Appendix 1.
Fountain Head Gold Project Air Quality and Greenhous Gas Assessment

Fountain Head Gold Project: Air Quality and Greenhouse Gas Assessment

Prepared for:

ERIAS Group Pty Ltd

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Final

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Glossary

Term	Definition
$\mu g/m^3$	micrograms per cubic metre
µm	microns
°C	degrees Celsius
km	kilometre
km/h	kilometre per hour
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
MJ/m^2	megajoules per square metre
tpa	tonnes per annum
Nomenclature	**Definition**
CH_4	Methane
CN	Cyanide
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
HFCs	hydro fluorocarbons
IPCC	Intergovernmental Panel on Climate Change
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
PFCs	per fluorocarbons
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
SF_6	sulfur hexafluoride
SO_2	sulfur dioxide
CH_4	methane
Abbreviations	**Definition**
Air NEPM	*National Environment Protection (Ambient Air Quality) Measure*
BGP	Bonaparte Gas Pipeline
BoM	Bureau of Meteorology
CIL	Carbon in leach facility
ERF	Emissions Reduction Fund
EF	Emission factor
EIS	Environmental Impact Statement
GHG	Greenhouse gases
GWP	Global warming potential
LULUCF	Land use, land use change and forestry
NEPC	National Environment Protection Council
NGER	National Greenhouse and Energy Reporting
NT EPA	Northern Territory Environment Protection Authority
NPI	National Pollutant Inventory database
PWC	Power and Water Corporation
ROM	Run of mine
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

Katestone Environmental Pty Ltd (Katestone) was commissioned by ERIAS Group Pty Ltd (ERIAS) to complete an Air Quality Assessment and Greenhouse Gas (GHG) Assessment of the Fountain Head Gold Project (the Project). The Project is located in the Northern Territory approximately 130 km southeast of Darwin.

The Project involves expansion and open-cut gold mining of the Fountain Head pit and construction and operation of a carbon in leach (CIL) gold processing plant and other related infrastructure. Approximately 2.7 million tonnes of ore is expected to be mined and processed in the CIL and the Project over approximately 4 years after a 10-month construction period.

The most important air pollutant emitted from the Project will be particulate matter (dust), which is generated primarily due to wheel action of haul trucks on unsealed roads during material transport, excavation and material handling. Cyanide is used in the CIL process and may also be emitted to air as hydrogen cyanide.

The Project is located in a relatively remote region, with the nearest sensitive receptor, an isolated rural residence, approximately 5.5km to the east of the Project's operational areas. The meteorological conditions in the region have been inferred from data measured by the nearest monitoring station operated by the Bureau of Meteorology, which is at Douglas River Research Farm, approximately 50km to the southwest. Predominant winds are from the northeast during the wet season, and southwest during the dry season.

A dust emissions inventory was calculated for the Project for the construction stage and Year 3 of operations. Year 3 of operations is expected to be the operational year with the highest dust emissions.

Air quality impacts for the Project have been inferred from an air quality assessment for an approved mining activity that is similar in nature and location to the Project, namely, the Mount Todd gold mine. The air quality assessment prepared in 2013 for the Mount Todd gold mine Environmental Impact Statement included a dispersion modelling study of dust emissions. The results presented in the Mount Todd gold mine study were used to infer likely concentrations of air pollutants due to the Project taking into account the difference in scale of the two projects. The analysis shows that ground-level concentrations of particulate matter and dust deposition rates due to the Project would comply with the relevant air quality criteria at all sensitive receptors, with the exception of annual average $PM_{2.5}$ however that is predominantly due to elevated ambient background concentrations rather than the Project.

Operational management practices will be implemented to ensure ongoing environmental commitments to minimise emissions to air, including:

- Water will be used to suppress dust from haul roads, crushing and material handling, and areas exposed to wind erosion
- The waste rock stockpile will be progressively rehabilitated
- Crushing will occur during the day shift, during which time wind speeds will typically be stronger and dispersion better than overnight.

