

Chapter 23
Air quality

ESMERALDA GRAPHITE PROJECT

aarc ENVIRONMENTAL SOLUTIONS
APEM Group

GRAPHINEX

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Glossary, acronyms and abbreviations

Acronym or Abbreviation	Meaning
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industry Research Organisation
DESI	Department of Environment, Science and Innovation
DETSI	Department of the Environment, Tourism, Science and Innovation
EA	Environmental Authority
EIS	Environmental Impact Statement
EP Act	*Environmental Protection Act 1994*
EP Regulation	Environmental Protection Regulation 2019
EPA	Environmental Protection Authority
EPP (Air)	Environmental Protection (Air) Policy 2019
GHG	Greenhouse gas
MLA	Mining Lease Application
NO	Nitrogen dioxide
NPI	National Pollutant Inventory
PM	Particulate matter
QLD	Queensland
ROM	Run-of-Mine
TOR	Terms of Reference
TSF	Tailings Storage Facilities
TSP	Total suspended particulates

23 Air quality

23.1 Environmental objectives

This chapter has been prepared to enable an assessment of the Project against environmental objectives stated in the Terms of Reference (TOR), detailed in Section 23.6. With regards to air and GHG emissions, the Project design and execution are to:

1) avoid, minimise and/or mitigate adverse air impacts to sensitive receptors;

2) protect or enhance the environmental values of the airshed, the health and biodiversity of ecosystems and human health and wellbeing; and

3) contribute toward Queensland's emission reduction and renewable energy targets by developing and implementing greenhouse gas abatement measures for the Project.

The detailed assessment presented in this chapter and in the Air Quality and Greenhouse Gas Assessments demonstrates that the Project will achieve performance outcome 2 for the environmental objective, as outlined in Schedule 8 of the EP Regulation, as the Project will be operated in a way that achieves all of the following:

> *Fugitive emissions of contaminants from storage, handling and processing of materials and transporting materials within the site are prevented or minimised.*
>
> *Contingency measures will prevent or minimise adverse effects on the environment from unplanned emissions and shutdown and start up emissions of contaminants to air.*
>
> *Releases of contaminants to the atmosphere for dispersion will be managed to prevent or minimise adverse effects on environmental values.*

23.2 Legislation and guidelines

In Queensland, impacts of air pollutant emissions on sensitive receptors and environmental values are regulated by the Environmental Protection (Air) Policy 2019 (EPP (Air)) under the *Environmental Protection Act 1994* (EP Act). The EPP (Air) provides objectives for air quality indicators, in the form of pollutants, that address health, aesthetic environment, ecosystems and agriculture.

Schedule 8, Part 3, Division 1 of the Environmental Protection Regulation 2019 (EP Regulation) further sets out environmental objectives and performance outcomes that are used during an operational assessment for applications requiring an environmental authority (EA) under the Environmental Protection Act 1994. The environmental objectives and associated performance outcomes relevant to air are:

> ***Environmental Objective***
>
> *The activity will be operated in a way that protects the environmental values of air.*
>
> ***Performance Outcomes***
>
> *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.

Other relevant legislation and guidelines that support this framework include:

- 'Guideline: Application Requirements for Activities with Impacts to Air' (DESI 2021);
- 'Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emission' (Ministry for the Environment 2016);
- '1961: Guideline for Assessing and Minimising Air Pollution' (EPA Victoria 2022); and
- 'Air – EIS Information Guideline' (DESI 2024a).

This chapter has been prepared in accordance with the above legislation and guidelines.

23.2.1 Air quality objectives

The EPP (Air) objectives for air quality emissions relevant to the Project are presented in Table 23-1.

Table 23-1 also shows the dust deposition guideline commonly used in QLD as a benchmark for avoiding amenity impacts due to dust. The dust deposition guideline is not defined in the EPP (Air) but is contained within DETSI's Guideline and is therefore adopted here.

Table 23-1: Air quality objectives used in the assessment

Substance	Environmental value	Averaging period	Air quality objective (µg/m³)	Basis
TSP	Health and wellbeing	1-year	90	EPP (Air)
PM_{10}	Health and wellbeing	24-hour	50	EPP (Air)
		1-year	25	EPP (Air)
$PM_{2.5}$	Health and wellbeing	24-hour	20	EPP (Air)
		1-year	8	EPP (Air)
Dust deposition rate for total insoluble solids	Amenity guideline	Monthly	120 mg/m^2/day	Impacts to Air Guideline
NO_2	Health and wellbeing	1-hour	164	EPP (Air)
		1-year	31	EPP (Air)
SO_2	Health and wellbeing	1-hour	286	EPP (Air)
		24-hour	57	EPP (Air)
CO	Health and wellbeing	8-hour	11,000	EPP (Air)
Graphite respirable dust limit	Health and wellbeing	8-hour	3 mg/m^3	Safe Work Australia

23.3 Existing environment

Environmental values to be enhanced or protected under EPP (Air) are those that are conducive to protecting:

- the health and biodiversity of ecosystems;
- human health and wellbeing;
- the aesthetics of the environment, including the appearance of buildings, structures and other property; and
- agricultural use of the environment.

These values are considered relevant to the Project area and subsequently have been evaluated within the Air Quality Assessment, undertaken by Katestone (2026a).

23.3.1 Overview

The Project is located in a rural area surrounded by agricultural land (cattle grazing). There are isolated dwellings in the region, however none are present within the Project MLAs. The closest town is Croydon, which is located approximately 70 km north of the Project.

23.3.2 Climate and meteorology

The nearest Bureau of Meteorology (BoM) monitoring station is Croydon township, 70 km north of the Project site. Due to proximity, the Croydon township station is considered suitably representative of the project site. Data recorded at BoM's Croydon township station has been used to summarise the temperature, relative humidity and rainfall typically experienced in the region.

23.3.2.1 Temperature and rainfall

The mean daily temperatures recorded at the Croydon Township station for the years 1912 to 2014, are presented in Table 23-2 and Figure 23-1.

The climate in the region is tropical savanna climate with two distinct seasons: a hot, wet season (October–April) and a dry, warm season (May–September). The region experiences a fairly uniform temperature profile, with relatively warm temperatures year-round, and slightly cooler temperatures during winter. The mean recorded daily maximum temperature ranges from 29.2 to 38°C. The mean minimum temperature ranges from 14.1 to 24.6°C.

Table 23-2: Mean daily maximum and minimum temperatures at BoM's Croydon Township station

Mean maximum temperature (°C)												
Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*
35.5	*34.5*	*34.3*	*33.9*	*31.6*	*29.2*	*29.2*	*31.2*	*34.3*	*36.9*	*38*	*37.3*	*33.8*
Mean minimum temperature (°C)												
Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual*
24.2	*23.9*	*23.3*	*21*	*17.9*	*14.7*	*14.1*	*15.7*	*19.2*	*22.5*	*24.4*	*24.6*	*20.5*

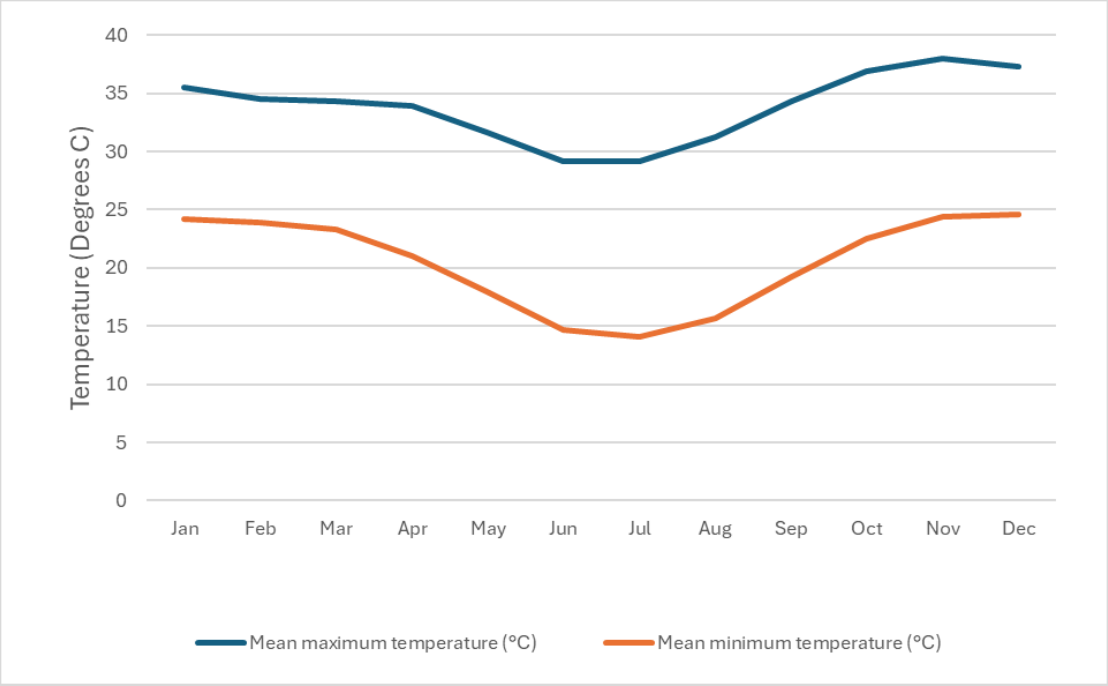


Figure 23-1: Mean daily maximum and minimum temperatures at BoM's Croydon Township station

23.3.2.2 Wind speed and direction

Winds across the Project area are predominantly light to moderate (up to around 5.7 m/s) and range from the northeast through to the southeast. Winds from the west are less frequent. Predicted annual average wind speed at the Project site in 2021 was 2.8 m/s.

The seasonal breakdown of winds (Figure 23-2) indicates that the predominant southeasterly winds are strongest and most common during the autumn and winter months. Spring and summer show increased frequency of winds from the northeast, with average wind speeds relatively uniform throughout the year.

The diurnal breakdown of winds (Figure 23-3) indicates that the strongest winds are predicted during the afternoon (midday to 6pm) when winds are predominantly from the southeast. Moderate winds from the northeast also occur during the afternoon. From 6pm through to the morning there is a shift towards lighter winds, with wind direction relatively uniform throughout.

