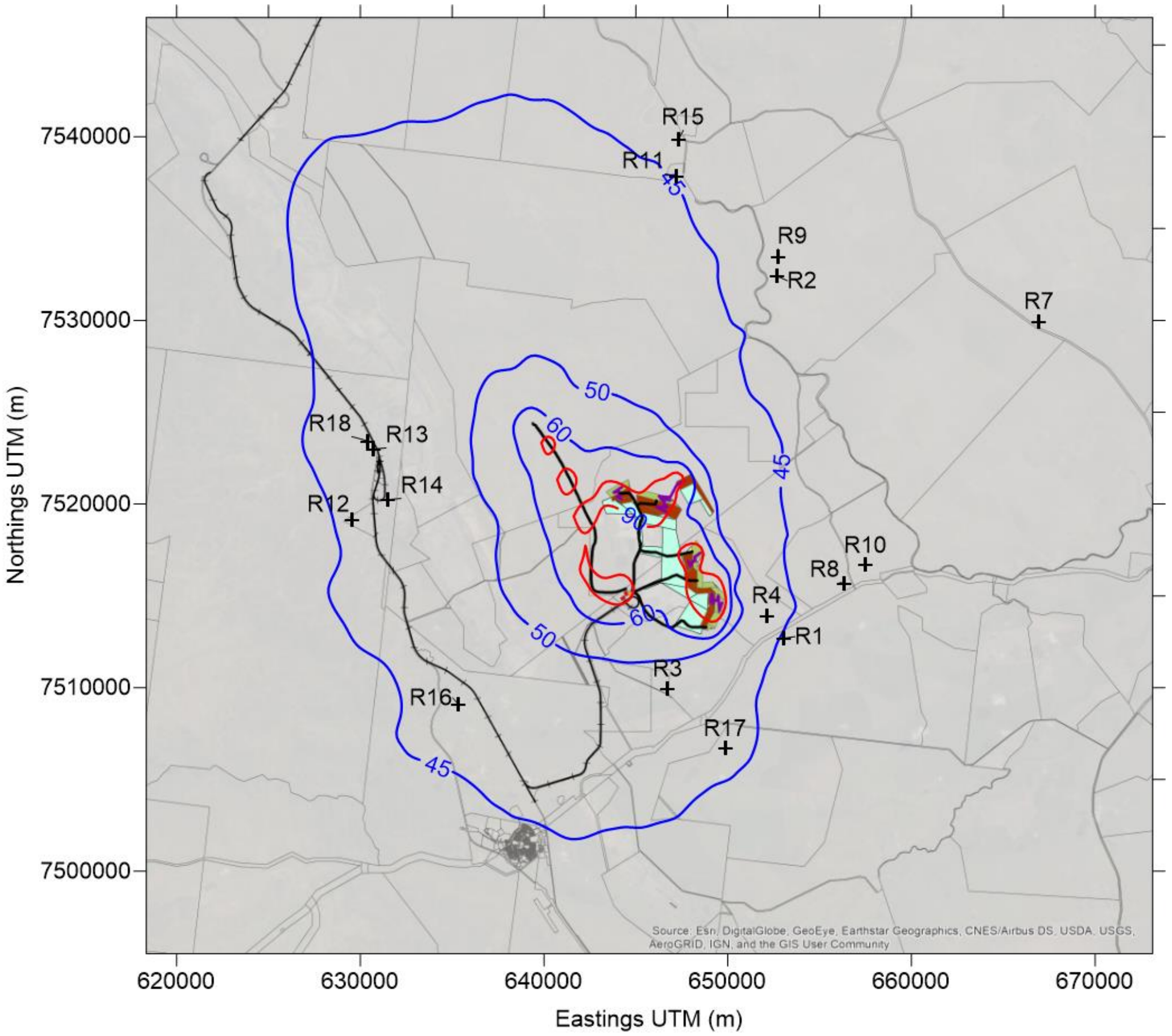


Plate 1	**Year 7 predicted annual average ground level concentration of TSP due to the proposed Project with existing operations and ambient backgrounds combined**		
Location: Lake Vermont Mine, Dysart, QLD	**Averaging period:** 1-year	**Data source:** CALPUFF	**Units:** µg/m³
Type: Annual average contour	**Objective:** 90 µg/m³	**Prepared by:** Sathya Roysmith	**Date:** April 2022

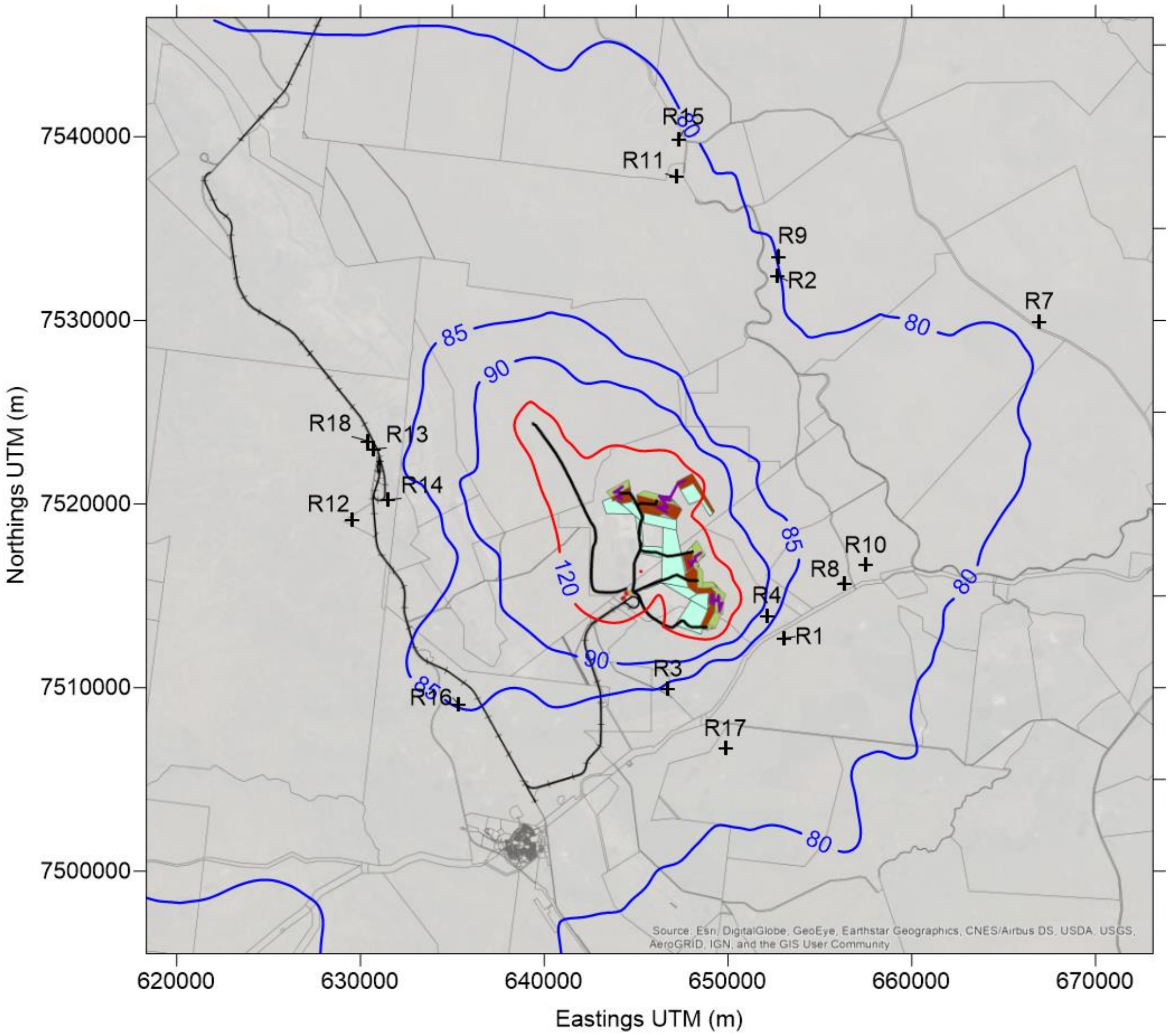


Plate 2	Year 7 predicted maximum monthly dust deposition rate due to the proposed Project with existing operations and ambient backgrounds combined		
Location: Lake Vermont Mine, Dysart, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** mg/m²/day
Type: Maximum contour	**Objective:** 120 mg/m²/day	**Prepared by:** Sathya Roysmith	**Date:** April 2022

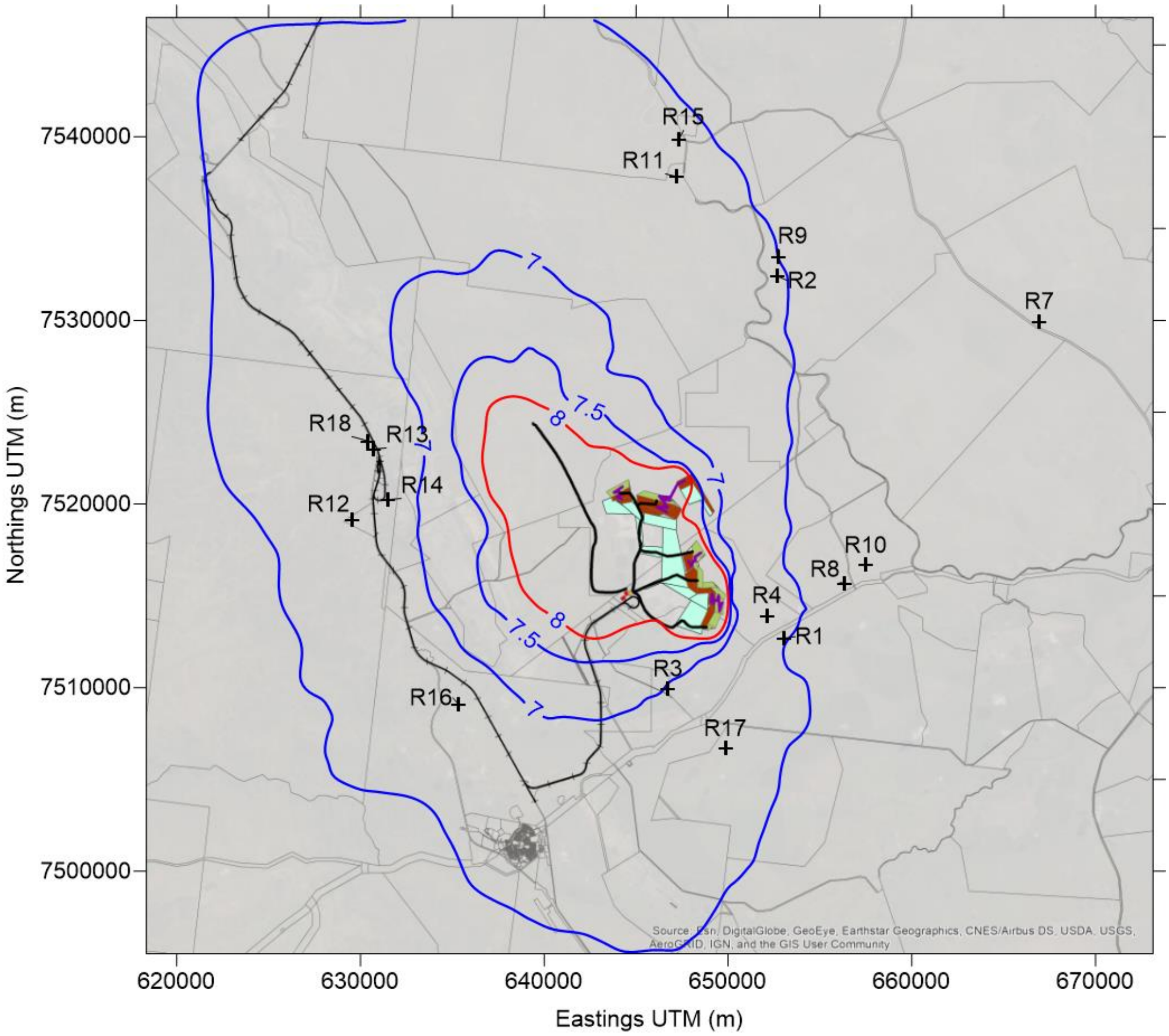


Plate 3 **Year 7 predicted annual average ground level concentration of $PM_{2.5}$ due to the proposed Project with existing operations and ambient backgrounds combined**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	1-year	CALPUFF	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average contour	8 µg/m^3	Sathya Roysmith	April 2022