GHG emissions associated with the Project are associated with the following activities, organised by project phase:

- Construction
  - Diesel generators
  - Machinery/equipment/vehicles
  - Land clearing and land revegetation (also referred to as LULUCF).
- Operations:

- Diesel use:
  - Machinery/equipment/vehicles
  - Explosives (diesel content)
- Diesel power station
- Land clearing and land revegetation.

Grid electricity is not required by the Project, as a result there will be no Scope 2 emissions.

The maximum annual GHG emissions for the Project are influenced by LULUCF. GHG emissions from LULUCF are not currently considered by the NGER scheme but do form part of Australia's national GHG inventory. Maximum annual emissions associated with the Project are:

- 38,383 tCO_2-e including LULUCF
- 34,404 tCO_2-e excluding LULUCF.

The total GHG emissions for the project are comprised of:

- Diesel equipment and vehicles: 33.6%
- Electricity supply: 51.6%
- Explosives: 1.0%
- Land clearing: 13.8%.

Annual energy use and GHG emissions (excluding LULUCF) associated with the Project exceed the NGER scheme energy use and GHG facility thresholds of 25,000 tCO_2-e and 100 TJ from Year 1 thru Year 4. Annual energy use and GHG emissions for the construction period do not meet NGER scheme thresholds. As a result, PNX Metals will have NGER scheme reporting obligations associated with the Project, nominally commencing in Year 1 of the project schedule. NGER Scheme reporting requires energy use and GHG emissions to be estimated on an annual basis in line with the requirements of the NGER Act and its associated regulatory instruments.

The Project will utilise best practice technology in its mining and minerals processing operations to ensure that the energy efficiency and associated GHG emissions are optimised. The GHG management strategy and best practice initiatives for the Project are detailed in Section 4.6 of this report.

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by ERIAS Group Pty Ltd (ERIAS Group) to complete an Air Quality Assessment and Greenhouse Gas Assessment of the Fountain Head Gold Project (the Project). The Project is located approximately 130 km southeast of Darwin.

In 2018, PNX Metals acquired four mineral leases at Fountain Head. During the 2018 field season, exploration drilling was undertaken to identify further gold resources and reserves at the Fountain Head site. PNX Metals is currently undertaking feasibility studies into a new project as a result of these investigations. The new project, the Fountain Head Gold Project, will involve the expansion and mining of the Fountain Head pit, expansion of the existing overburden stockpile, construction of an evaporation dam, construction and operation of a carbon in leach (CIL) processing plant and other related infrastructure.

ERIAS Group has been commissioned to prepare the Project EIS on behalf of PNX Metals. ERIAS Group provided Katestone with a scope of work for the preparation of an air quality and greenhouse gas assessment for the construction, operation and closure of the Project to support the EIS.

The following scope of works has been conducted for the air quality assessment:

- Describe the meteorology in the vicinity of the Project, including parameters that are important for dispersion of dust from mining activities
- Identify and describe neighbouring land-uses and sensitive receptors in conjunction with PNX Metals and ERIAS Group
- Characterise the existing air quality in the vicinity of the Project
- Compile an inventory of dust emissions due to the Project during construction and operations
- Qualitatively assess the likely impact of dust emissions from the Project on air quality in the vicinity by comparison with other similar operations and existing air quality, and including the potential cumulative impacts due to other projects in the area
- Qualitatively assess the potential impact of other emissions to air from the Project
- Identify any air quality constraints associated with the Project
- Identify management practices or mitigation measures to minimise air emissions.

The following scope of works has been conducted for the greenhouse gas assessment:

- Compile an inventory of Scope 1 and Scope 2 greenhouse gas emissions from the Project
- Summarise proposed measures to minimise and manage greenhouse gas emissions
- Outline a program for continual improvement of greenhouse gas emissions and management suitable for inclusion in the site environmental management plan.

2. PROJECT DESCRIPTION

2.1 Location

The Project is located approximately 130 km south-southeast of Darwin (Figure 1). Key features of the Project relevant to air quality emissions are described below.