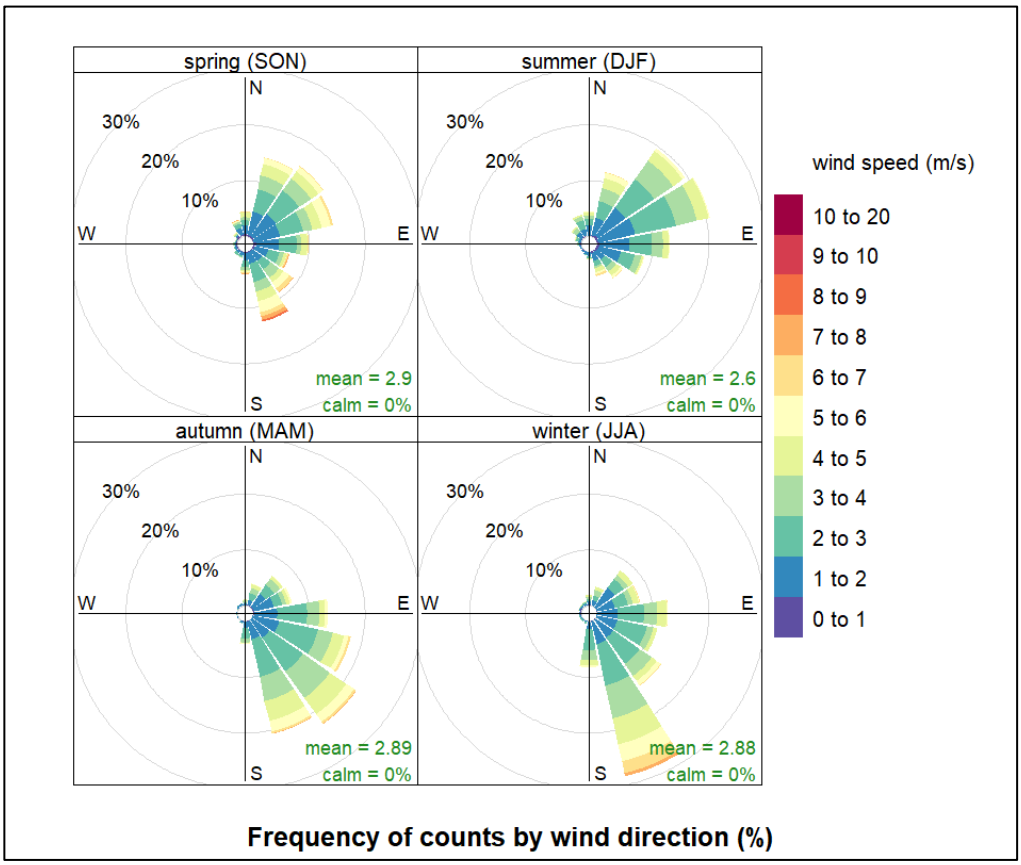


Figure 23-2: 2021 Seasonal distribution of winds predicted by TAPM/CALMET (Katestone 2026a)

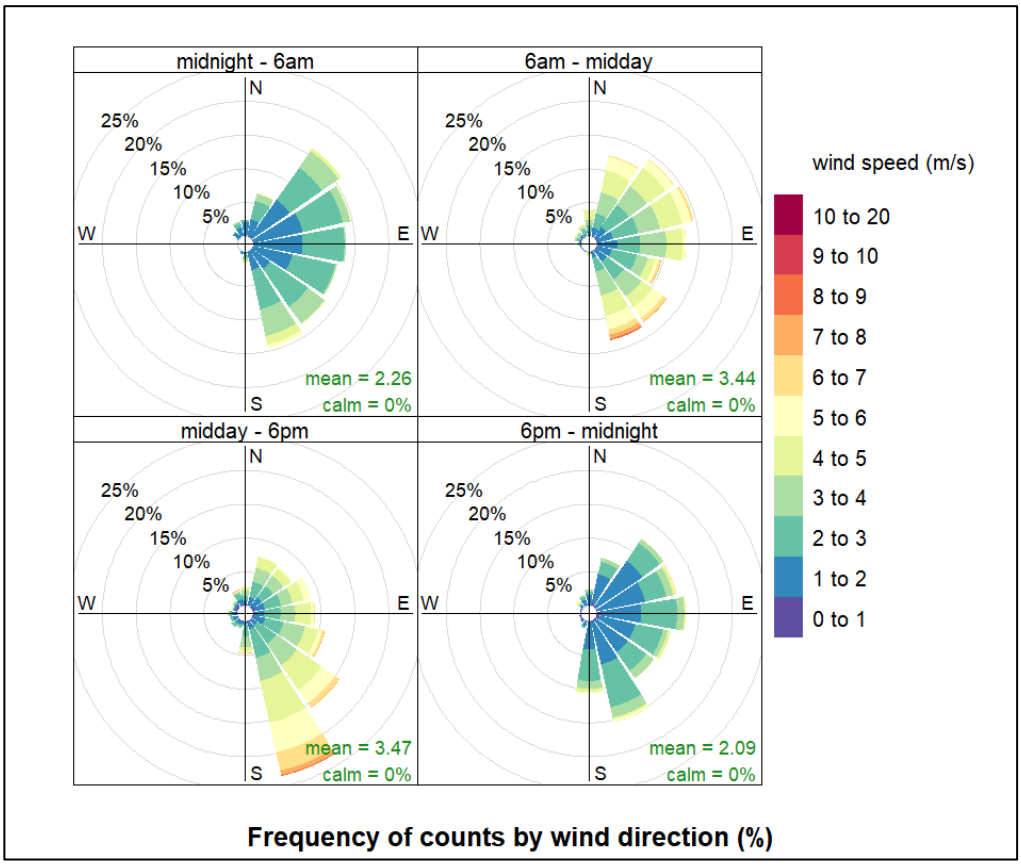


Figure 23-3: 2021 Diurnal distribution of winds predicted by TAPM/CALMET (Katestone 2026a)

23.3.2.3 Mixing depth

Mixing depth signifies the height above the surface where a pollutant can be dispersed. Higher mixing depths occur during the day, while lower mixing depths occur during the night, when stable conditions are dominant. At times when temperature inversions occur, which is typically in the mornings, air pollution can build up as the warm air above the cold air supresses the pollutants from rising through the atmospheric column and dispersing.

Mixing depth information extracted from the Katestone (2026a) modelling dataset is presented as a diurnal frequency (box and whisker) plot in Figure 23-4. The plot shows that, on average, the mixing depth begins to increase around 6 am and peaks around 4-5 pm before descending rapidly into the evening.

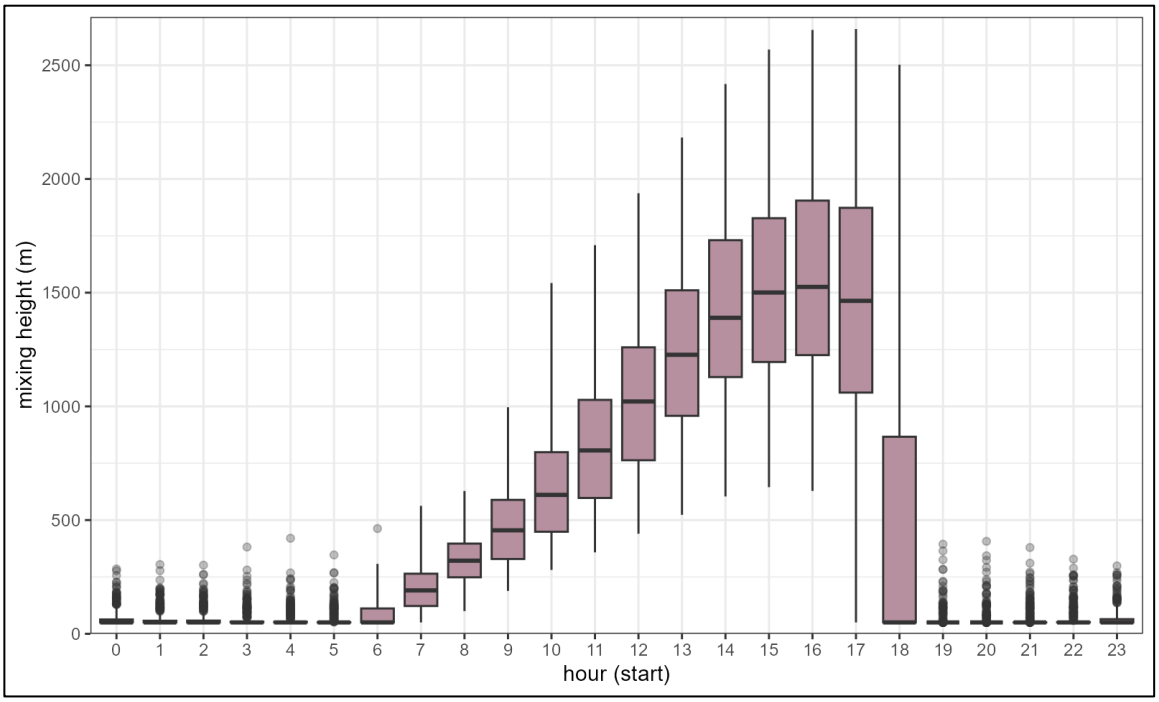


Figure 23-4: 2021 Diurnal profile of mixing depth predicted by TAPM/CALMET (Katestone 2026a)

23.3.3 Sensitive receptors

There are three sensitive receptors in the vicinity of the Project. The locations of the sensitive receptors are presented in Table 23-3 and shown in Figure 23-5.

Table 23-3: Sensitive receptors

Receptor ID	Description	Easting (km)	Northing (km)	Distance and direction from the Project
R1	Esmeralda Homestead (Residential)	665.762	7914.629	18 km E
R2	Prospect Homestead (Residential)	631.806	7908.655	5 km S
R3	Homestead (Residential)	612.870	7910.311	14 km SW

A fourth receptor, R4, is the on-site accommodation facility. This receptor is considered for air quality impacts under the *Work Health and Safety Act 2011*.

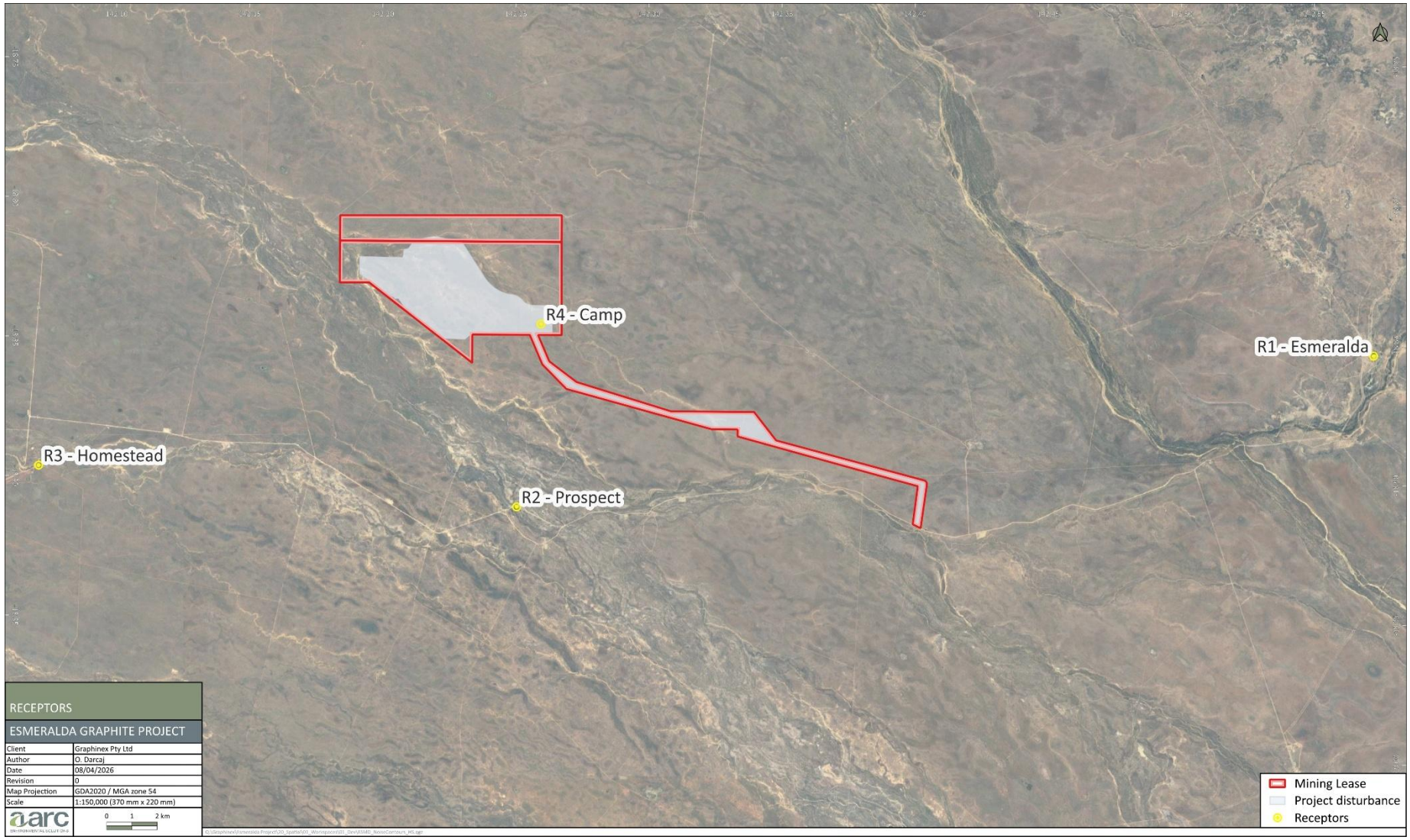


Figure 23-5: Sensitive receptors

23.3.4 Background air quality

The air quality of the local and regional air shed can be considered as typical of a rural environment, noting the remote nature and low intensity grazing land-use of the Project site. The region is sparsely populated with only three homesteads located within 20 km of the proposed MLA boundary (Section 23.3.3). Ambient levels of air pollutants in the study area will therefore be predominantly influenced by naturally generated dust in the environment, from sources such as pollen, grass seeds and wind erosion of non-vegetated areas, smoke during bushfire events, or dust from road transport on unsealed roads and agricultural activities.