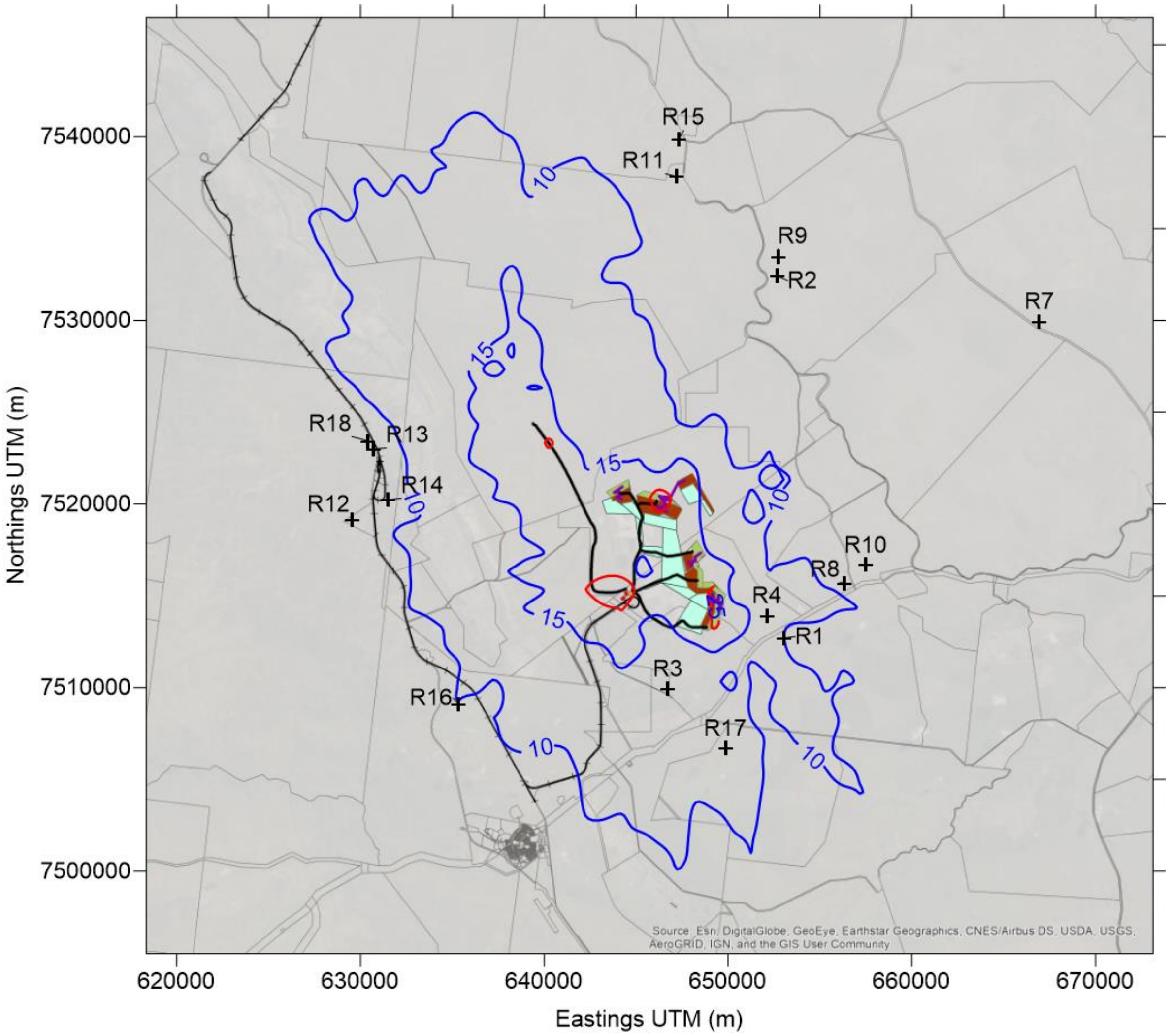


Plate 4	**Year 7 predicted 24-hour maximum ground level concentration of $PM_{2.5}$ due to the proposed Project with existing operations and ambient backgrounds combined**		
Location: Lake Vermont Mine, Dysart, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contour	**Objective:** 25 µg/m³	**Prepared by:** Sathya Roysmith	**Date:** April 2022

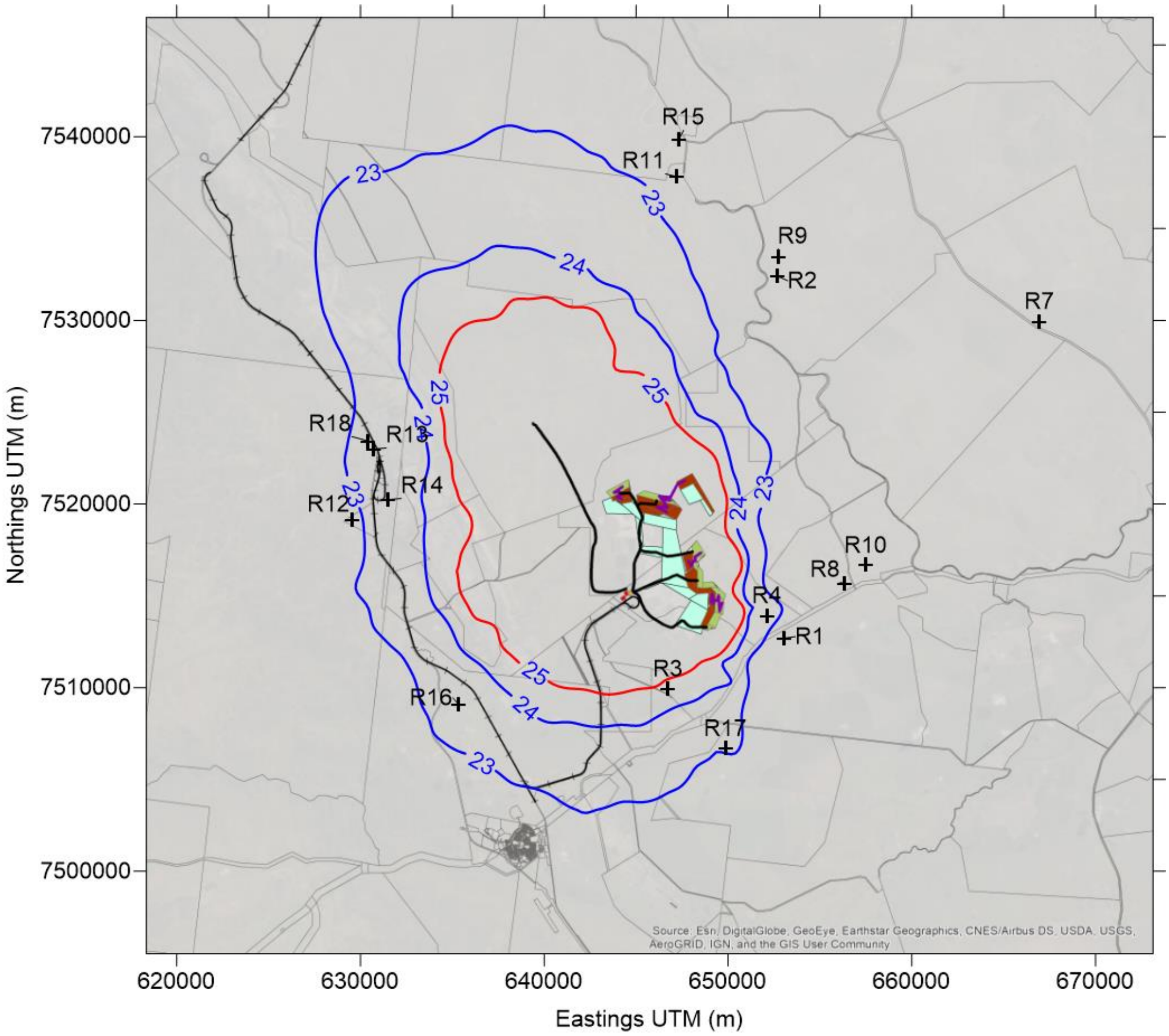


Plate 5	**Year 7 predicted annual average ground level concentration of PM_{10} due to the proposed Project with existing operations and ambient backgrounds combined**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average contour	25 µg/m³	Sathya Roysmith	April 2022

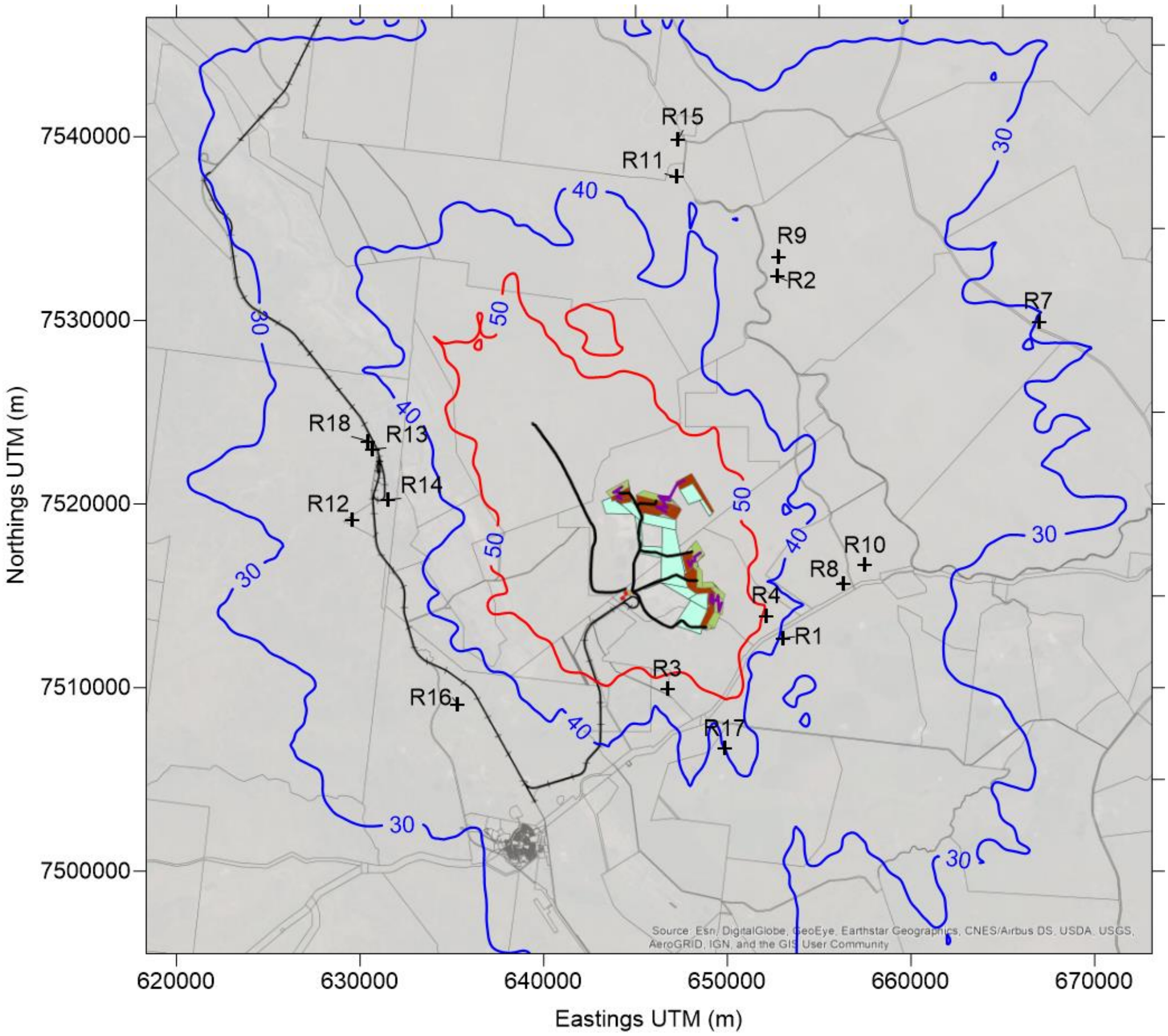


Plate 6 **Year 7 predicted 24-hour maximum ground level concentration of PM_{10} due to the proposed Project including existing operations and ambient backgrounds, with 24 days of mitigation**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	24-hour	CALPUFF	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contour	50 µg/m^3	Sathya Roysmith	April 2022