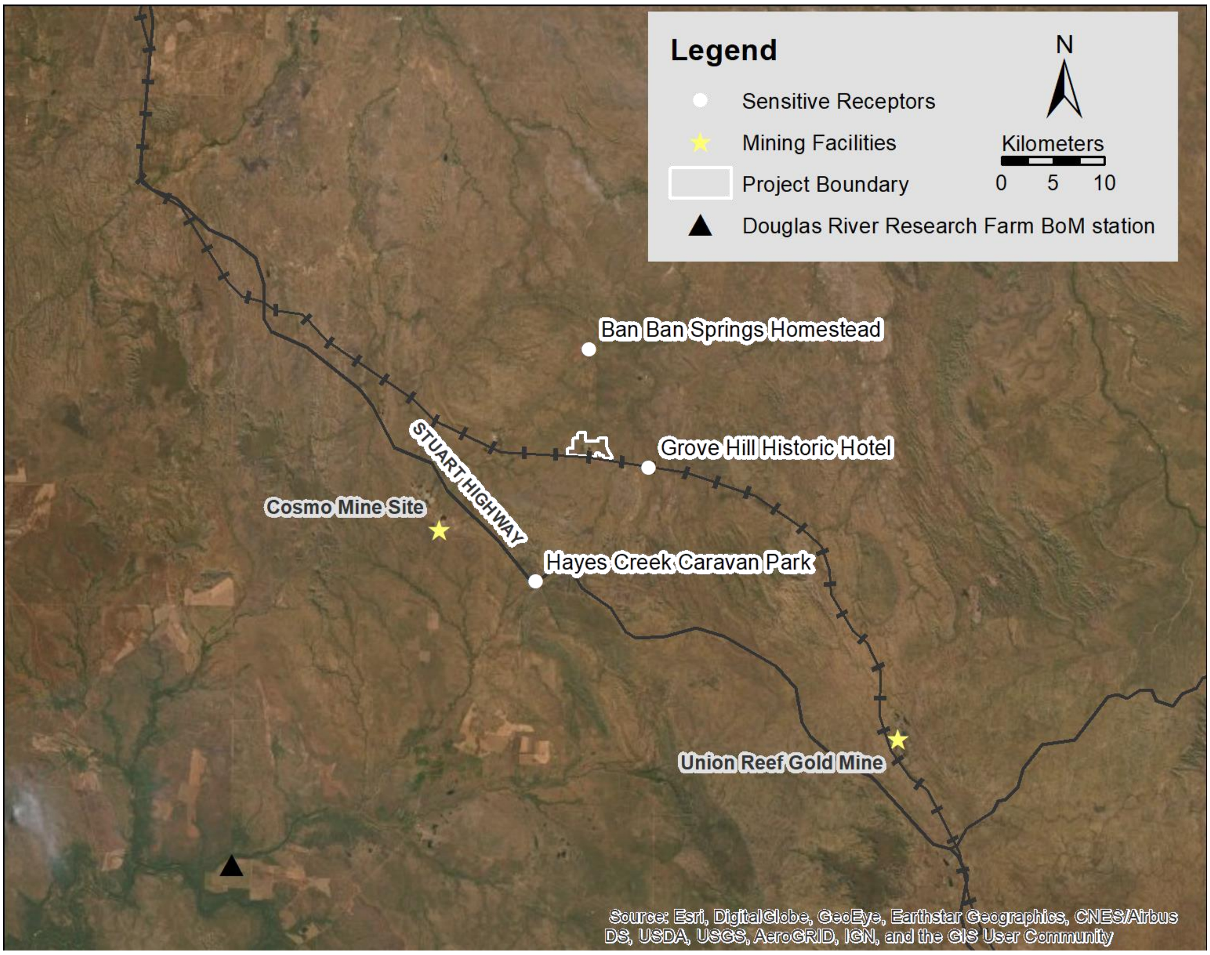

Figure 1 Location of the Project

2.2 Mining activities

The Fountain Head open pit gold mine will use conventional drill & blast techniques with hydraulic excavators and diesel powered off highway trucks. The mining sequence will consist of clearing of any surface topsoil and sub-soils, which will be stockpiled for later use in site rehabilitation. After drilling and blasting, the ore and waste will be excavated. Ore will be hauled to the Run of Mine (ROM) pad for stockpiling, and waste will be hauled to the waste rock stockpile.