A review of the National Pollutant Inventory (NPI) database for the 2023/2024 reporting period supports the above assumptions, indicating that there were no facilities within 100 km of the project site that reported emissions to air. It is additionally unlikely that facilities outside of this radius will have any influence on air quality at the sensitive receptors in the region of the project.

To develop a baseline air quality dataset for the purposes of assessing potential air quality impacts, Katestone considered the network of ambient air quality monitoring stations throughout Queensland that are operated by DETSI.

There are no DETSI monitoring stations near the Project, with the nearest potentially suitable stations located at Mount Isa and Townsville, roughly 350 km and 460 km away respectively. Given the large-scale mining and smelting operations present at Mount Isa, monitoring data from this area is not considered appropriately representative of air quality at the project site. Of the multiple monitoring stations active in Townsville, the North Ward station has been deemed to be the most appropriate for the purposes of the air quality assessment. The North Ward station will still provide a conservative estimate of ambient background in the Project area, noting it is proximal to residential areas that would have higher levels of air pollutants due to anthropogenic activities such as vehicle use, than would occur in the project area.

A summary of the background air quality levels used in this assessment are presented in Table 23-4. Five years of monitoring data have been analysed for 1-hour and 24-hour averaging periods, the 70th percentile value has been presented in the table. The maximum annual average is also presented.

The highest concentration for each air pollutant over the five years (relevant to each averaging period) has been used as the background value in this assessment (unless otherwise stated).

Carbon monoxide (CO) is not measured at the North Ward monitoring station. Data for ambient CO has instead been derived from the Miles Airport monitoring station, considered to be suitable as a non-urban location.

Ambient background concentrations selected for use in the air quality assessment are presented in Table 23-5.

Table 23-4: Background air quality measured at the DETSI North Ward monitoring station

Pollutant	Averaging Period [a]	Assessment criterion	Concentration (µg/m³)				
			2020	2021	2022	2023	2024
PM_{10}	24-hour	**50**	18.3	18.7	17.5	18.1	17.7
	Annual	**25**	16.1	16.3	15.2	16.2	15.6
$PM_{2.5}$	24-hour	**20**	6.6	6.7	6.6	6.5	6.4
	Annual	**7**	5.8	5.8	5.8	6.2	5.6
NO_2	1-hour	**164**	4.1	6.2	6.2	6.2	6.2
	Annual	**31**	4.5	5.3	5.5	5.0	4.9
SO_2	1-hour	**214**	2.9	0	0	0	0
	24-hour	**57**	1.7	0.5	0.5	0.8	0.2

CO [a]	8-hour	**11,000**	229.2	125	125	125	-
Table notes: [a] CO ambient air quality levels are from DETSI's Miles Airport monitoring station							

Table 23-5: Ambient background concentrations selected for use in the air quality assessment

Pollutant	Averaging period	Ambient background (ug/m^3)	Source
PM_{10}	24-hour	18.7	Maximum, 70th percentile from 2020 to 2024 from North Ward monitoring station
	Annual	16.3	Highest annual average from 2020 to 2024 from North Ward monitoring station
$PM_{2.5}$	24-hour	6.7	Maximum, 70th percentile from 2020 to 2024 from North Ward monitoring station
	Annual	6.2	Highest annual average from 2020 to 2024 from North Ward monitoring station
TSP	Annual	32.5	Derived from PM_{10} using PM_{10} to TSP ratio of 0.5 for rural areas
Dust deposition	Monthly	40 mg/m^2/day	Katestone (2026a)
NO_2	1-hour	6.2	Maximum, 70th percentile from 2020 to 2024 from North Ward monitoring station
	Ann	5.5	Highest annual average from 2020 to 2024 from North Ward monitoring station
SO_2	1-hour	2.9	Maximum, 70th percentile from 2020 to 2024 from North Ward monitoring station
	24-hour	1.7	Maximum, 70th percentile from 2020 to 2024 from North Ward monitoring station
CO	8-hour	229.2	Maximum, 70th percentile from 2020 to 2023 from Miles Airport monitoring station

23.4 Impact assessment

23.4.1 Emission sources

Emissions of dust and particulates constitute the primary relevant substances generated by the Project. Specifically, this includes total suspended particulates (TSP), particulate matter of an aerodynamic diameter of 10 micrometres or less (PM_{10}), of an aerodynamic diameter of 2.5 micrometres or less ($PM_{2.5}$), and deposited dust. Emissions of nitrogen dioxide (NO_2), carbon monoxide (CO), and sulphur dioxide (SO_2) as well as particulates from the diesel generators onsite have also been assessed. These emissions can have impacts on sensitive receptors and environmental values and may arise during all phases of the Project.

23.4.1.1 Construction

The construction phase of the Project has the potential to cause elevated levels of dust if not managed appropriately. Construction phase activities at the Project site can be broadly described as:

- site clearance of areas, including vegetation clearance;

- excavation and stockpiling of topsoil and subsoil;
- earthworks associated with the construction of the haul roads and mine infrastructure,
- civil works including temporary and permanent drainage works; and
- structure and plant transport, and installation.

23.4.1.2 Operation

The greatest risk for air quality impacts from the Project occurs during the operational phase. The air quality impact assessment quantitatively assessed emissions associated with the operational phases of the Project, including:

- drilling and blasting;
- dozing of ROM and overburden materials;
- handling of extracted materials including loading and unloading from vehicles;
- haulage of ROM to onsite stockpiles, including return trips;
- haulage of overburden to waste dumps, including return trips;
- in-pit backfilling of overburden and tailings, including return trips;
- haulage of graphite product and delivery of diesel and reagents via B-double trucks, including return trips;
- grading of haul routes;
- wind erosion of exposed surfaces;
- crushing and screening of ore;
- processing of ore; and
- diesel generators.

Small quantities of combustion products may be emitted from vehicles. However, the emission rates of these substances are low compared to the emission rates of particulate matter and combustion from the diesel generators and are likely to have negligible impacts. Therefore, these emissions have not been considered further.

Odour emissions due to the flotation process or sewage effluent irrigation are also expected to be minor, and due to the distance from the nearest sensitive receptors, odour impacts are considered to be unlikely and thus odour emissions have not been considered further. Assessment of sewage is detailed further in Chapter 17, Waste.

23.4.1.3 Rehabilitation

Rehabilitation activities are expected to present lower emissions source potential than the construction or operation phases. Emissions during this phase are largely be associated with earthworks and vehicle movements required to establish or maintain rehabilitation areas, and the removal of infrastructure. The subsequent progressive establishment of vegetation, and removal of emissions sources such as the processing plant and majority of vehicles will result in a significantly reduced emissions inventory for the rehabilitation phase and a lower risk the air quality impacts.

23.4.2 Modelling methodology

23.4.2.1 Assessment scenario

Mine progression data for each year of the Project, including annual quantities of material movement (waste, ore, reclaim and backfill), were reviewed to determine a single maximum operational scenario for adoption as a suitable modelling year. A review of operational data identified mine year 42 to be the maximum operational case. This was determined based on:

- year 42 has the highest amount of earth (backfill) movement (15.5 Mt, hauled by truck from TSFs to pit;
- ore and overburden extraction from pit is sustained during this year; and
- the process plant continues to operate at an assumed peak of 3.5 Mtpa.

Emissions from the selected maximum operational year are expected to exceed emissions associated with other periods of the mine life, including construction and closure of the mine. Later operational years, until approximately year 53, while showing slightly higher material quantities, largely represent backfilling of the mine void - with reduced mine production related operations such as ore excavation, stockpiling, processing, hauling of waste material from the pit to dumps, graphite production, or road train hauling of product. These years are therefore limited in their activities and sources of emissions to air and so were not deemed to represent a conservative degree of operations of the mine for assessment purposes.

By assessing compliance against the relevant air quality objectives for the selected conservative maximum case year, demonstration of compliance can be assumed to also demonstrate compliance for all other mine years with less intensive operations, and during construction and closure phases.

23.4.2.2 Emission types

Emission rates of dust associated with the operation of the Project during mine year 42 have been estimated, accounting for proposed emission controls, using emission factors published in authoritative sources including the National Pollutant Inventory (NPI) Handbooks or the USEPA AP42 Emission Estimation Manuals (NPI, 2012; USEPA, 1998; USEPA, 2004; USEPA, 2006a; USEPA, 2006b, USEPA, 2006c). Emission rates of key exhaust pollutants due to combustion of diesel in the generators have also been estimated using emission factors for stationary large (greater than 450kW) diesel engines from the NPI (NPI, 2008), with the per generator capacity being 2,700 kW.

23.4.2.3 Emission inventory

The calculated emission rates for mine year 42 of the Project are presented in Table 23-6. Emissions were calculated using NPI emission factor calculations in conjunction with Project specific operational data. Presented emission rates are inclusive of the routine mitigation control factors summarised in Table 23-9. The year 42 mine layout, emission areas and haul routes applied in emissions estimation and dispersion modelling are presented in Figure 23-6.

Emissions from the diesel generators have been assumed to occur continuously at maximum load, presented in Table 23-7. Stack characteristics used in the dispersion modelling of emissions from the generators were based on Katestone data from similar generators and are shown in Table 23-8.