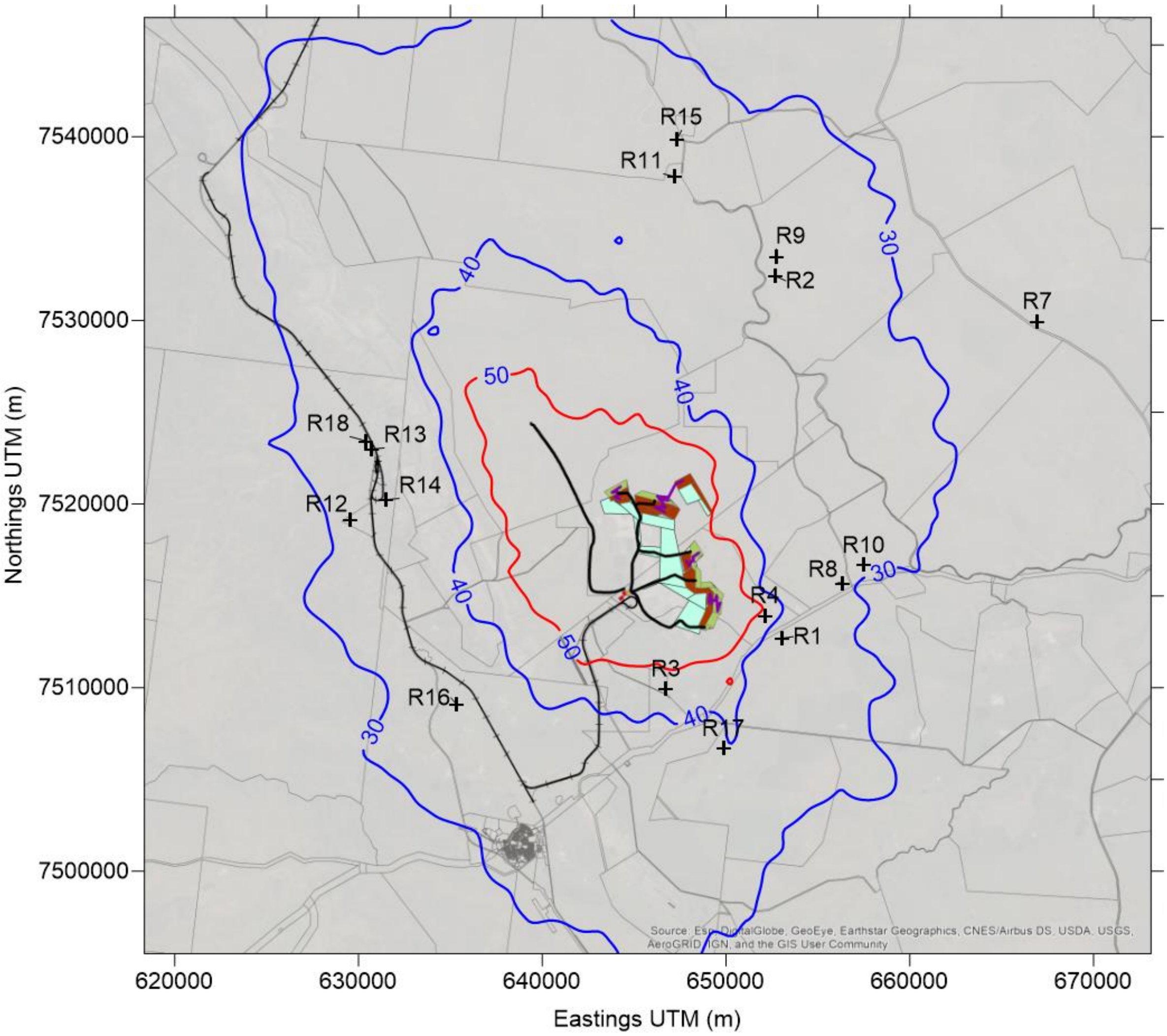


Plate 7	Year 7 predicted 6th highest ground level concentration of PM_{10} due to the proposed Project including existing operations and ambient backgrounds, with 24 days of mitigation

Location:	Averaging period:	Data source:	Units:
Lake Vermont Mine, Dysart, QLD	24-hour	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
6th high contour	50 µg/m³	Sathya Roysmith	April 2022

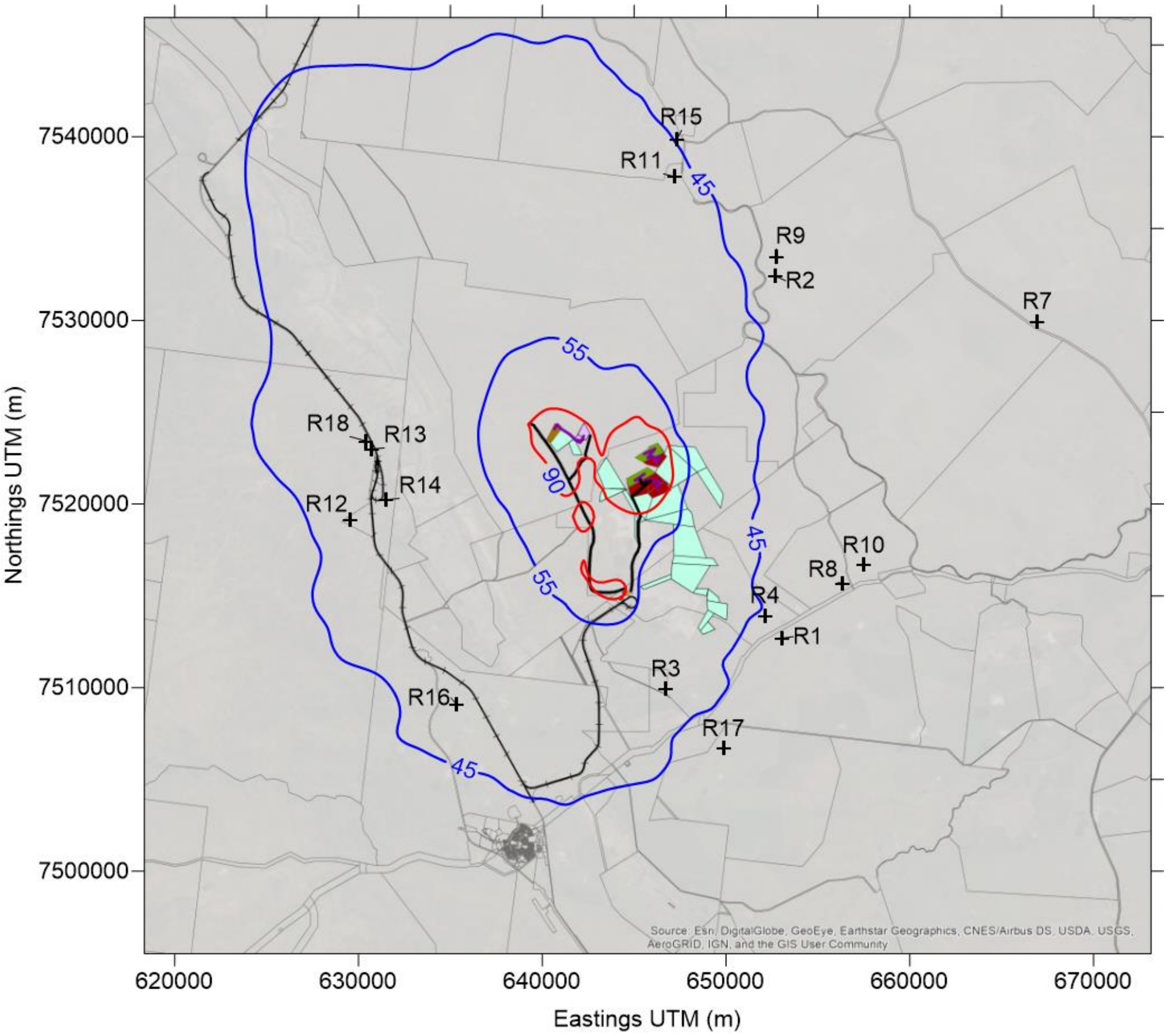
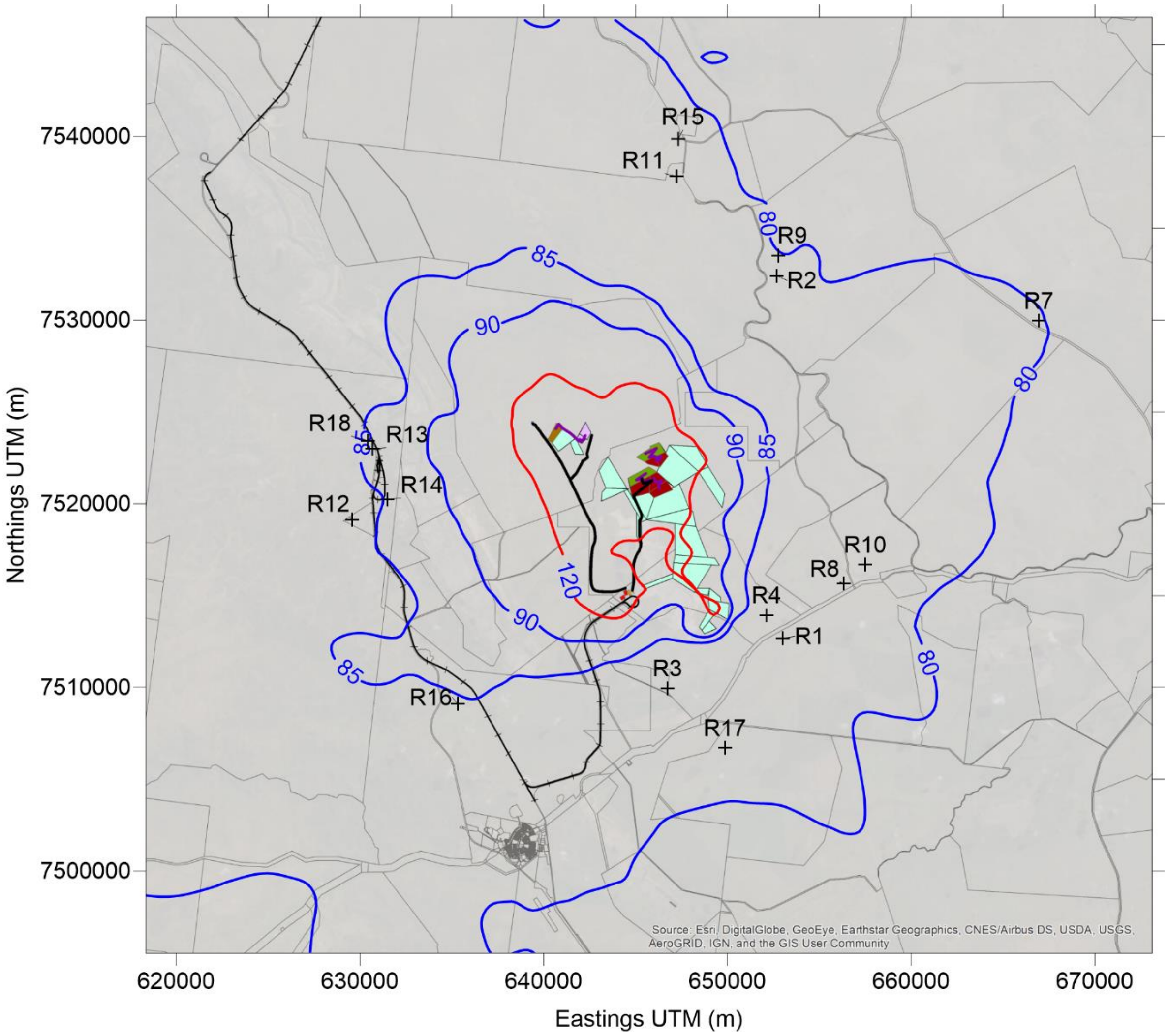