The proposed mining involves a cutback of the existing Fountain Head pit with a further extension to the north. The cutback effectively engulfs the entire existing void and deepens the pit by a further 65 metres. The overall site layout is shown in Figure 2.

Subject to receiving the relevant environmental and regulatory approvals it is expected that mining will commence in the 1st quarter of 2022. The operation has been designed to provide approximately 2.7 million tonnes (Mt) to the CIL processing plant, which will be extracted over approximately four years.

The waste rock stockpile will be progressively rehabilitated.

Dewatering

The current Fountain Head void has filled over the past 11 years with ground water inflows and rainfall. There is currently approximately 1.9Mm^3 of water contained in the pit. It is proposed that the volume of water be reduced as much as possible using mine water evaporators with the remaining water being stored in a surface dam for natural evaporation and retention.

Dewatering of the current pit will need to be strictly scheduled and managed so that dewatering is always in advance of mining so that no production delays result.

It is proposed that three (3) large 90kW electrical evaporators are installed in the pit with a separation distance of 50 m between them for the first 12 months of operation. The evaporators will be aimed back over the pit with the unevaporated plume of spray water falling back into the pit lake, thus retaining any heavy metals or precipitates that may result as the water evaporates. Once the evaporation pond has been constructed and prior to mining impacting the evaporators, the evaporators will be moved to the evaporation pond for the duration of the remaining mining activity (approximately two years). PNX Metals has provided an estimate of 42% of the water pumped (37.5l/s per unit) through the evaporators will be evaporated, this was calculated taking into account seasonal evaporation rates. The Evaporators are expected to be operated 24 hours per day 7 days per week and will be shut down if high winds speeds are expected to carry the spray plume outside of the pit or dam areas.

The potential impacts of dewatering are outside the scope of this report.

Ore Processing

The gold bearing ore from the mining operation will be stockpiled on the run-of-mine (ROM) stockpile until it is required to be crushed and screened and stockpiled . Low grade ore will also be stockpiled with the intention of addressing any short-falls in yield, otherwise remaining low grade ore will be processed at the end of mine-life.

The stockpiled ore will be picked up by a front-end loader and crushed through a three-stage mobile crushing circuit, the final product is screened and any oversize material is returned to the crushing and grinding circuits until it is of the required size. The crushed and sized ore is stored in a product stockpile which will hold up to 24-hours worth of mill feed. This mill feed is then fed to the mill feed hopper before being subjected to the CIL process.

As the CN, ore, and activated carbon slurry is mixed in the CIL tanks, CN will complex with gold before being adsorbed to activated carbon in solution. The CIL solution will be dosed with lime to maintain a pH =10. The CIL process recycles carbon and reclaims water to be reused by the process. The tailings will be filter pressed to reduce moisture content to between 10 and 20% and then transported and stored within a dedicated cell within an integrated waste landform (IWL).

Construction works

Construction of the processing plant and associated infrastructure including the evaporation pond is anticipated to take approximately 10 months. In addition, the existing water storage dam will be expanded, and the wall heights raised. Material required for the wall construction are expected to be excavated from the existing waste dump and within the dam footprint. Haul roads and laydown areas will be developed, utilising some of the material in the existing waste rock dump that is encroaching on the mining area.

Power

It is proposed that power requirements will be provided by an on-site diesel fired power station. Electricity demand for the site will be approximately 30 MWh/yr with the power station expected to comprise of three 1.5 MW units equating to 3.9 MW of total peak power, fuelled by 7,500 kL/yr of diesel during operations.