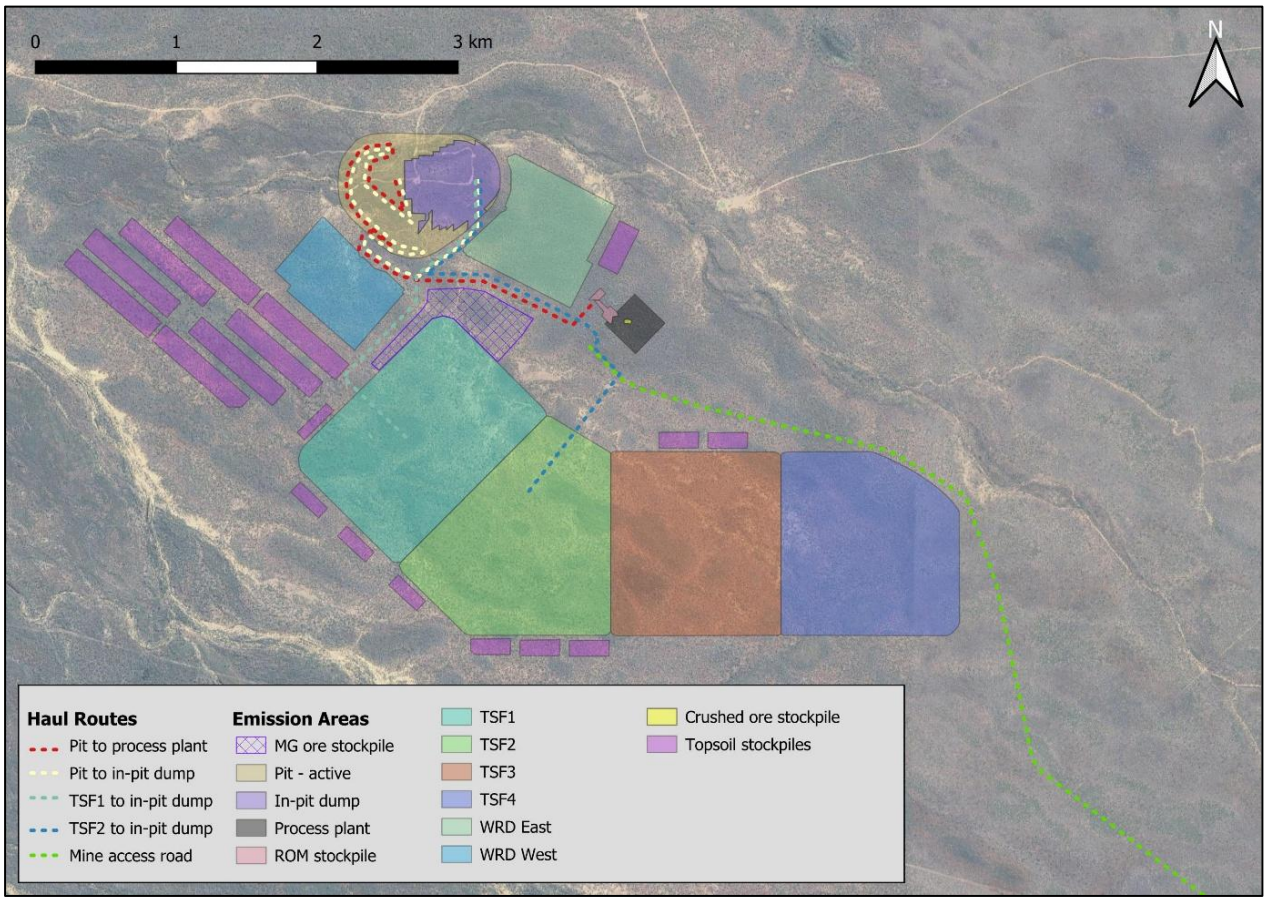


Figure 23-6: Year 42 mine layout, emission areas and haul routes

Table 23-6: Emissions inventory – mine year 42

Activity	**Emission rates (g/s)**		
	TSP	**PM_{10}**	**$PM_{2.5}$**
TOTAL	151.3	58.0	9.3
Active pit / in-pit dump			
Drilling/blasting	0.8	0.4	0.02
Dozers	0.8	0.1	0.1
Handling/transfers	0.7	0.3	0.05
Western dump			
Dozer	1.4	0.3	0.1
Stockpiles			
Handling/transfers	0.4	0.2	0.03
Process plant			
Screening/crushing	13.9	10.1	0.4
Handling/Transfers	0.2	0.1	0.01

Activity	Emission rates (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Tailings storage facility			
Handling/transfers	0.6	0.3	0.05
Haulage			
Pit to MG ore stockpile	6.1	1.7	0.2
Pit to process plant	8.5	2.4	0.2
Pit to in-pit dump	1.1	0.3	0.03
MG ore stockpile to process plant	10.7	3.0	0.3
TSF 1 backfill to in-pit dump	18.4	5.3	0.5
TSF 2 backfill to in-pit dump	44.6	12.7	1.3
Product delivery	7.6	2.0	0.2
Resource delivery	1.3	0.3	0.03
Grading			
All routes	2.3	0.7	0.1
Wind Erosion			
Active pit	1.3	0.6	0.1
Backfill pit - in-pit dump	0.9	0.4	0.1
West dump	1.2	0.6	0.1
East dump	1.7	0.8	0.1
TSF 1	2.2	1.1	0.2
TSF 2	2.2	1.1	0.2
TSF 3	2.1	1.1	0.2
TSF 4	2.1	1.0	0.2
ROM stockpile	0.2	0.1	0.02
Crushed ore stockpile	0.02	0.01	0.002
MG ore stockpile	3.7	1.8	0.3
Topsoil stockpiles	10.9	5.5	0.9
Power Generation			
Diesel gensets (10 units)	3.2	3.2	3.2
Concentrate flash dryer			
Dust collector	0.2	0.2	0.2

Table 23-7: Emission rates for combustion gases

Location	Emission rate (g/s)		
	NOx	SO_2	CO
Diesel gensets (per genset)	11.25	0.004	2.48

Table 23-8: Stack characteristics for diesel gensets

Parameter	Diesel Gensets	
	Value	Units
Stack height	5	m
Exit temperature	550	°C
Exit velocity	39	m/s
Stack diameter	0.6	m

Table 23-9: Routine mitigation measures

Activity	Mitigation Measure	Control Efficiency	Reference
Drilling	Cyclone	70%	NPI Mining v3.1 Table 4
Wheel generated dust from OB hauling	level 1 watering (2 L/m2/h) vehicle speed limits	50%	NPI Mining v3.1 Table 4
Wheel generated dust from ROM hauling	level 1 watering (2 L/m2/h) vehicle speed limits	50%	NPI Mining v3.1 Table 4
Wheel generated dust from tailings and waste backfill hauling	level 2 watering (>2 L/m2/h) vehicle speed limits	75%	NPI Mining v3.1 Table 4
Crushing	Water sprays	50%	NPI Mining v3.1 Table 4
Screening	Water sprays	50%	NPI Mining v3.1 Table 4
Topsoil stockpiles – wind erosion	Vegetation established but not demonstrated to be self-sustaining	40%	NPI Mining v3.1 Table 4
Tailings storage – wind erosion	Initial slurry then crusting of surface	50%	Katestone

23.4.2.4 Dispersion modelling

The CALPUFF dispersion model (version 7.2.1) has been used to quantify the incremental change in air pollutants and dust associated with the Project.

CALPUFF is an advanced non-steady-state air quality modelling system that is approved by DETSI for dispersion modelling. The TAPM/CALMET models were used to simulate meteorological conditions in the region around the project site, in consideration of the existing environment as detailed in Section 23.3. The data generated by these models was used as inputs for the dispersion model to account for all weather conditions likely to be

experienced in the region during a typical year. The modelling has been used to predict maximum ground-level concentrations and deposition rates of dust across a cartesian grid of the Project region and at the locations of the identified sensitive receptors. Ground-level concentrations of dust and key exhaust pollutants, and dust deposition rates associated with the Project have been predicted at the sensitive receptors through this process.

Ambient background dust levels have been added to the incremental model predictions to obtain an estimate of the potential cumulative impact of the project, with existing natural and anthropogenic sources of dust. Air pollutant levels have been assessed by comparing the predicted concentrations and dust deposition rates with the relevant air quality objectives at sensitive locations.

Predicted results of modelled pollutants due to the Project have been tabulated in isolation, and in combination with background levels. Contour plots indicative of ground-level concentrations or dust deposition rates due to the project and existing ambient background levels have also been developed. Both are presented in Section 23.4.3.

Additional details of the CALPUFF configuration are provided in Section A2 of Appendix A, Air Quality Assessment.

23.4.2.5 Assessment quality assurance

The Air Quality Assessment undertaken by Katestone relied on the accuracy of a number of data sets that feed into the dispersion modelling, all of which have an inherent degree of associated uncertainty. The input data sets include:

- meteorological monitoring observations from BoM;
- air quality monitoring observations from DETSI;
- synoptic and surface information datasets from CSIRO;
- operational data provided by Graphinex;
- approximations of haul routes and lengths; and
- accuracy and consistency of application of mitigation measures.

Additionally, 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 emissions levels.

To counter uncertainty in the modelling and provide a thorough assessment of potential impacts, the dispersion model has been configured with conservative assumptions and, therefore, the assessment is likely to overpredict potential impacts of the Project. Conservative assumptions include the:

- Assumption that mining activities occur constantly for every hour of operation with constant emission rates (does not reflect fluctuations in emissions intensity, i.e. a section of haul road will be constantly generating dust and particulates in the model, however the same section of haul would only produce emissions for the few moments a truck is driving across it in reality).
- Assumption that “snapshot” representations of mine layouts are constant over an entire year for the purposes of dispersion modelling which likely overestimate active mining areas.
- Use of a maximum year operational data to reflect conservative emissions scenarios for the whole Project.
- Inability of dispersion modelling to account for the impacts of rainfall on the reduction of dust/particulate emissions.

23.4.3 Potential impacts

Modelling results are based on the maximum 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 maximum value is obtained and stored from each point in the modelled domain. As these maximum values may occur at different times at different grid points, these figures do not represent a single snapshot of conditions at any given time.

23.4.3.1 Sensitive receptors

Results of the air quality assessment demonstrated that predicted ground-level concentrations of all air pollutants and dust deposition rates due to the Project with ambient background levels included are predicted to comply with the relevant air quality objectives at all sensitive receptors.

Predicted concentrations due to the Project in isolation are presented in Table 23-10, and combined Project and background levels in Table 23-11.

Contour plots of modelled gaseous and particulate emissions relative to sensitive receptors are presented in Figure 23-7 to Figure 23-17.

The assessment predicts no exceedances of the relevant air quality criteria at sensitive receptors, indicating that dust emissions from the Project can be adequately managed using the above mitigation measures to prevent adverse impacts at sensitive receptors and protect the environmental values of the air environment in the region. The Project will meet the environmental objectives and performance outcomes for air as stated in Schedule 8 of the EP Regulation.

The health and safety of the Project workforce is essential. The Project will comply with all relevant legislation, including the *Work Health and Safety Act 2011*.

Table 23-10: Predicted ground-level concentrations due to the Project in isolation

Receptor		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		TSP (µg/m³)	Dust deposition (mg/m²/day)	NO_2 (µg/m³)		SO_2 (µg/m³)		CO (µg/m³)
ID	**Description**	**Maximum 24-hour**	**Annual Average**	**Maximum 24-hour**	**Annual Average**	**Annual average**	**Maximum Monthly**	**Maximum 1-hour**	**Annual average**	**Maximum 1-hour**	**Maximum 24-hour**	**Maximum 8-hour**
R1	Esmeralda Homestead	0.1	0.005	0.02	0.001	0.01	0.04	0.82	0.01	0.001	0.0001	0.2
R2	Prospect Homestead	24.2	1.2	4.6	0.2	1.3	1.8	39.4	0.2	0.04	0.004	5.3
R3	Homestead	26.7	1.5	4.5	0.3	1.6	2.3	50.4	0.5	0.05	0.003	4.9
EPP (Air) objective		**50**	**25**	**20**	**8**	**90**	**120**	**164**	**31**	**286**	**57**	**11,000**

Table 23-11: Predicted ground-level concentrations due to the Project plus ambient background concentrations

Receptor		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		TSP (µg/m³)	Dust deposition (mg/m²/day)	NO_2 (µg/m³)		SO_2 (µg/m³)		CO (µg/m³)
ID	**Description**	**Maximum 24-hour**	**Annual Average**	**Maximum 24-hour**	**Annual Average**	**Annual average**	**Maximum Monthly**	**Maximum 1-hour**	**Annual average**	**Maximum 1-hour**	**Maximum 24-hour**	**Maximum 8-hour**
R1	Esmeralda Homestead	18.8	16.3	6.7	6.2	32.5	40.0	7.0	5.5	2.9	1.7	229.4
R2	Prospect Homestead	42.9	17.5	11.3	6.4	33.8	41.8	45.6	5.7	2.9	1.7	234.5
R3	Homestead	45.4	17.8	11.2	6.5	34.1	42.3	56.6	6.0	3.0	1.7	234.1
EPP (Air) objective		**50**	**25**	**20**	**7**	**90**	**120**	**164**	**31**	**214**	**57**	**11,000**