Plate 8 **Year 22 predicted annual average ground level concentration of TSP due to the proposed Project with existing operations and ambient backgrounds combined**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average contour	90 µg/m³	Sathya Roysmith	April 2022



late 9	**Year 22 predicted maximum monthly dust deposition rate due to the proposed Project with existing operations and ambient backgrounds combined**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	Monthly	CALPUFF	mg/m²/day
Type:	**Objective:**	**Prepared by:**	**Date:**
Maximum contour	120 mg/m²/day	Sathya Roysmith	April 2022

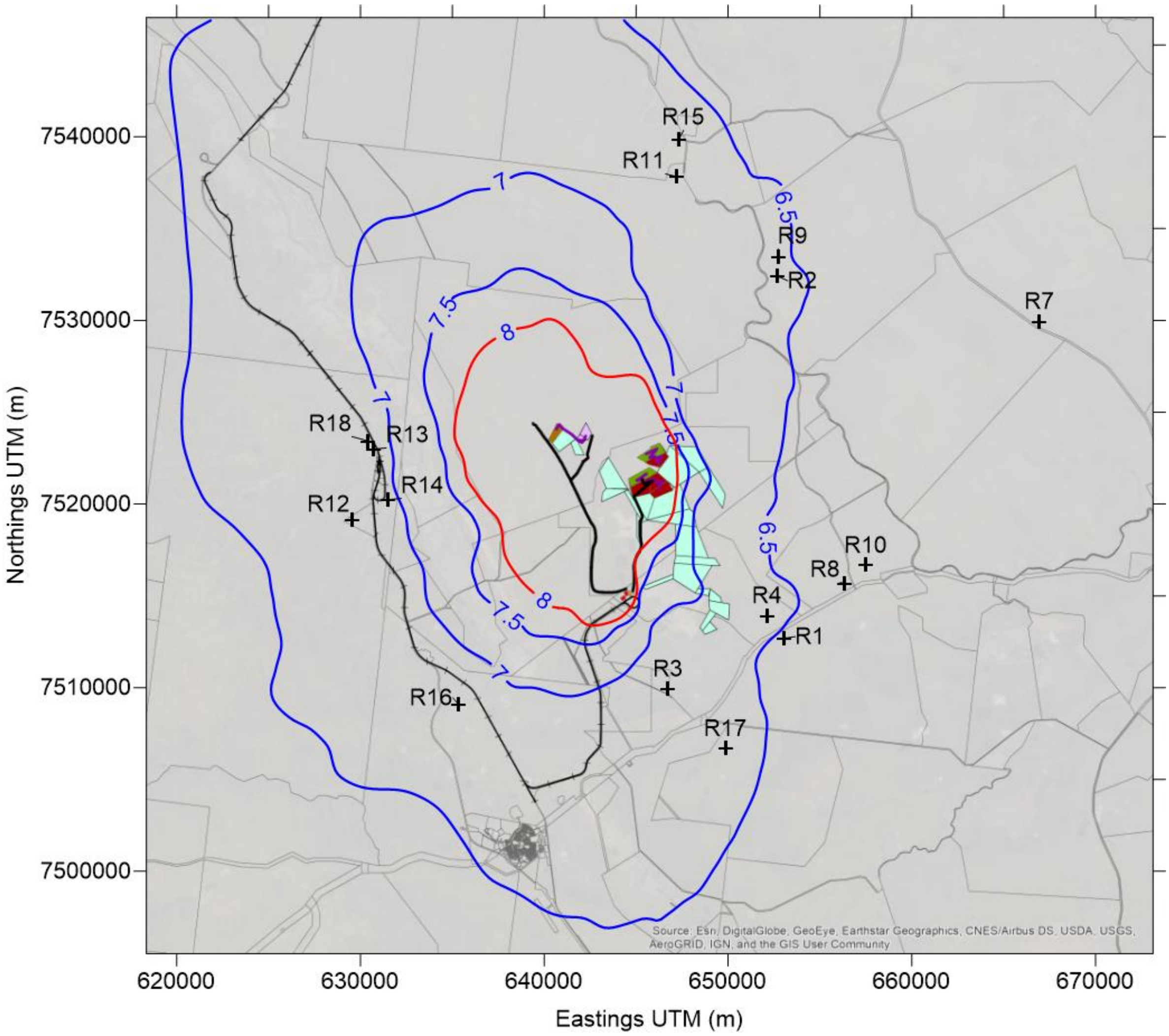


Plate 10 **Year 22 predicted annual average ground level concentration of $PM_{2.5}$ due to the proposed Project with existing operations and ambient backgrounds combined**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	1-year	CALPUFF	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average contour	8 µg/m^3	Sathya Roysmith	April 2022

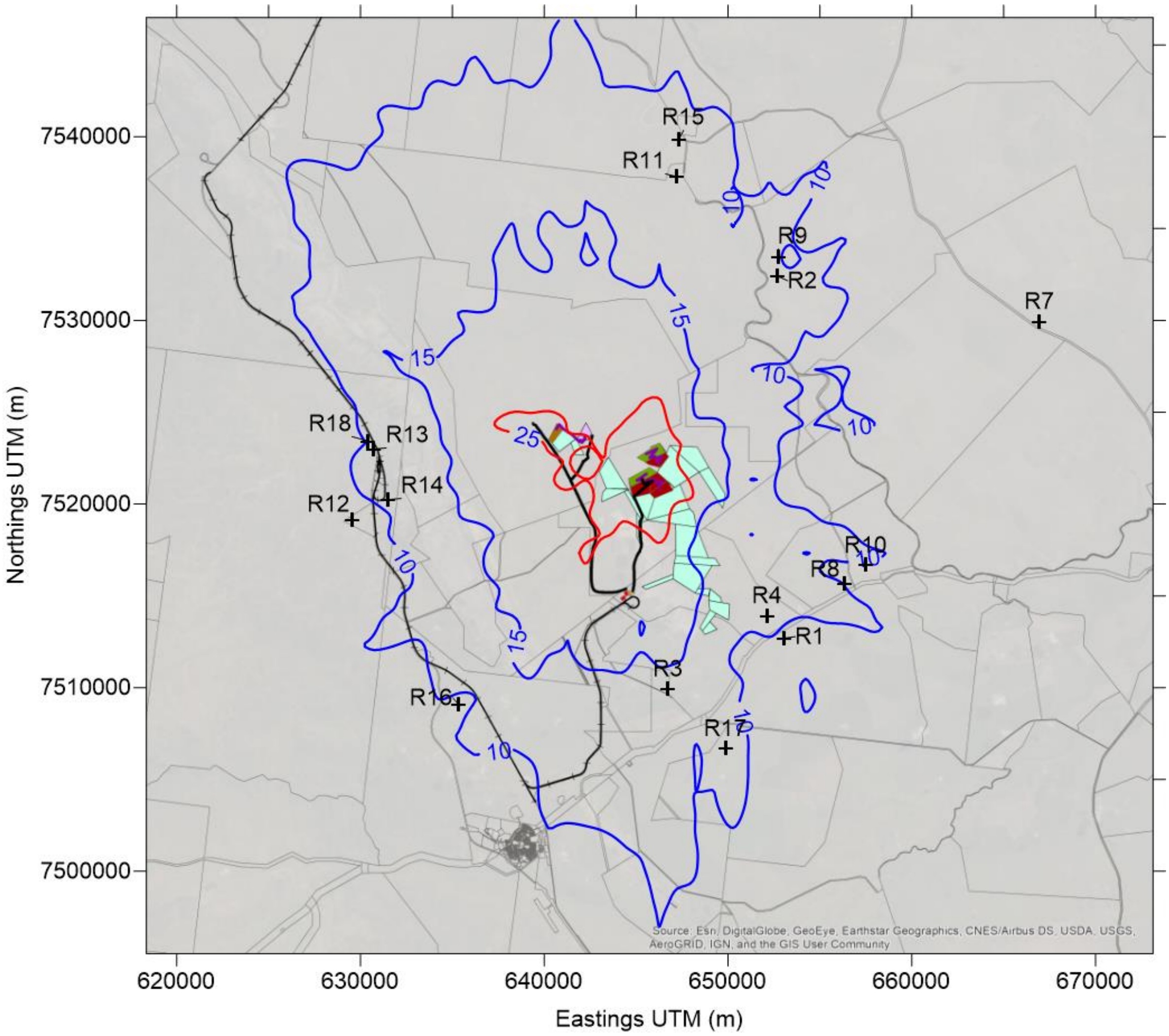


Plate 11	Year 22 predicted 24-hour maximum ground level concentration of $PM_{2.5}$ due to the proposed Project with existing operations and ambient backgrounds combined		
Location: Lake Vermont Mine, Dysart, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contour	**Objective:** 25 µg/m³	**Prepared by:** Sathya Roysmith	**Date:** April 2022