The emission of greenhouse gases from power generation has been quantified. Emissions of other air pollutants from power generation have not been quantified as they are not expected to be significant given the scale of the project and proximity of sensitive receptors. Notwithstanding this, the power generating units should be selected and/or designed to minimise emissions and increase dispersion, for instance, by:

- Selection of units complying with best practice Australian emission limits.
- Ensuring vertical release of exhaust gases.
- Considering stack height, as a higher release point will enhance dispersion.

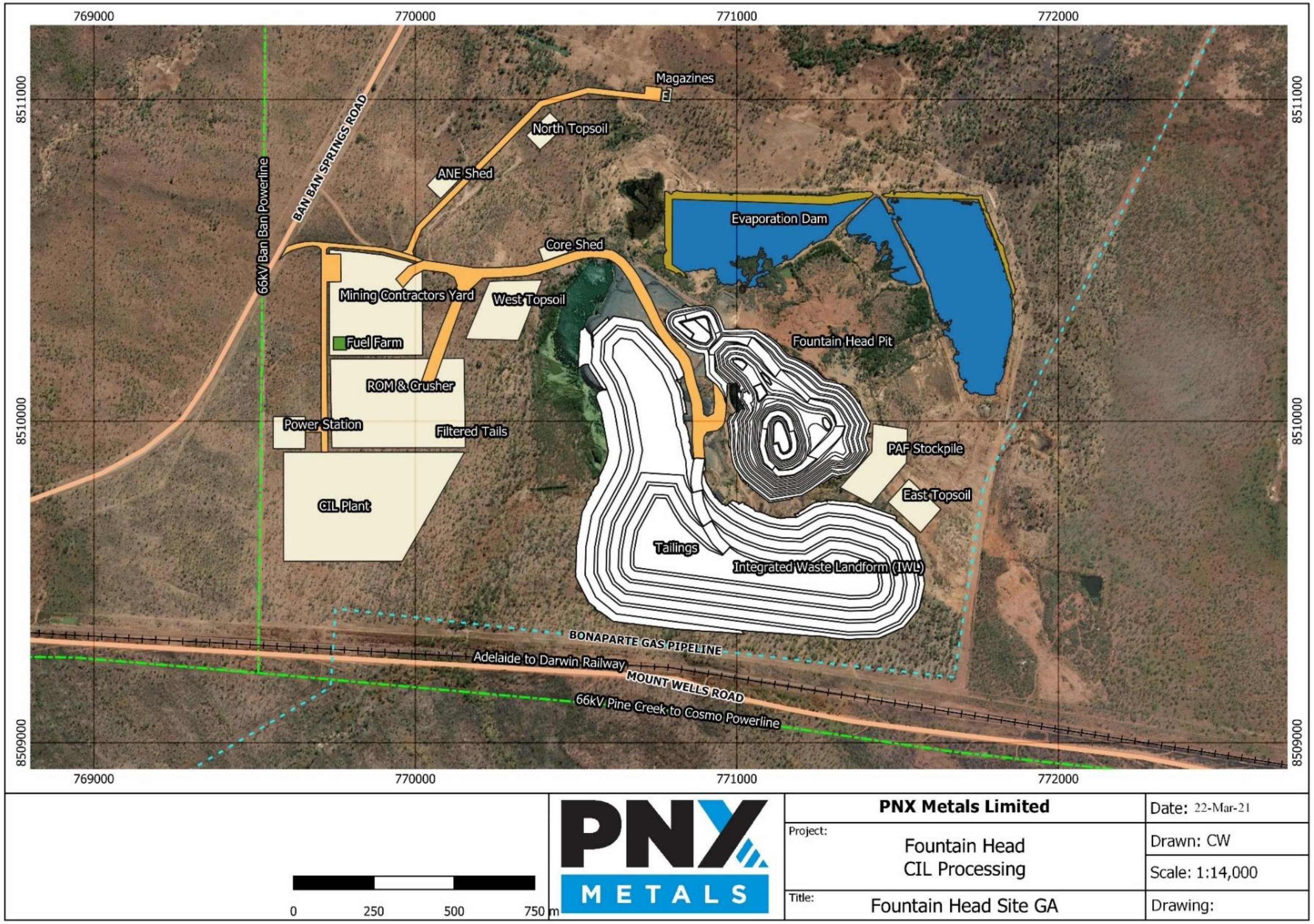

Figure 2 Fountain Head Infrastructure Layout (provided by ERIAS)