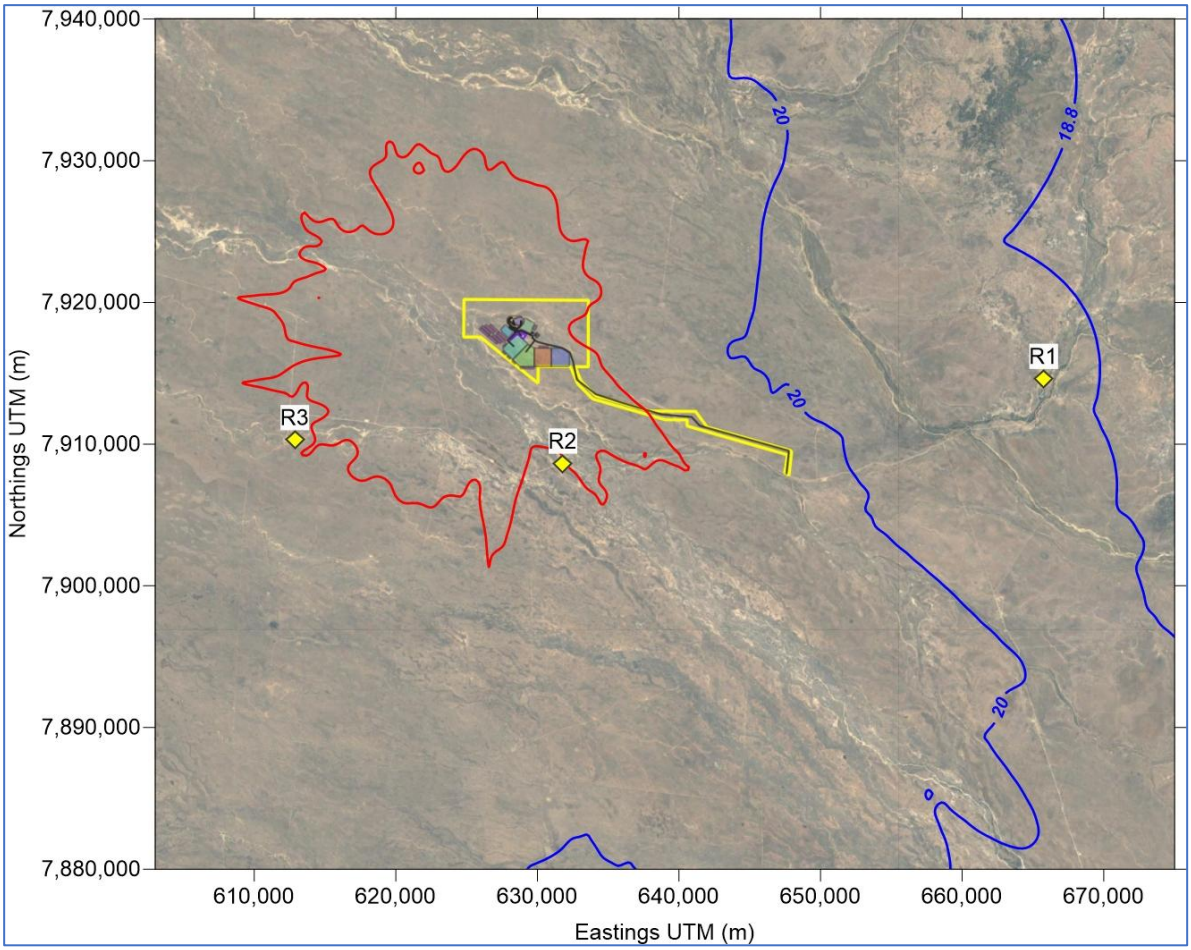


Figure 23-7: Predicted maximum 24-hour average ground-level concentrations of PM10

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	24-hour **Type:** Maximum contour	µg/m^3 **Objective:** 50 µg/m^3

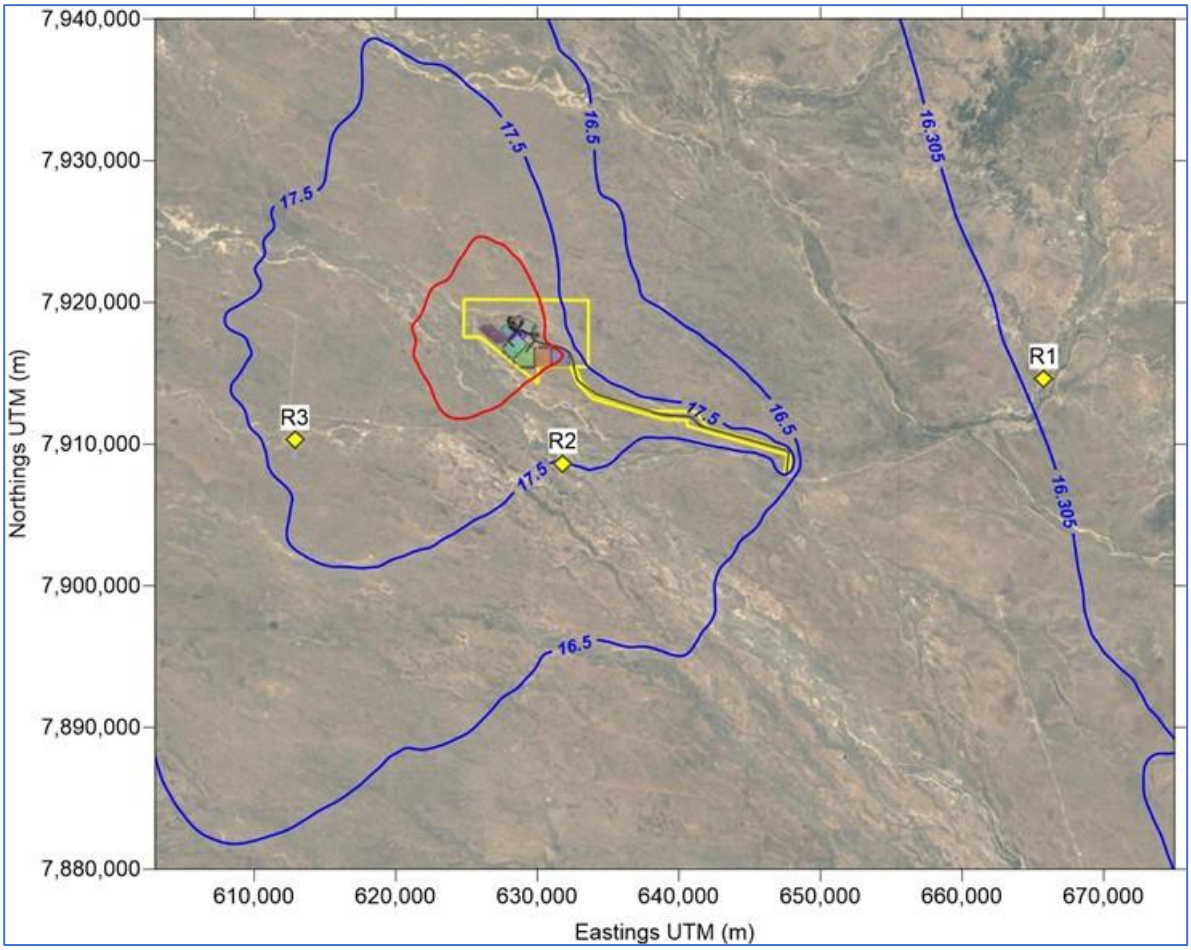


Figure 23-8: Predicted annual average ground-level concentrations of PM10

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	Annual **Type:** Average contour	µg/m^3 **Objective:** 25 µg/m^3

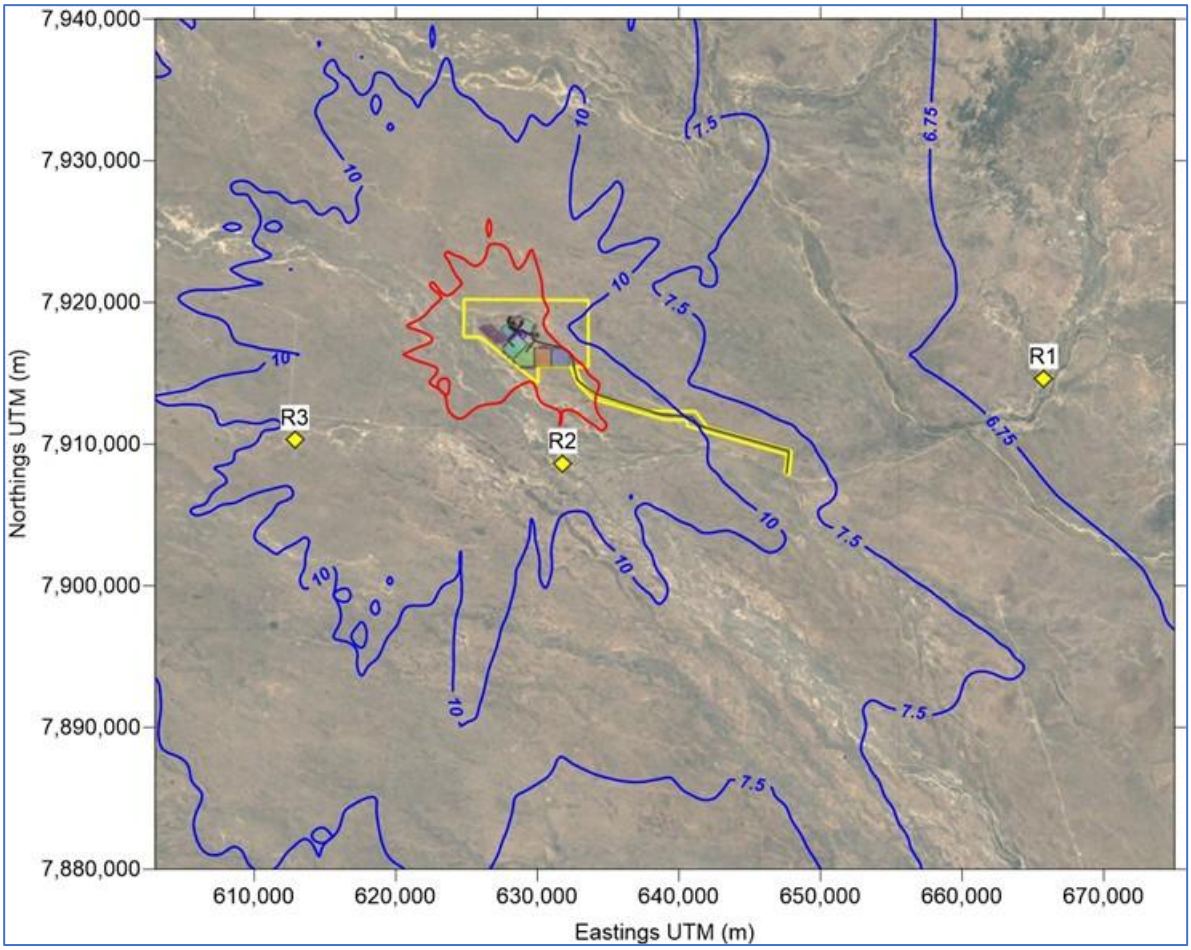


Figure 23-9: Predicted maximum 24-hour average ground-level concentrations of PM2.5

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	24-hour **Type:** Maximum contour	µg/m^3 **Objective:** 20 µg/m^3