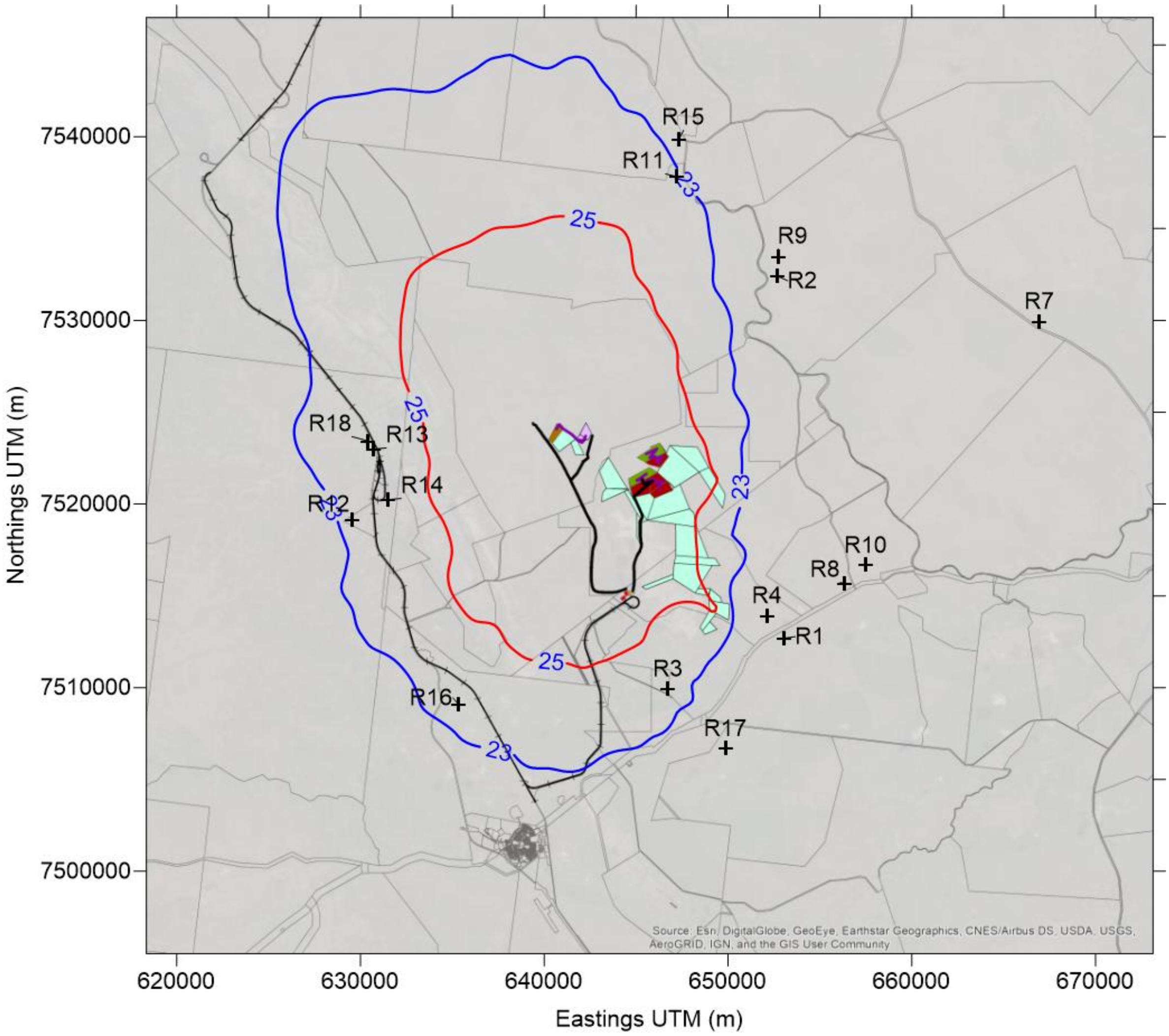


Plate 12 **Year 22 predicted annual average ground level concentration of PM_{10} due to the proposed Project with existing operations and ambient backgrounds combined**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	1-year	CALPUFF	µg/m³
Type:	**Objective:**	**Prepared by:**	**Date:**
Annual average contour	25 µg/m³	Sathya Roysmith	April 2022

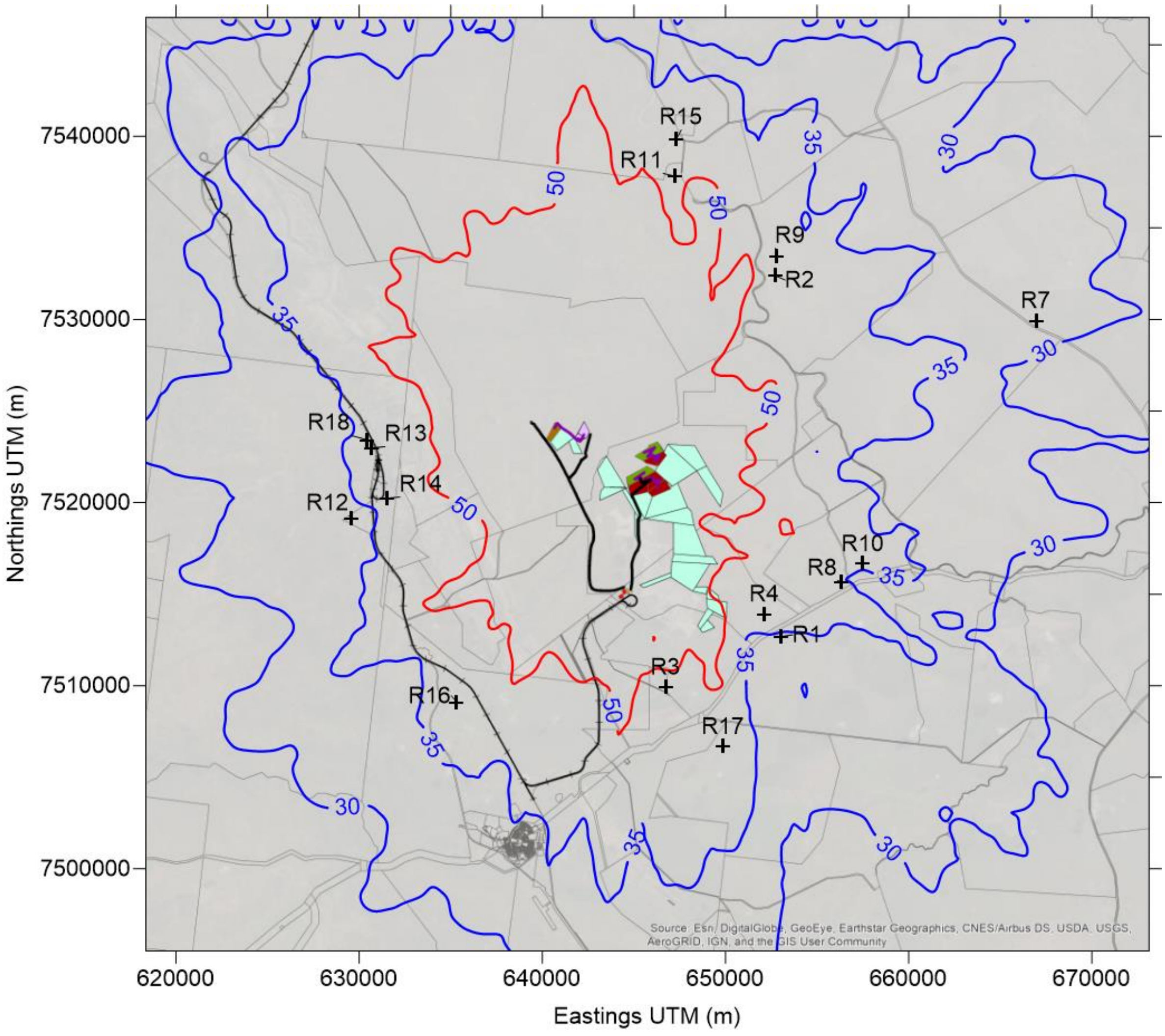


Plate 13 **Year 22 predicted 24-hour maximum ground level concentration of PM_{10} due to the proposed Project including existing operations and ambient backgrounds, with 24 days of mitigation**

Location: Lake Vermont Mine, Dysart, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m^3
Type: Maximum contour	**Objective:** 50 µg/m^3	**Prepared by:** Sathya Roysmith	**Date:** April 2022

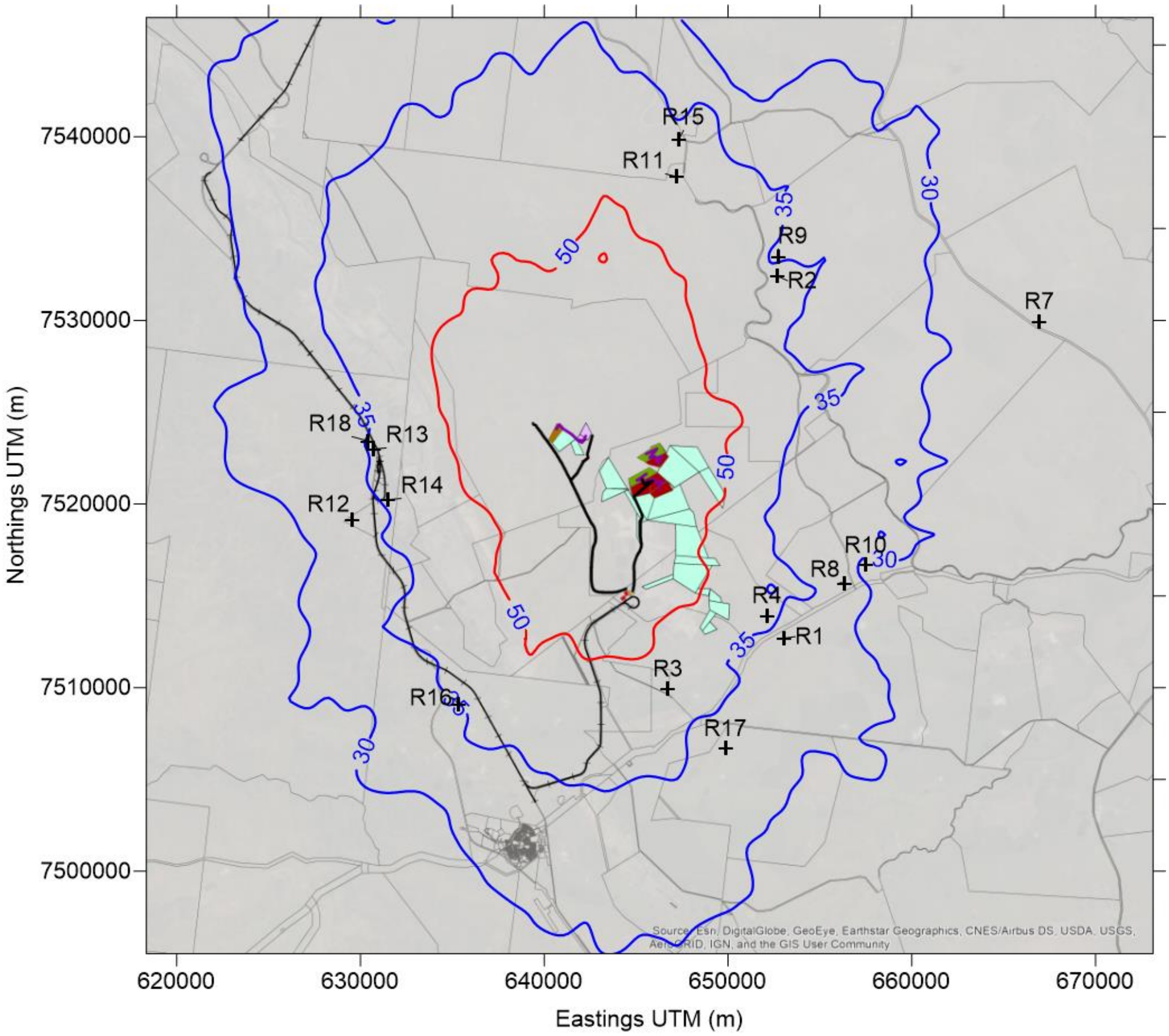


Plate 14 **Year 22 predicted 24-hour 6th highest ground level concentration of PM_{10} due to the proposed Project including existing operations and ambient backgrounds, with 24 days of mitigation**

Location:	**Averaging period:**	**Data source:**	**Units:**
Lake Vermont Mine, Dysart, QLD	24-hour	CALPUFF	µg/m^3
Type:	**Objective:**	**Prepared by:**	**Date:**
6th highest contours	50 µg/m^3	Sathya Roysmith	April 2022

APPENDIX A METEOROLOGICAL AND DISPERSION MODELLING METHODOLOGY

A1 METEOROLOGY

A1.1 TAPM meteorology

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.5, was developed by the CSIRO and has been validated by the CSIRO, Katestone and others for many locations in Australia, in south-east Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone has used the TAPM model throughout Australia and it has performed well for simulating regional winds patterns. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM requires synoptic meteorological information for the region surrounding the Project. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 metres to five km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM resolves local terrain and land use features that may influence local meteorology and generates a meteorological dataset that is representative of site-specific geographic conditions. A year of synoptic data must be selected as input for TAPM. The selection of this year should be such that the year is representative of typical meteorological conditions (and therefore is not necessarily the most recent year of available data) and whether monitoring data is available for the time period to validate the output dataset. In addition, Katestone's experience elsewhere in Central Queensland suggests that variability of dispersion meteorological conditions from year to year are unlikely to change the outcome of the air quality assessment.

TAPM was configured for the Project area as follows:

- Modelling period for one year from 1 January 2018 to 31 December 2018
- 65 x 65 grid point domain with an outer grid of 20 km and nesting grids of 10 km, 3 km and 1 km
- Grid centred near the site at latitude -22.28°, longitude 148.25° (645757 m E, 7514829 m S) (UTM Zone 55 S)
- Geoscience Australia 9-second digital elevation model terrain data
- Land use checked for consistency with aerial imagery of the site
- 25 vertical grid levels.
- No observational meteorological data assimilated
- Default options selected for advanced meteorological inputs.