3. AIR QUALITY ASSESSMENT

3.1 Legislative framework for air quality

The primarily pollutants emitted by the Project will be particulate matter. The Northern Territory Environment Protection Authority (NT EPA) has not enacted legislation that specifies air quality standards or criteria relevant to the assessment of new projects. This report has, therefore, nominated air quality standards for the project based on the standards that are used in other Australian jurisdictions.

The key air pollutants that are likely to be emitted from the Project are measured using the common dust metrics: total suspended particles (TSP), PM_{10}, $PM_{2.5}$ and dust deposition rate and hydrogen cyanide (HCN).

3.1.1 Commonwealth Government - Ambient Air Quality NEPM

The National Environment Protection Council (NEPC) defines national ambient air quality standards and goals in consultation, and with agreement from all Australian state and territory governments. These were first published in 1998 in the *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM). The Air NEPM contains, amongst other parameters, standards for PM_{10} and $PM_{2.5}$ and was revised most recently in 2019.

With the exception of Victoria, other jurisdictions within Australia have adopted the Air NEPM standards for PM_{10} and $PM_{2.5}$ as assessment criteria for new projects.

The Air NEPM does not specify ambient air quality standards for the other key pollutants likely to be emitted by the Project, namely, TSP, dust deposition, HCN.

3.1.2 NSW and Queensland

The NSW EPA has specified impact assessment criteria for TSP and dust deposition rate in its *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC 2016) (Approved Methods), which are commonly used for environmental assessments in the NT. Similar impact assessment criteria for TSP and dust deposition are used in other Australian state jurisdictions.

3.1.3 Relevant Air Quality Standards

Table 1 presents the air quality standards relevant to this Project, which have been sourced from the Air NEPM standard, and legislation published in other jurisdictions within Australia. Air quality criteria with averaging periods of less than 24-hour hours have not been considered as the qualitative assessment is based on results with these averaging periods.

Table 1 Applicable air quality standards

Pollutant	Averaging period	Air quality criteria/standard	Source
Total Suspended Particulates	1-year	90 µg/m^3	NSW Approved Methods
Particulate matter as PM_{10}	24-hour	50 µg/m^3	Air NEPM
	Annual	25 µg/m^3	Air NEPM
Particulate matter as $PM_{2.5}$	24-hour	25 µg/m^3	Air NEPM
	Annual	8 µg/m^3	Air NEPM
Deposited Dust (incremental) [1]	1-year	2 g/m^2/month	NSW Approved Methods
Hydrogen cyanide	1-year	9 µg/m^3	Protocol for Environmental Management: Mining and Extractive Industries

Table note:

[1] NSW Approved Methods. The incremental guideline applies to the dust deposition rate due the project only.

3.2 Assessment methodology and limitations

The air quality assessment has been conducted by estimating emissions of key pollutants due to the Project, and comparing these to the emission rates and dispersion modelling results for a nearby mining operation to infer the likely impacts of the Project on air quality.

Quantitative assessments of a number of mining operations in Northern Territory and Queensland have been reviewed to identify projects with similar operations and climatic conditions. An air quality assessment of the Mount Todd gold mine (GHD, 2013) has been selected. This is considered to be a suitable reference point for the following reasons:

- Climatic and meteorological conditions are expected to be similar to those in the Project area:
    - The Mount Todd gold mine is located approximately 100km southeast of the Fountain Head Gold Project. Both sites are classified as tropical savanna according the Koppen classification scheme, and are likely experience similar patterns of rainfall and temperature variation throughout the year.
    - The meteorological data used in the Mount Todd gold mine dispersion modelling study illustrates predominant wind directions that are similar to those recorded at Douglas River (presented in Section 3.3.4), namely, wet season winds are predominantly from the northwest, while southeasterlies are predominant during the dry season, and dry season winds that are slightly stronger than those occurring during the wet season.
- Activities generating dust were similar to the Project, i.e. haulage of material, material handling, crushing and screening and wind erosion.
- The similarity in meteorological conditions and types of dust emission sources means that the dispersion of dust emissions from both operations is expected to be similar.