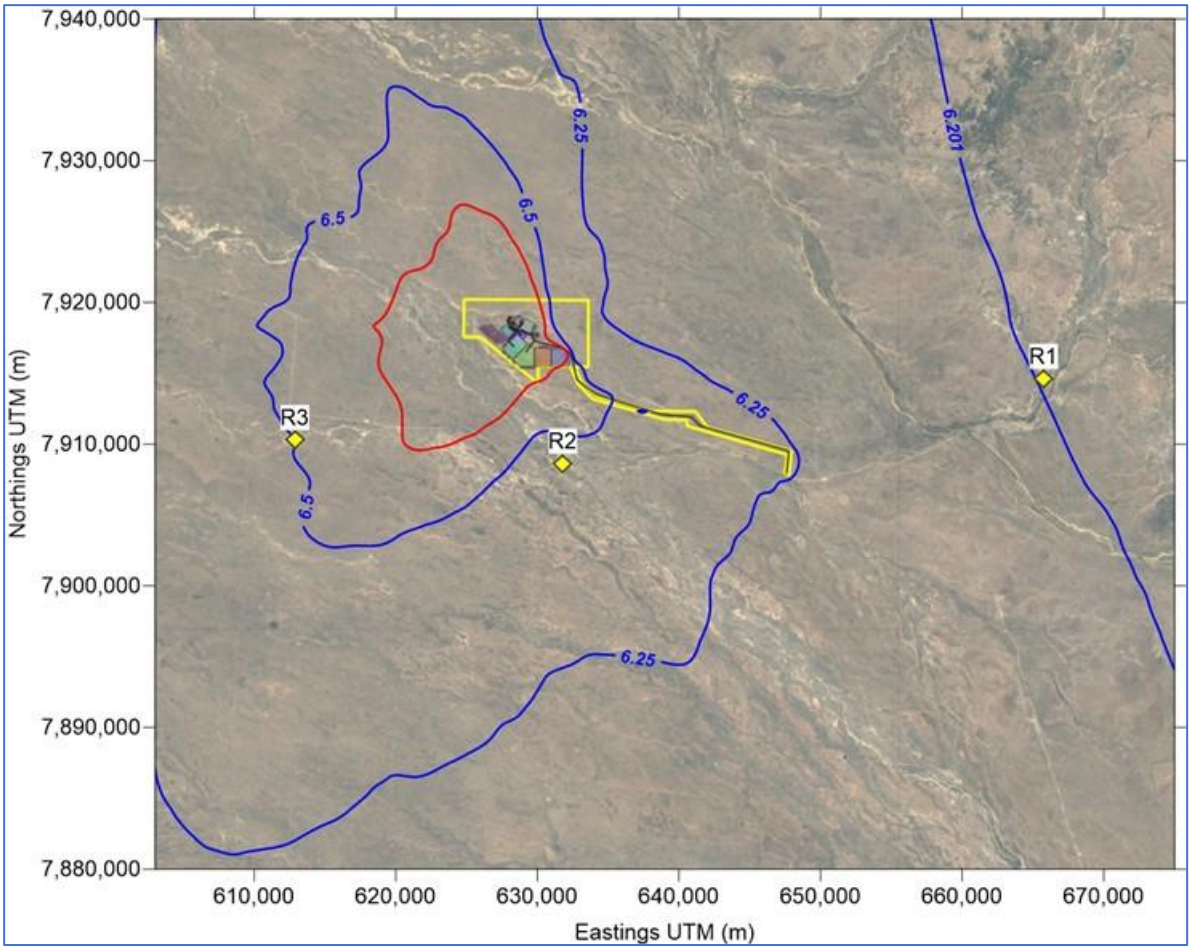


Figure 23-10: Predicted cumulative annual average ground-level concentrations of PM2.5

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	Annual **Type:** Average contour	µg/m^3 **Objective:** 7 µg/m^3

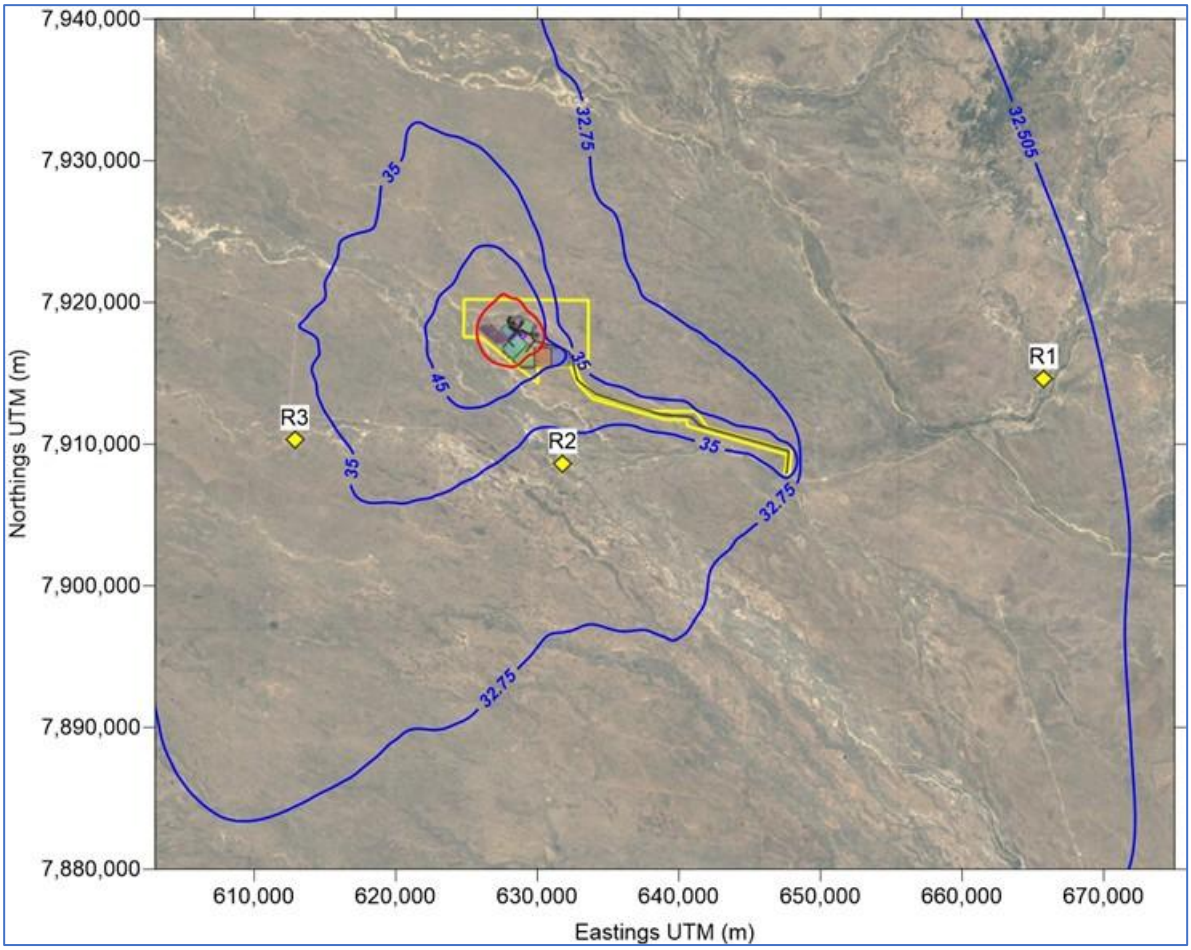


Figure 23-11: Predicted annual average ground-level concentrations of TSP

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	Annual **Type:** Average contour	µg/m^3 **Objective:** 90 µg/m^3

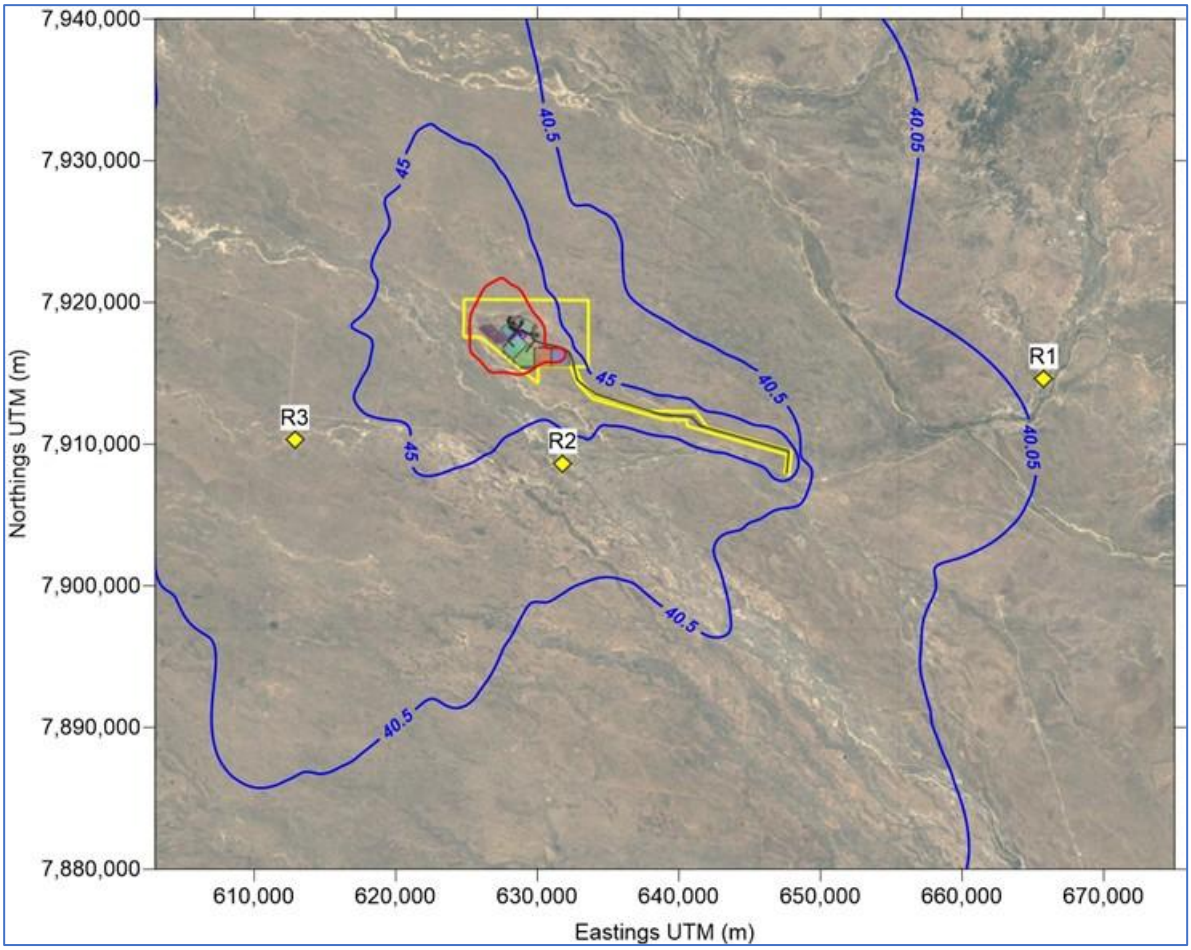


Figure 23-12: Predicted maximum monthly dust deposition rate

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	Monthly **Type:** Maximum contour	mg/m^2/day **Objective:** 120 mg/m^2/day