TAPM output data is converted from the TAPM.outa format into a CALMET-readable MM5 datafile.

A1.2 CALMET meteorological modelling

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.334) was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 3km grid. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

CALMET was set up with twelve vertical levels with heights at 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600, 4600 metres at each grid point.

All default options and factors were selected except where noted below.

- Domain area of 64 by 64 grid points at 1 km spacing centred close to the project site
- Twelve vertical levels with heights at 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600, 4600 metres at each grid point
- Modelling for one year from 1 January 2018 to 31 December 2018
- No observations mode, with full prognostic wind fields generated by TAPM (1km domain) input as MM5/3D.dat at surface and upper air for 'initial guess' field
- No extrapolation of surface winds observations
- Mixing height parameters all set as default
- Terrain radius of influence set at 5.0 km
- 3D relative humidity and temperature from prognostic data
- Terrain data from the default database (SRTM1 terrain files)
- No data assimilation

A1.3 Comparison of TAPM output with observational data

The model validation in the following sections compares observational meteorological data with data derived from running TAPM.

A1.3.1 Wind Roses

A comparison between the annual distribution of winds observed at the Moranbah BoM weather station and predicted by TAPM/CALMET are presented in Figure A1. The analysis of the observed wind speed and wind direction at the BoM site shows that mean wind speed is 4.24 with 2.4% of winds as calms. Wind comes generally from the southeast, with easterlies present as well. Comparing this with the predicted TAPM output data, wind speed is overall lower averaging at 2.9 m/s with 0.1% of winds as calms. Predicted wind direction was very similar to observed wind direction, with minimal winds in any quadrant other than the southeast.

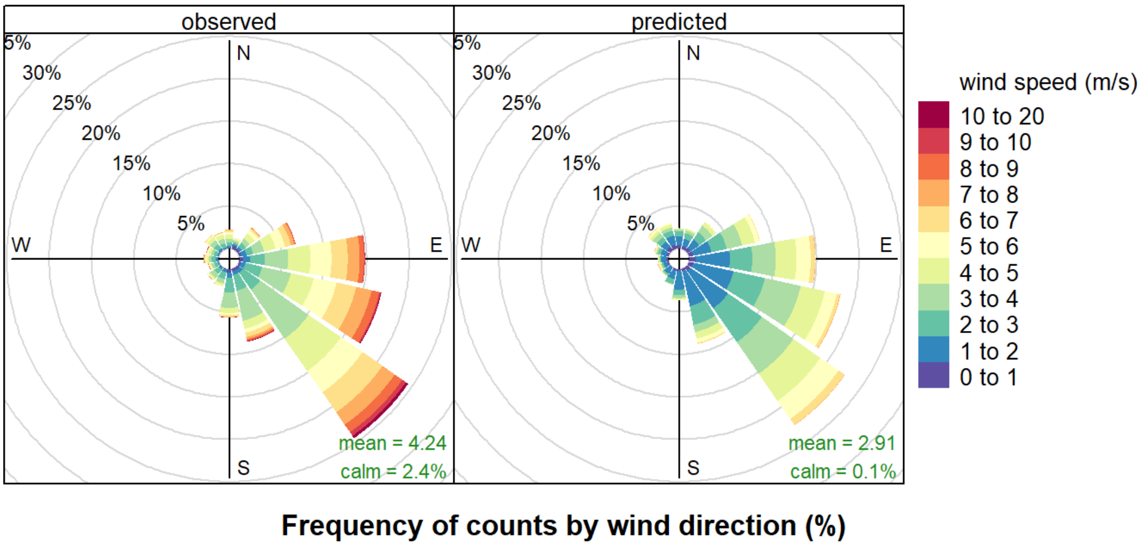


Figure A1 **Comparison between Moranbah BoM observational data and first-level TAPM output**

A1.3.2 Statistical comparisons

Table A1 presents statistical comparisons of TAPM output (wind speed and temperature) to meteorological data recorded at Moranbah BoM weather station. The TAPM output was extracted from the closest inner grid point to the location of the Moranbah BoM weather station.

The following statistical measures of model accuracy are presented in the tables.

The mean bias, which is the mean model prediction minus the mean observed value. Values of the mean bias close to zero show good prediction accuracy.

The root mean square error (RMSE), which is the standard deviation of the differences between predicted values and observed values. The RMSE is non-negative and values of the RMSE close to zero show good prediction accuracy. The RMSE is given by

$$\text{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)^2}$$

where N is the number of observations, P_i are the hourly model predictions and O_i are the hourly observations

The index of agreement (IOA), which takes a value between 0 and 1, with 1 indicating perfect agreement between predictions and observations. The IOA is calculated following a method described in Willmott (1982), using the equation

$$\text{IOA} = 1 - \frac{\sum_{i=1}^{N}(P_i - O_i)^2}{\sum_{i=1}^{N}(|P_i - O_{mean}| + |O_i - O_{mean}|)^2}$$

where N is the number of observations, P_i are the hourly model predictions, O_i are the hourly observations and O_{mean} is the observed observation mean.

The predicted wind speeds are within the benchmarks for performance and are therefore representative of the area. Both the temperature bias and index of agreement are within the benchmark ranges, and the mean and range of predicted temperatures is similar to the observed temperatures. The probability density functions illustrate reasonable agreement between predicted and observed meteorological data.

Table A1 A comparison of the observed meteorological data at the Moranbah BoM weather station with the first-level TAPM output

Statistic	"Good" value	Wind speed			Temperature		
		Benchmark	Observational data	TAPM	Benchmark	Observational data	TAPM
Mean	-	-	4.24	2.91	-	22.93	21.72
Standard deviation	-	-	2.08	1.48	-	6.97	5.69
Minimum	-	-	0	0	-	0.0	4.6
Maximum	-	-	13.35	8.40	-	41.65	39.30
Bias	0	<±0.5 m/s	-1.33		<±0.5 °C	-1.22	
Root mean square error (RMSE)	Close to 0	<2 m/s	1.98		-	3.22	
Index of agreement	Close to 1	>0.6	0.72		≥0.8	0.93	

A2 CALPUFF DISPERSION MODELLING

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 64 by 64 grids at 1 km spacing, equivalent to the domain defined in CALMET, with a nesting factor of 2
- 365 days modelled (1 January 2018 to 31 December 2018)
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables
- Stack tip downwash, transitional plume rise and PDF used for dispersion under convective conditions

All other options set to default.

APPENDIX B AIR QUALITY ASESSMENT TABLES

B1 ACTIVITY DATA

Table B1 Summary of activity data used in emissions calculations

Activity	Values Year 2032	Values Year 2047	Units	Information source
General Information				
Operations				
Days per year	363	363	days/year	BBC
Standard hours of operation	24	24	hours/day	
Days per week	7	7	days/week	
Material Characteristics				
ROM moisture content	10.4	10.4	%	AP-42, Table 11.9-3
ROM silt content	8.6	8.6	%	
Overburden Density	2.4	2.4	%	
Overburden moisture content	7.9	7.9	%	
Overburden silt content	6.9	6.9	%	
Material Quantities				
Total ROM Coal through CHPP	10,567,082	7,987,847	Tonnes	BBC
	1,213	917	Tonnes per hour (tph)	
Haul Road Characteristics				
Silt Content – Unpaved ROM Hauls	5.1	5.1	%	Ap-42, Table 13.2.2-1
Silt Content – Unpaved OB Hauls	8.4	8.4	%	
Silt Loading – Paved Road	2.0	2.0	g/m2	
Haul Widths	30	30	m	Assumed

Activity	Values Year 2032	Values Year 2047	Units	Information source
Met Conditions				
Mean Onsite wind speed	2.81	2.81	m/s	TAPM/CALMET
Meadowbrook Underground Mine				
Material/Waste Quantities				
ROM Coal	6,340,317	4,410,978	tonnes	BBC
Overburden	0	0	tonnes	
	0	0	bcm	
Mine Areas				
Underground ROM Stockpile at Mining Infrastructure Area	14,567	14,567	m^2	GIS
Mine-Specific Haul Lengths				
Paved haul from Underground ROM stockpile to CHPP	13	13	km	Whitehaven
Transport				
Road trains haulage - ROM	917,444	639,394	VKT/year	Whitehaven
Meadowbrook Open Cut Mine				
Material/Waste Quantities				
ROM Coal	0	1,321,576	tonnes	BBC
Overburden	0	17,578,874	tonnes	
	0	42,189,299	bcm	
Mine Areas				
Open Cut Active Pits	-	455,208	m^2	GIS
Overburden Dumps	-	371,526	m^2	
ROM Stockpile	-	4,441	m^2	
Exposed areas	-	809,517	m^2	

Activity	Values Year 2032	Values Year 2047	Units	Information source
Rehabbed/contoured areas	-	1,104,971	m^2	
Drilling and Blasting				
Drilling – Holes per blast	-	968	holes/blast	BBC
Drilling - Total number of holes drilled	-	11,616	holes/year	
Blasting – Total blasts per year	-	12	blasts/year	
Blasting - Area per blast	-	48,387	m^2	
Mine-Specific Haul Lengths				
Unpaved haul from active pit to paved ROM haul	-	1.6	km	GIS
Unpaved haul between active pit and overburden dump	-	2.4	km	
Paved haul from open cut mine to CHPP	-	9.7	km	
Transport				
Haulage - Overburden	-	898,331	VKT	Calculated from BBC information
Haulage - Coal	-	42,373	VKT	
Road Trains -ROM haulage	-	141,798	VKT	
Grading				
Number of graders	-	2	#	BBC
Grader speed	-	11.4	km/hr	AP-42 Table 13.2.2-1
Total grader travel	-	102,304	VKT	Calculated from BBC information
Bulldozing				

Activity	Values Year 2032	Values Year 2047	Units	Information source
Number of Dozers	-	6	#	BBC
Total hours of operation per vehicle	-	23,657	hours operation/vehicle/year	
Existing Lake Vermont Mine				
Material/Waste Quantities				
ROM Coal	4,226,765	2,255,294	tonnes	BBC
Overburden	126,435,631	123,040,652	tonnes	
	52,681,513	51,266,939	bcm	
Mine Areas				
Existing Active Pits	3,215,734	1,399,892	m^2	GIS
Overburden Dumps	5,297,834	2,419,770	m^2	
ROM Stockpile	18,508	18,508	m^2	
CHPP	36,004	36,004	m^2	
Product Stockpiles	91,519	91,051	m^2	
Exposed areas	8,333,133	3,697,167	m^2	
Rehabbed/contoured areas	10,871,352	20,022,416	m^2	
Drilling and Blasting				
Drilling – Holes per blast	968	968	holes/blast	BBC
Drilling - Total number of holes drilled	30,976	30,976	holes/year	
Blasting – Total blasts per year	32	32	blasts/year	
Blasting - Area per blast	48,387	48,387	m^2	
Mine-Specific Haul Lengths				
Unpaved overburden hauls	2.1	2.7	km	GIS

Activity	Values Year 2032	Values Year 2047	Units	Information source
Unpaved ROM haul from active pits	4	5	km	
Paved ROM haul to CHPP	2	2	km	
Transport				
Haulage - Overburden	1,786,983	2,282,307	VKT	Calculated from BBC information
Haulage – Coal (Unpaved)	168,725	119,346	VKT	
Haulage – Coal (Paved)	100,006	54,268	VKT	
Grading				
Number of graders	4	5	#	BBC
Grader speed	11.4	11.4	km/hr	AP-42 Table 13.2.2-1
Total grader travel	255,843	272,997	VKT	Calculated from BBC information
Bulldozing				
Number of Dozers	17	15	#	BBC
Total hours of operation per vehicle	62,673	56,366	hours operation/vehicle/year	

Note:
m^2 = square metres, ha = hectares, VKT/year = vehicle kilometres travelled per year, hr.op/year/vehicle = hours of operation per year per vehicle, km/h = kilometres per hour, km = kilometres, % = percent, hrs/yr = hours per year, ACARP = Australian Coal Association Research Program, m/s = metres per second.