There is some uncertainty associated with this approach, as the spatial distribution of emission sources at the Mount Todd gold mine may differ from the Project, which may impact downwind concentrations of dust.

Dust emissions from the Mount Todd gold mine were calculated in the air quality assessment and the Ausplume model was used (without depletion) to predict ground-level concentrations of dust due to the operation of the mine. The dispersion modelling conducted for the air quality assessment of the Mount Todd gold mine did not account for dust depletion, and so is expected to provide a conservative assessment of ground-level concentrations of particulates.

3.3 Existing environment

3.3.1 Local terrain and land-use

The Project is located at an elevation of approximately 100m in an area of gently undulating terrain with scattered hills.

The Project is located within the Pine Creek goldfields, an area containing numerous gold and other ore deposits and a long history of mining activities. The nearest operating gold mine is located at least 15km from the Project, and the majority of land in the vicinity is used for cattle grazing. Various exploration activities occur in the area.

3.3.2 Sensitive receptors

ERIAS has identified that the nearest sensitive receptor is located approximately 5.5km east of the operational Project areas, on Mt Wells Road (Figure 3), which previously was the Grove Hill Historic Hotel and is now a residence. The Hayes Creek Wayside Inn and Caravan Park which have recently closed for business are located approximately 13km to the south. Whilst these two facilities are not currently operating, they have been considered as sensitive receptors as people still reside there. The Ban Ban Springs homestead is located approximately 9km north of the Project operational areas. No other sensitive receptors were identified within the vicinity of the Project.

Beyond Hayes Creek, the closest townships are Adelaide River and Pine Creek, approximately 50km from the Project area.