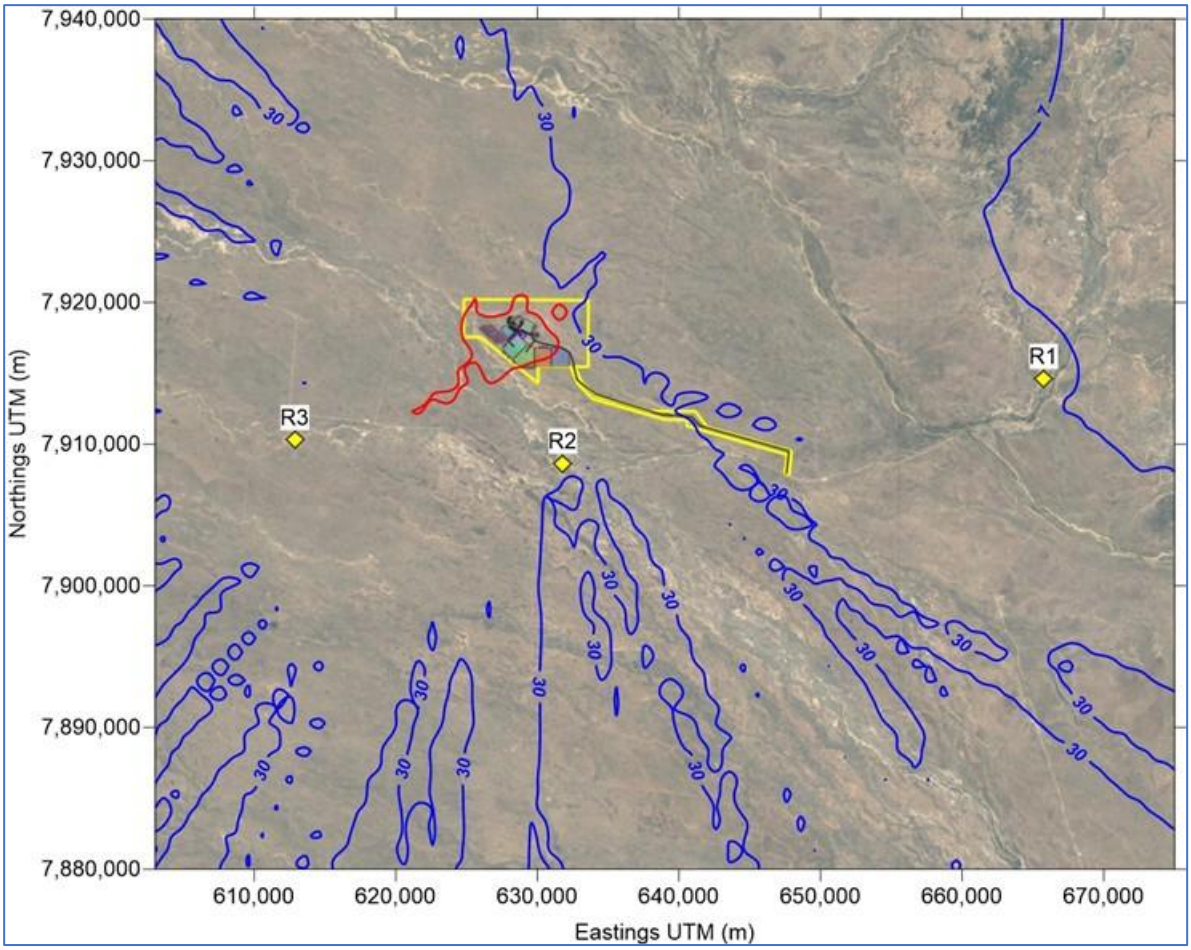


Figure 23-13: Predicted maximum 1-hour average ground-level concentrations of NO2

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	1-hour **Type:** Maximum contour	µg/m^3 **Objective:** 164 µg/m^3

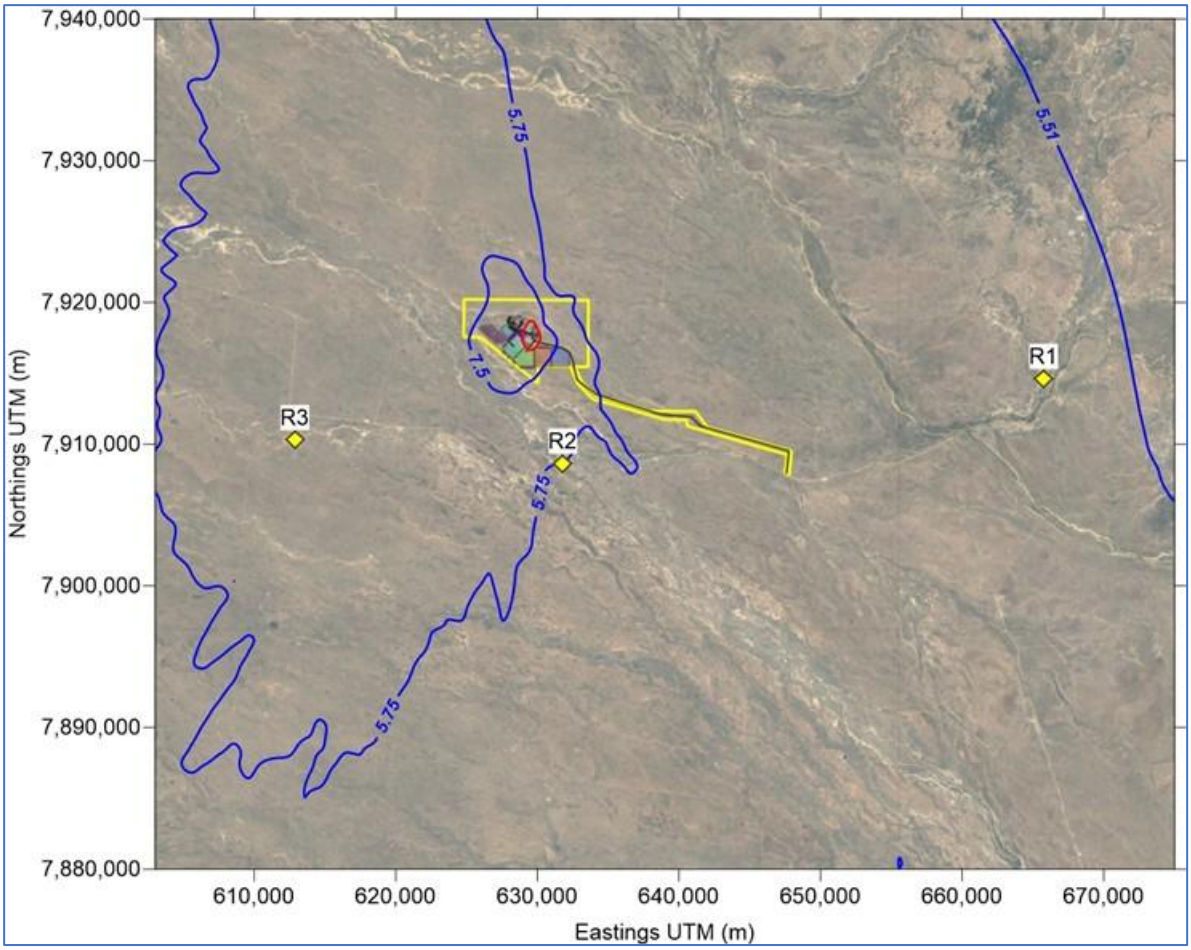


Figure 23-14: Predicted annual average ground-level concentrations of NO2

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	Annual **Type:** Average contour	µg/m^3 **Objective:** 31 µg/m^3

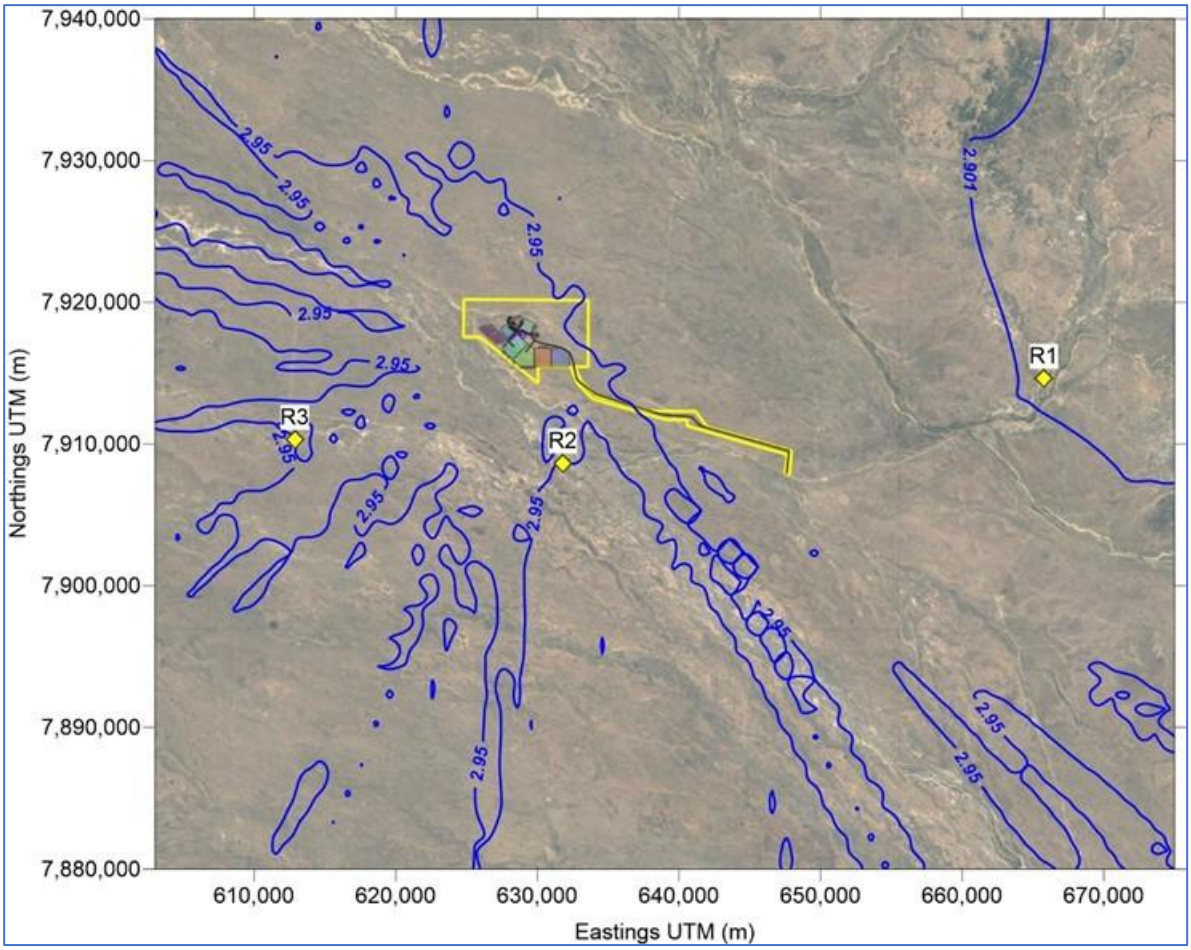


Figure 23-15: Predicted maximum 1-hour average ground-level concentrations of SO2

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	1-hour **Type:** Maximum contour	µg/m^3 **Objective:** 214 µg/m^3

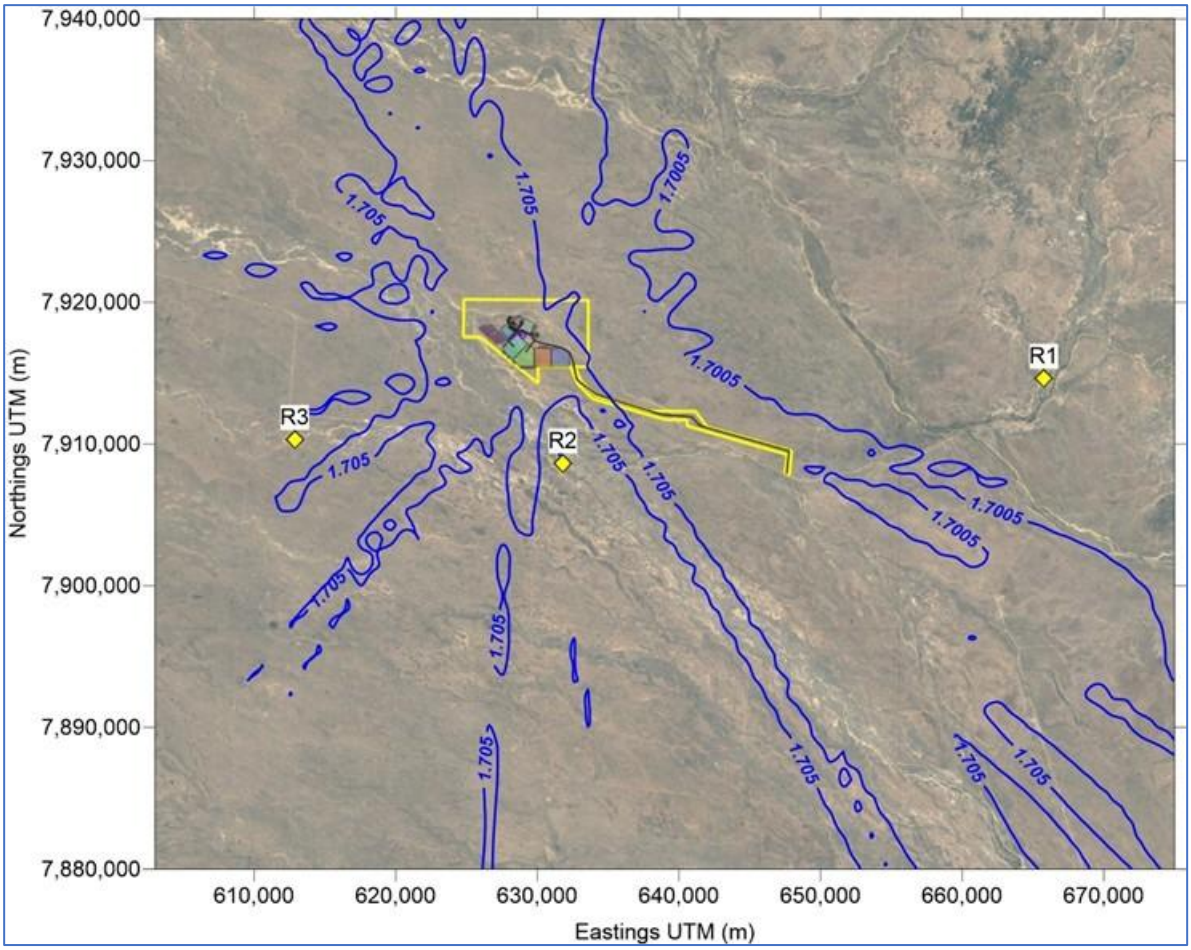


Figure 23-16: Predicted maximum 24-hour average ground-level concentrations of SO2