APPENDIX C GREENHOUSE GAS ASSESSMENT TABLES

Assumptions, data, and extended energy and GHG emissions summaries associated with the GHG assessment for the Project are summarised in the following sections.

C1 COAL SHIPPING

Information used in the calculation of shipping distance to destination ports is provide in Table C1 .

Table C1 Information used in the calculation of shipping distance to destination ports

Destination	Sales shipped during 2021/22 (Mt)	% of total sales	Distance to port (km) [1]	Port used for calculation purposes	Total distance travelled (km)
Japan	670,668	7%	6,439	Japan, Osaka Port	469
Korea	451,301	5%	7,054	Korea (North), Hungnam port	346
Taiwan	191,287	2%	5,415	Taiwan, Kaohsiung Port	113
China	-	0%	6,307	China, Shanghai Port	-
Vietnam	769,196	8%	5,890	Vietnam, Saigon Port	492
Indonesia	215,044	2%	4,826	Indonesia, Tanjung Priok Port	113
Brazil	1,886,388	21%	13,715	Brazil, Santos Port	2,812
Argentina	78,974	1%	12,572	Argentina, Buenos Aires Port	108
Germany	745,769	8%	18,966	Germany, Hamburg Port	1,537
South Africa	312,206	3%	11,322	South Africa, Durban Port	384
India	3,678,333	40%	9,757	India, Kandla Port	3,901
Australia	200,834	2%	0	NA	-
Total	**9,200,000**	**100%**	**-**	**-**	**10,276**

Table note:
[1] Source: https://sea-distances.org/advanced

C2 ENERGY USE

A summary of the energy use for Lake Vermont Existing Operations and the Project that has been used in the calculation of greenhouse gas emissions is presented Table C2.

Table C2 Summary of energy use (GJ) for Lake Vermont Existing Operations and for the Project

Year	Ongoing existing and approved Lake Vermont operations				Project operations (Meadowbrook)			
	Diesel (mining) (GJ)	Blasting (GJ)	Electricity (GJ)	Transport Energy (GJ)	Diesel (mining) (GJ)	Blasting (GJ)	Electricity (GJ)	Transport Energy (GJ)
-3	3,568,233	117,494	266,400	1,512,484	-	-	-	-
-2	3,700,760	122,066	266,400	1,502,506	-	-	-	-
-1	3,777,712	124,656	266,400	1,473,623	46,320	-	72,000	-
0 (2025)	3,766,579	125,325	266,400	1,469,721	46,320	-	108,000	-
1	3,768,773	124,863	266,400	1,432,758	60,250	-	126,000	17,399
2	3,823,109	122,235	266,400	1,384,869	66,070	-	180,000	61,929
3	2,440,707	78,707	266,400	909,807	143,104	-	239,624	564,956
4	1,607,442	51,287	266,400	584,117	194,529	-	397,275	951,682
5	1,523,244	47,248	266,400	545,484	200,976	-	417,042	1,005,209
6	1,531,141	47,248	266,400	566,669	205,457	-	430,777	1,034,730
7	2,134,334	70,051	266,400	553,591	193,522	-	394,190	944,127
8	2,209,385	69,694	266,400	682,416	173,177	-	331,817	784,297
9	2,185,701	68,939	266,400	738,613	173,577	-	333,044	741,635
10	2,210,292	69,192	266,400	778,975	163,668	-	302,666	673,721
11	2,765,308	93,361	266,400	703,050	175,396	-	338,621	746,720
12	2,821,271	90,436	266,400	878,053	144,670	-	244,424	544,802
13	2,859,869	91,807	266,400	761,113	163,530	-	302,245	681,929
14	2,891,620	92,664	266,400	709,707	173,987	-	334,301	753,384
15	2,892,017	93,599	266,400	685,377	178,090	-	368,756	838,089
16	3,048,478	92,954	266,400	771,869	148,862	-	279,154	652,063
17	3,052,418	93,522	266,400	808,154	153,913	-	294,639	693,978
18	2,906,980	95,569	266,400	718,535	160,539	-	314,953	740,010
19	2,861,601	97,404	266,400	733,060	150,632	-	284,580	665,071
20	2,214,505	74,731	266,400	484,469	711,600	19,933	294,306	711,361
21	1,982,314	66,210	266,400	236,278	898,605	23,515	355,960	940,279

Year	Ongoing existing and approved Lake Vermont operations				Project operations (Meadowbrook)			
	Diesel (mining) (GJ)	Blasting (GJ)	Electricity (GJ)	Transport Energy (GJ)	Diesel (mining) (GJ)	Blasting (GJ)	Electricity (GJ)	Transport Energy (GJ)
22	2,194,792	71,078	266,400	304,527	907,575	25,894	274,239	774,582
23	2,259,102	71,248	266,400	547,037	838,042	25,956	184,399	562,047
24	1,541,909	51,229	266,400	419,653	711,798	25,151	-	188,569
25	1,498,968	49,805	266,400	360,946	750,507	25,408	-	192,076
26	1,592,760	52,230	266,400	279,485	815,044	26,268	-	171,680
27	1,659,641	51,348	266,400	295,039	742,118	26,253	-	158,842
28	1,545,686	46,367	266,400	276,948	706,385	25,201	-	190,684
29	1,221,018	37,700	266,400	214,867	570,900	18,790	-	261,791
30	1,434,208	47,244	266,400	299,371	66,321	1,630	-	53,842
31	1,046,596	38,004	266,400	199,176	171,963	-	-	-
32	1,041,901	38,004	266,400	185,898	196,130	-	-	-
33	1,041,901	38,004	266,400	185,898	191,070	-	-	-
34	1,032,512	38,004	266,400	159,341	160,640	-	-	-
35	1,028,633	38,004	266,400	146,062	23,352	-	-	-
36	540,873	19,591	266,400	112,173	-	-	-	-
TOTAL	**89,224,292**	**2,909,122**	**10,656,000**	**25,611,717**	**11,578,641**	**243,999**	**7,203,012**	**17,301,482**

C3 ACTIVITY DATA

Activity data for Lake Vermont Existing Operations and the Project that has been used in the calculation of greenhouse gas emissions is presented in Table C3 for Lake Vermont, and in Table C4 for the Project.

Table C3 Activity data for the ongoing existing and approved Lake Vermont operations used in the calculation of greenhouse gas emissions

Year	ROM production (Mt)	Coking Product (Mt)	Industrial coal Product (Mt)	Total Product (Mt)	Diesel consumption (kL) - mining	Diesel consumption (kL) - transport	Explosive usage (t)	Land clearing (ha)	Electricity (kWh)
-3	11.2	8.3	0.8	9.1	92,441	39,184	48,656	111	74,000,000
-2	11.1	8.2	0.8	9.1	95,875	38,925	50,550	120	74,000,000
-1	11.0	7.9	0.9	8.9	97,868	38,177	51,622	79	74,000,000
0 (2025)	10.9	7.8	1.1	8.9	97,580	38,076	51,899	86	74,000,000
1	10.7	7.4	1.2	8.6	97,637	37,118	51,708	84	74,000,000
2	10.4	7.0	1.3	8.3	99,044	35,877	50,620	137	74,000,000
3	6.9	4.6	0.8	5.5	63,231	23,570	32,594	78	74,000,000
4	4.5	3.0	0.5	3.5	41,644	15,133	21,239	48	74,000,000
5	4.2	2.8	0.5	3.3	39,462	14,132	19,566	33	74,000,000
6	4.3	2.9	0.5	3.4	39,667	14,681	19,566	33	74,000,000
7	4.2	2.8	0.5	3.3	55,294	14,342	29,009	50	74,000,000
8	5.2	3.5	0.6	4.1	57,238	17,679	28,862	51	74,000,000
9	5.7	3.8	0.6	4.5	56,624	19,135	28,549	33	74,000,000
10	6.0	4.1	0.6	4.7	57,261	20,181	28,654	33	74,000,000
11	5.3	3.7	0.5	4.2	71,640	18,214	38,662	68	74,000,000
12	6.6	4.7	0.6	5.3	73,090	22,747	37,451	90	74,000,000
13	5.8	4.1	0.5	4.6	74,090	19,718	38,019	54	74,000,000
14	5.5	3.7	0.6	4.3	74,912	18,386	38,374	51	74,000,000
15	5.2	3.5	0.6	4.1	74,923	17,756	38,761	47	74,000,000
16	5.8	4.0	0.7	4.7	78,976	19,997	38,494	58	74,000,000
17	6.0	4.2	0.6	4.9	79,078	20,937	38,729	67	74,000,000

Year	ROM production (Mt)	Coking Product (Mt)	Industrial coal Product (Mt)	Total Product (Mt)	Diesel consumption (kL) - mining	Diesel consumption (kL) - transport	Explosive usage (t)	Land clearing (ha)	Electricity (kWh)
18	5.3	3.8	0.5	4.3	75,310	18,615	39,577	53	74,000,000
19	5.5	3.9	0.5	4.4	74,135	18,991	40,337	43	74,000,000
20	3.6	2.6	0.3	2.9	57,371	12,551	30,948	46	74,000,000
21	1.7	1.3	0.1	1.4	51,355	6,121	27,419	44	74,000,000
22	2.3	1.6	0.2	1.8	56,860	7,889	29,435	25	74,000,000
23	4.1	2.9	0.4	3.3	58,526	14,172	29,505	14	74,000,000
24	3.1	2.3	0.3	2.5	39,946	10,872	21,215	5	74,000,000
25	2.7	1.9	0.2	2.2	38,833	9,351	20,625	15	74,000,000
26	2.1	1.5	0.2	1.7	41,263	7,241	21,629	18	74,000,000
27	2.2	1.5	0.2	1.8	42,996	7,643	21,264	20	74,000,000
28	2.0	1.5	0.2	1.7	40,044	7,175	19,201	14	74,000,000
29	1.6	1.1	0.2	1.3	31,633	5,566	15,612	2	74,000,000
30	2.2	1.5	0.3	1.8	37,156	7,756	19,565	26	74,000,000
31	1.5	0.9	0.3	1.2	27,114	5,160	15,738	32	74,000,000
32	1.4	0.9	0.3	1.1	26,992	4,816	15,738	32	74,000,000
33	1.4	0.9	0.3	1.1	26,992	4,816	15,738	32	74,000,000
34	1.2	0.7	0.2	1.0	26,749	4,128	15,738	32	74,000,000
35	0.8	0.7	0.2	0.9	26,649	3,784	15,738	39	74,000,000
36	0.6	0.5	0.2	0.7	14,012	2,906	8,113	21	74,000,000

Table C4 Activity data for the Project used in the calculation of greenhouse gas emissions

Year	ROM production (Mt)	Coking Product (Mt)	Industrial coal Product (Mt)	Total Product (Mt)	Diesel use (kL) Mining	Diesel use (kL) Transport	Explosive usage (t)	Land clearing (ha)	Electricity (kWh)
-3	-	-	-	-	-	-	-	-	-
-2	-	-	-	-	-	-	-	-	-
-1	-	-	-	-	1,200	-	-	44	20,000,000
0 (2025)	-	-	-	-	1,200	-	-	44	30,000,000
1	0.12	0.10	0.01	0.10	1,561	451	-	-	35,000,000
2	0.41	0.34	0.03	0.37	1,712	1,604	-	-	50,000,000
3	3.85	3.14	0.26	3.40	3,707	14,636	-	-	66,562,291
4	6.39	5.33	0.41	5.73	5,040	24,655	-	-	110,354,117
5	6.71	5.70	0.36	6.06	5,207	26,042	-	-	115,845,010
6	6.93	5.91	0.33	6.23	5,323	26,806	-	-	119,660,204
7	6.34	5.29	0.40	5.69	5,014	24,459	-	-	109,497,268
8	5.34	4.36	0.36	4.73	4,486	20,319	-	-	92,171,380
9	5.36	3.58	0.89	4.47	4,497	19,213	-	-	92,512,230
10	4.87	3.23	0.83	4.06	4,240	17,454	-	-	84,073,877
11	5.45	3.48	1.02	4.50	4,544	19,345	-	-	94,061,284
12	3.93	2.53	0.75	3.28	3,748	14,114	-	-	67,895,634
13	4.86	3.33	0.78	4.11	4,237	17,667	-	-	83,956,830
14	5.38	3.76	0.78	4.54	4,507	19,518	-	-	92,861,450
15	5.93	4.25	0.80	5.05	4,614	21,712	-	-	102,432,340
16	4.49	3.66	0.27	3.93	3,857	16,893	-	-	77,542,866
17	4.74	3.91	0.27	4.18	3,987	17,979	-	-	81,844,296
18	5.07	4.18	0.28	4.46	4,159	19,171	-	-	87,486,811
19	4.58	3.76	0.24	4.01	3,902	17,230	-	-	79,049,936
20	4.99	3.90	0.39	4.29	18,435	18,429	8,255	128	81,751,740
21	6.79	5.04	0.63	5.67	23,280	24,360	9,738	98	98,877,734
22	5.73	4.03	0.63	4.67	23,512	20,067	10,723	76	76,177,585
23	4.24	2.91	0.48	3.39	21,711	14,561	10,749	44	51,221,915

Year	ROM production (Mt)	Coking Product (Mt)	Industrial coal Product (Mt)	Total Product (Mt)	Diesel use (kL) Mining	Diesel use (kL) Transport	Explosive usage (t)	Land clearing (ha)	Electricity (kWh)
24	1.40	0.91	0.23	1.14	18,440	4,885	10,416	42	-
25	1.49	0.86	0.29	1.16	19,443	4,976	10,522	108	-
26	1.44	0.68	0.36	1.03	21,115	4,448	10,878	30	-
27	1.32	0.67	0.29	0.96	19,226	4,115	10,872	32	-
28	1.45	0.87	0.27	1.15	18,300	4,940	10,436	26	-
29	1.92	1.27	0.31	1.58	14,790	6,782	7,781	7	-
30	0.40	0.26	0.06	0.32	1,718	1,395	675	-	-
31	-	-	-	-	4,455	-	-	-	-
32	-	-	-	-	5,081	-	-	-	-
33	-	-	-	-	4,950	-	-	-	-
34	-	-	-	-	4,162	-	-	-	-
35	-	-	-	-	605	-	-	-	-
36	-	-	-	-	-	-	-	-	-

C4 GREENHOUSE GAS EMISSIONS ESTIMATIONS

Annual greenhouse gas estimations for Lake Vermont Existing Operations are presented in Table C5 for Scope 1 and Scope 2 GHG emissions and Table C6 for Scope 3 GHG emissions.

Table C5 Summary of estimated annual Scope 1 and Scope 2 GHG emissions (tCO_2-e) and energy use (GJ) for Lake Vermont Existing Operations

Mine Year	Energy	Scope 1					Scope 2	TOTAL (Scope 1 + Scope 2)	
		Diesel (mining)	Fugitive gas	Blasting	Land clearing	Total	Electricity	Including LULUCF	Excluding LULUCF
	GJ	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
-3	3,952,128	251,204	257,600	8,272	12,171	529,246	59,200	588,446	576,275
-2	4,089,226	260,534	255,185	8,593	13,164	537,476	59,200	596,676	583,512
-1	4,168,768	265,951	252,448	8,776	8,605	535,780	59,200	594,980	586,375
0(2025)	4,158,305	265,167	250,516	8,823	9,392	533,898	59,200	593,098	583,706
1	4,160,036	265,322	245,733	8,790	9,159	529,004	59,200	588,204	579,045
2	4,211,744	269,147	238,945	8,605	14,977	531,674	59,200	590,874	575,897
3	2,785,814	171,826	159,645	5,541	8,557	345,569	59,200	404,769	396,212
4	1,925,128	113,164	102,592	3,611	5,244	224,611	59,200	283,811	278,567
5	1,836,892	107,236	95,580	3,326	3,587	209,730	59,200	268,930	265,343
6	1,844,789	107,792	99,292	3,326	3,587	213,998	59,200	273,198	269,611
7	2,470,785	150,257	97,216	4,932	5,521	257,925	59,200	317,125	311,604
8	2,545,479	155,541	120,080	4,906	5,596	286,123	59,200	345,323	339,727
9	2,521,040	153,873	129,950	4,853	3,664	292,341	59,200	351,541	347,877
10	2,545,884	155,605	136,970	4,871	3,556	301,002	59,200	360,202	356,646
11	3,125,068	194,678	122,662	6,573	7,417	331,329	59,200	390,529	383,113
12	3,178,107	198,617	152,672	6,367	9,878	367,534	59,200	426,734	416,857
13	3,218,076	201,335	133,047	6,463	5,891	346,736	59,200	405,936	400,045
14	3,250,684	203,570	125,514	6,524	5,617	341,225	59,200	400,425	394,808

Mine Year	Energy	Scope 1					Scope 2	TOTAL (Scope 1 + Scope 2)	
		Diesel (mining)	Fugitive gas	Blasting	Land clearing	Total	Electricity	Including LULUCF	Excluding LULUCF
	GJ	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
15	3,252,016	203,598	119,911	6,589	5,094	335,192	59,200	394,392	389,299
16	3,407,832	214,613	133,364	6,544	6,303	360,824	59,200	420,024	413,721
17	3,412,340	214,890	138,425	6,584	7,289	367,189	59,200	426,389	419,099
18	3,268,949	204,651	122,808	6,728	5,835	340,022	59,200	399,222	393,387
19	3,225,405	201,457	125,555	6,857	4,735	338,604	59,200	397,804	393,069
20	2,555,636	155,901	82,232	5,261	5,056	248,450	59,200	307,650	302,594
21	2,314,924	139,555	39,990	4,661	4,834	189,041	59,200	248,241	243,406
22	2,532,270	154,513	51,872	5,004	2,741	214,130	59,200	273,330	270,589
23	2,596,750	159,041	93,701	5,016	1,532	259,290	59,200	318,490	316,958
24	1,859,538	108,550	71,254	3,607	523	183,934	59,200	243,134	242,611
25	1,815,173	105,527	61,222	3,506	1,641	171,897	59,200	231,097	229,456
26	1,911,390	112,130	47,313	3,677	1,945	165,065	59,200	224,265	222,321
27	1,977,389	116,839	50,214	3,615	2,242	172,909	59,200	232,109	229,867
28	1,858,452	108,816	47,125	3,264	1,486	160,692	59,200	219,892	218,406
29	1,525,118	85,960	36,236	2,654	197	125,046	59,200	184,246	184,049
30	1,747,852	100,968	50,700	3,326	2,858	157,852	59,200	217,052	214,194
31	1,351,000	73,680	34,500	2,675	3,494	114,350	59,200	173,550	170,056
32	1,346,305	73,350	32,200	2,675	3,494	111,720	59,200	170,920	167,425
33	1,346,305	73,350	32,200	2,675	3,494	111,720	59,200	170,920	167,425
34	1,336,916	72,689	27,600	2,675	3,494	106,459	59,200	165,659	162,164
35	1,333,037	72,416	19,511	2,675	4,285	98,887	59,200	158,087	153,802
36	826,864	38,077	12,954	1,379	2,286	54,697	59,200	113,897	111,611
TOTAL	**102,789,414**	**6,281,390**	**4,406,537**	**204,802**	**210,441**	**11,103,170**	**2,368,000**	**13,471,170**	**13,260,729**
Average	2,569,735	157,035	110,163	5,120	5,261	277,579	59,200	336,779	331,518

Mine Year	Energy	Scope 1					Scope 2	TOTAL (Scope 1 + Scope 2)	
		Diesel (mining)	Fugitive gas	Blasting	Land clearing	Total	Electricity	Including LULUCF	Excluding LULUCF
	GJ	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
%	Scope 1	57%	40%	2%	2%	100%	-	-	-
	Scope 1 + 2	47%	33%	2%	2%	82%	18%	100%	-

Table C6 Summary of estimated annual Scope 3 GHG emissions in t CO_2-e for Lake Vermont Existing Operations

Year	Diesel + Electricity*	Rail transport of coal	Shipping of coal	End use of product coal (industrial)	End use of product coal (coking)	Total
	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
-3	21,726	109,714	331,490	2,280,568	22,955,639	25,699,136
-2	22,203	108,990	329,303	2,347,963	22,724,568	25,533,027
-1	22,480	106,895	322,973	2,695,222	21,908,704	25,056,273
0(2025)	22,440	106,612	322,117	3,034,003	21,516,551	25,001,723
1	22,448	103,931	314,016	3,463,995	20,486,353	24,390,742
2	22,643	100,457	303,520	3,741,403	19,421,810	23,589,833
3	17,667	65,996	199,402	2,416,359	12,799,593	15,499,017
4	14,667	42,371	128,020	1,553,571	8,215,499	9,954,128
5	14,364	39,569	119,553	1,494,472	7,629,962	9,297,920
6	14,392	41,106	124,196	1,552,513	7,926,288	9,658,496
7	16,564	40,157	121,330	1,457,418	7,800,605	9,436,074
8	16,834	49,502	149,564	1,730,037	9,680,128	11,626,065
9	16,749	53,578	161,881	1,780,867	10,565,816	12,578,891
10	16,837	56,506	170,727	1,741,290	11,275,416	13,260,776
11	18,835	50,998	154,087	1,389,969	10,351,848	11,965,738
12	19,037	63,693	192,442	1,660,096	13,001,914	14,937,182
13	19,176	55,210	166,812	1,489,821	11,221,212	12,952,231
14	19,290	51,481	155,546	1,644,324	10,216,883	12,087,524
15	19,291	49,716	150,213	1,720,120	9,738,961	11,678,302
16	19,855	55,990	169,170	1,946,404	10,959,088	13,150,507
17	19,869	58,623	177,122	1,821,092	11,683,694	13,760,400
18	19,345	52,122	157,481	1,426,119	10,574,507	12,229,574
19	19,182	53,175	160,664	1,471,302	10,772,469	12,476,792
20	16,852	35,143	106,181	812,006	7,274,269	8,244,451

Year	Diesel + Electricity*	Rail transport of coal	Shipping of coal	End use of product coal (industrial)	End use of product coal (coking)	Total
	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e	t CO_2-e
21	16,016	17,139	51,785	372,422	3,570,489	4,027,851
22	16,781	22,090	66,743	534,804	4,548,893	5,189,311
23	17,013	39,681	119,894	1,076,040	8,059,972	9,312,600
24	14,431	30,441	91,975	787,980	6,219,340	7,144,168
25	14,276	26,183	79,108	701,628	5,326,224	6,147,419
26	14,614	20,274	61,255	588,730	4,080,255	4,765,127
27	14,855	21,402	64,663	659,966	4,270,163	5,031,049
28	14,444	20,090	60,699	624,222	4,003,771	4,723,225
29	13,276	15,586	47,092	430,202	3,158,529	3,664,685
30	14,043	21,716	65,613	760,572	4,245,040	5,106,984
31	12,648	14,448	43,653	814,595	2,526,224	3,411,568
32	12,631	13,485	40,743	760,289	2,357,809	3,184,956
33	12,631	13,485	40,743	760,289	2,357,809	3,184,956
34	12,597	11,558	34,923	651,676	2,020,979	2,731,733
35	12,583	10,595	32,012	597,370	1,852,564	2,505,124
36	10,827	8,137	24,585	458,768	1,422,732	1,925,048
TOTAL	**676,407**	**1,857,845**	**5,613,297**	**57,250,488**	**370,722,572**	**436,120,610**
Average	16,910	46,446	140,332	1,431,262	9,268,064	10,903,015
%	0.16%	0.43%	1.29%	13.13%	85.00%	100.00%
Notes: *Full fuel cycle GHG emissions including production and distribution related emissions						