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	24-hour **Type:** Maximum contour	µg/m^3 **Objective:** 57 µg/m^3

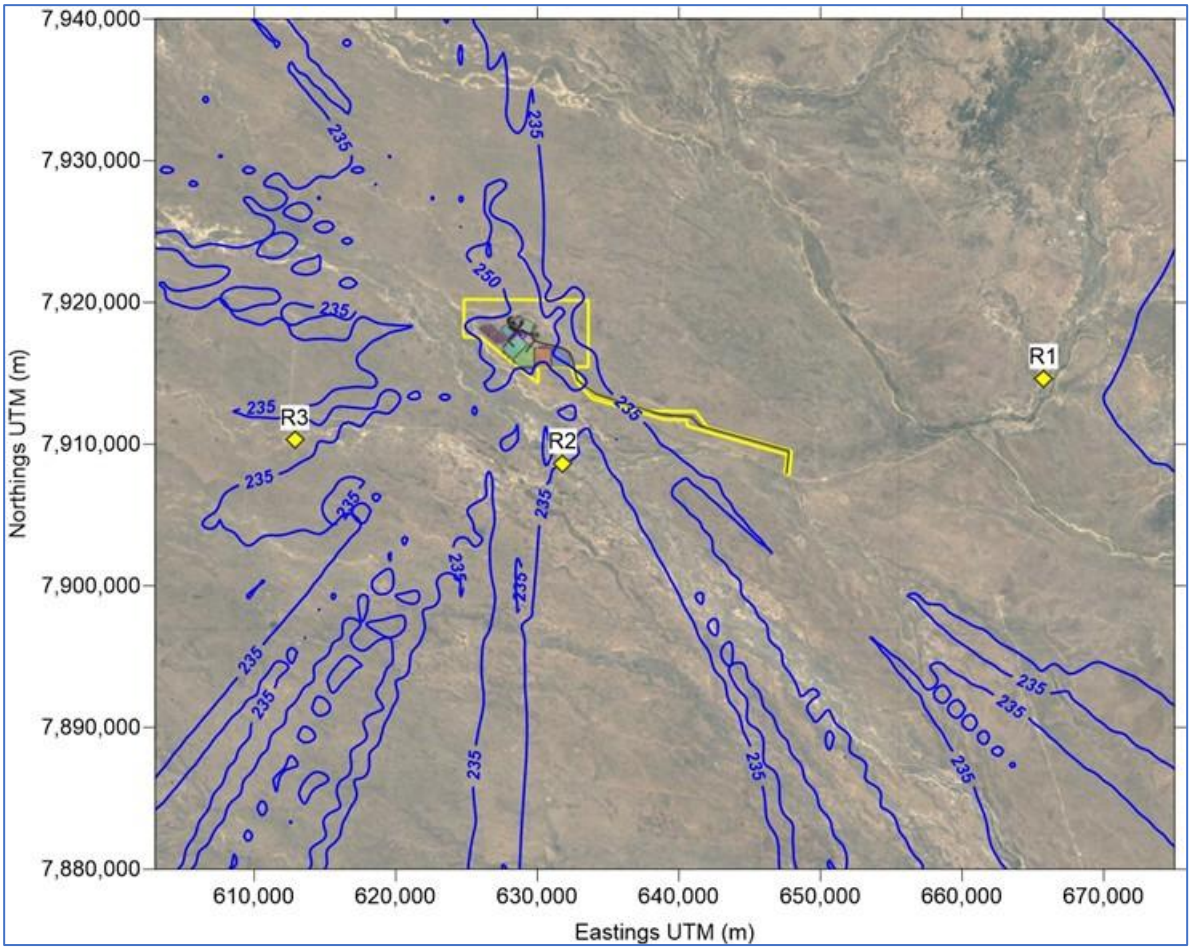


Figure 23-17: Predicted maximum 8-hour average ground-level concentrations of CO

Location:	**Data source:**	**Averaging period:**	**Units:**
Esmeralda, QLD	CALPUFF *Red contour indicates objective limit.	8-hour **Type:** Maximum contour	µg/m^3 **Objective:** 11,000 µg/m^3

23.4.3.2 Flora and fauna

The calculated dust deposition on vegetation is below dust nuisance parameters and therefore is unlikely to result in any significant impact. Impacts such as a reduction in the vegetation growth due to dust deposition are likely to be indiscernible compared to the impacts of other factors, including changes in temperature and water availability. For example, in a dry season, while dust may accumulate on foliage, the leaves would also likely be inactive due to limited water availability, which minimises the impacts of the dust deposition on the vegetation.

As the predominant land use in the surrounding area, grazing cattle are not expected to be impacted by the Project's dust emissions. Studies have shown that cattle are found to not have a preference for feed that is free of coal dust over those that contain the coal dust from a maximum dust deposition rate of 8,000 mg/m^2/day (Andrews & Skriskandaraha 1992). Additionally, cattle that grazed next to an active mine showed similar weight gain compared to those that grazed elsewhere, as stated in the *Pembroke Olive Downs Pty Ltd v Sunland Cattle Co Pty Ltd* (2020) QLC 27. Therefore, it can be expected that the low levels of dust deposition from the Project will also not have a negative impact on grazing cattle.

23.4.3.3 Odour and fumes

Odour may occur during mineral processing. However, emissions are expected to be minor and only detectable in the immediate vicinity of the processing plant. This is due to the relatively mild odours associated with the chemicals used for processing, including Methyl Isobutyl Carbinol (MIBC), and diesel. Due to the distance between the processing plant and the nearest sensitive receptors, the risk of odour impacts at sensitive receptors is unlikely.

Odour from the sewage treatment plant and irrigation area adjacent to the on-site accommodation facility will be managed through treatment, buffer distances, spray control and timing irrigation to avoid sensitive conditions such as wind toward accommodation and utilizing calm nights. Odour impacts are therefore not expected to occur off-site or at any off-lease sensitive receptor.

23.5 Mitigation measures

The air quality assessment has taken into account a range of routine mitigation measures that will be enacted by the Project, including:

- watering used on all ROM, overburden and backfill haulage roads;
- water sprays on ROM feed to the process plant;
- water sprays on transfers within crushing and screening operation;
- vegetation establishment of topsoil stockpiles and waste rock dumps;
- cyclones on drills; and
- cyclone on concentrate flash dryer dust collector in process plant.

Without these measures, impacts associated with particulate and gaseous emissions may exceed air quality objectives.

A dust management plan will be developed prior to Project commencement facilitating routine mitigation measures and potential changes to operations to mitigate dust impacts, including under adverse meteorological conditions.

The plan will include the following:

- overview of the routine operational procedures and mitigation measures enacted to prevent or minimise dust emissions;
- procedures for visual inspection of dust emissions from the Project;

- procedures for reduced operations in the event dust suppression cannot be undertaken (i.e. broken watercart);
- utilisation of publicly available meteorological forecasting tools to inform potential adverse meteorological conditions, such that:
    - blasting and major earthworks are not undertaken during high winds;
- a framework for identifying actual and potential dust impacts based on visual inspection and forecast analysis, and for applying pro-active and reactive mitigation and management measures to address those potential impacts;
- adequate record keeping for any actions taken;
- procedures for investigating and addressing dust complaints or exceedances of air quality objectives; and
- procedures for review and revision of the management plan.

The mitigation and management measures detailed above will reduce the mobilisation and spread of particulate and gaseous emissions from the Project, and the impact on sensitive receptors including homesteads and environmental values.

23.6 TOR Reconciliation table

Terms of reference - Content requirements of the EIS		EIS Section
Section 23 - Air quality		
23.1	The following guidance is relevant for the assessment of air quality: (a) Queensland Government, Air – EIS information guideline, ESR/2020/5294 (b) Queensland Government, Guideline – Application requirements for activities with impacts to air, ESR/2015/1840.	Section 23.2
Air quality - Existing environment		
23.2	Identify and map the location of any sensitive receptors and environmental values of the project footprint and surrounding areas that may be impacted by air emissions from the project.	Section 23.3.3
23.3	Provide baseline data on local and regional meteorology up to the airshed scale. Parameters should include air temperature, wind speed and directions, atmospheric stability, mixing depth and other parameters necessary for input to the model.	Section 23.3.2
23.4	Discuss the existing local and regional airshed and air quality, referencing available data from any site-specific air monitoring, the National Pollutant Inventory reporting, and/or ambient air quality monitoring undertaken by the Queensland Government, including background/ambient levels and sources of particulates, gaseous and odorous compounds, and any major constituent and contaminants. Identify/illustrate any existing significant sources of contaminants.	Section 23.3.4
Air quality - Impact assessment		
23.5	Identify, quantify and describe the air emissions from the project (point, diffuse and fugitive emission sources) in an emissions inventory.	Section 23.4.1 Section 23.4.2.2
23.6	Tabulate the air quality criteria and objectives applicable to the air emissions from the project.	Section 23.2.1
23.7	Detail the potential impacts of air emissions from the project on environmental values and sensitive receptors, including identifying any exceedances of the air quality criteria in accordance with the Environmental Protection (Air) Policy 2019 (EPP (Air)), Air – EIS information guideline, and Application requirements for activities with impacts to air. The potential impacts must include the quantification of human health risk and amenity impacts associated with emissions from the project for all contaminants whether or not they are covered by the National Environmental Protection (Ambient Air Quality) Measure or the EPP (Air).	Section 23.4.3
23.8	Where there is potential for nuisance odours to impact on sensitive receptors, an odour impact assessment should be undertaken in accordance with Guideline – Odour Impact Assessment from Developments.	Section 23.4.1.2 Chapter 17, Waste
23.9	Detail the compatibility of air quality impacts from the project on existing and approved land uses in the project footprint and surrounding area.	Section 23.4.3
23.10	Demonstrate how the project will meet the environmental objectives and performance outcomes relevant to air in Schedule 8 of the EP Regulation.	Section 23.4.3
Air quality - Mitigation measures		
23.11	Describe the mitigation measures that will be applied to the project to:	Section 23.5
	(a) achieve the air quality criteria that has been developed for the project	

Terms of reference - Content requirements of the EIS		EIS Section
	(b) avoid, minimise and/or mitigate adverse air quality impacts to sensitive receptors	
	(c) protect the environmental values of the air environment.	
23.12	Describe the monitoring and auditing processes to achieve the air quality criteria that has been developed for the project.	Section 23.5
23.13	Describe the process for corrective actions to address any exceedance of the air quality criteria.	Section 23.5