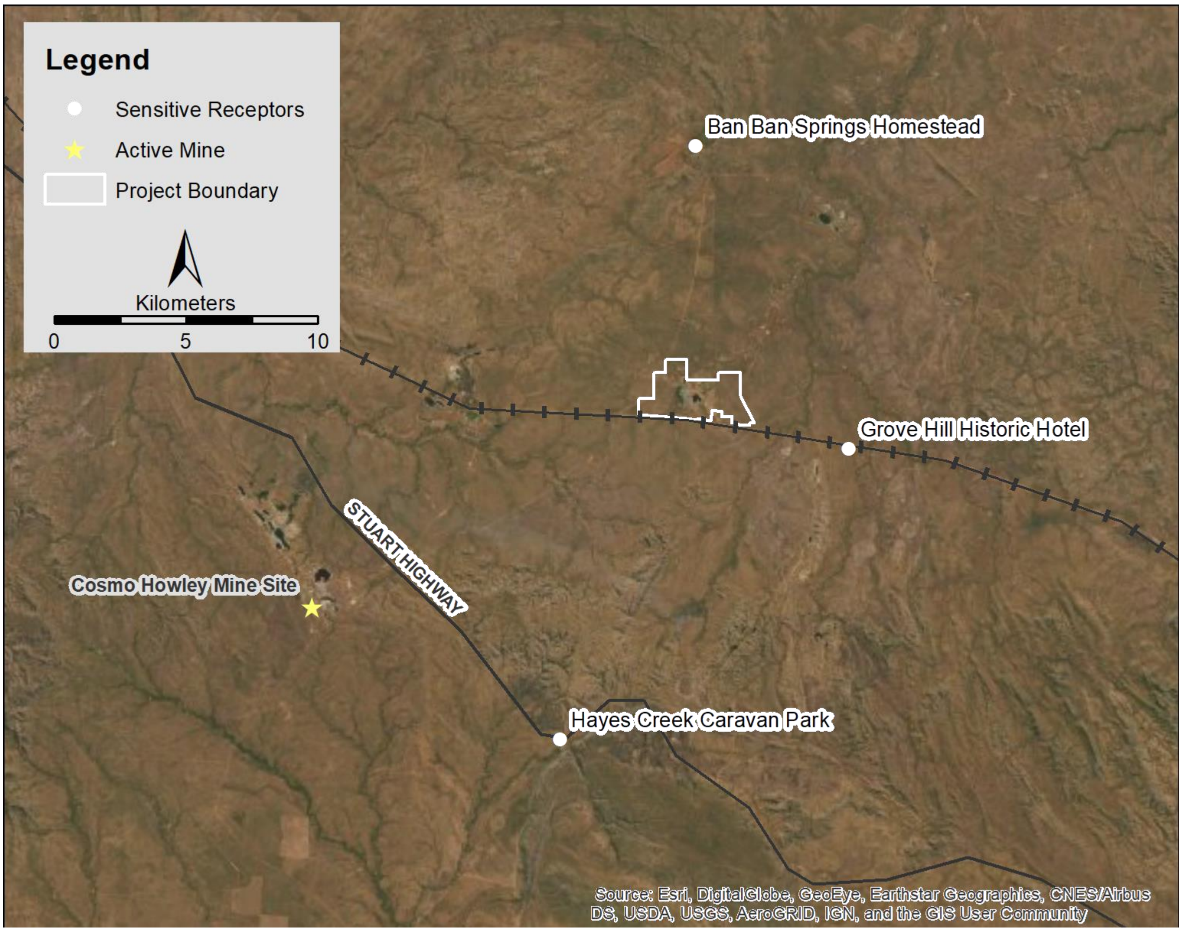

Figure 3 **Nearest sensitive receptors to the Project**

Table 2 **Nearest sensitive receptors to the Project**

Receptor	Easting (km)	Northing (km)	Distance and direction from the Project operational areas
Grove Hill Historic Hotel – Residence	776.984	8508.138	5.5km E
Hayes Creek Wayside Inn and Caravan Park	766.011	8497.090	13km S
Ban Ban Springs homestead	771.170	8519.643	9km N

3.3.3 Existing air quality

3.3.3.1 Existing sources of emissions

A search of the National Pollutant Inventory database identified that the Cosmo Gold Mine is the only facility within 40km of the Project that reported particulate emissions for the 2017/2018 reporting year. Emissions of PM_{10} and $PM_{2.5}$ for the 2017/2018 reporting year were 10,000 kg/year and 6,100 kg/year, respectively.

Operations at the Cosmo Gold Mine recommenced in November 2019 after entering a care and maintenance period in June 2017. Ore from the Cosmo Gold Mine is processed approximately 70km south of the Project, at the Kirkland Lake Gold's Union Reefs processing facility. Kirkland Lake Gold has recently announced that operations at the Cosmo mine and Union Reefs processing facility will cease at the end of March 2020 (ABC, 2020).

Particulate emissions in the area would also occur from natural sources such as wind erosion of exposed ground.

3.3.3.2 Existing ambient air quality

The NT EPA conducts ambient air quality monitoring in the Darwin region to assess air quality on an ongoing basis. These monitoring stations are a significant distance from the Project (130 km). The NT EPA's annual reports to NEPC indicate that Darwin sustains good air quality, with the largest source of PM_{10} being bushfires that occur predominantly during the dry season.

Table 3 and Table 4 present a summary of PM_{10} and $PM_{2.5}$ concentrations measured by the NT EPA over the last four calendar years. The occasional exceedances of the Air NEPM standard are the result of bushfires. At other times, concentrations of PM_{10} comply with the Air NEPM standards. The 75th percentile 24-hour average and annual average concentrations are well below the Air NEPM standards. The annual average $PM_{2.5}$ concentrations at all three sites were higher than the Air NEPM standard during 2018 and 2019.

Table 3 Summary of 24-hour average PM_{10} concentrations measured by NT EPA

Year	Max 24-hour average			75th %tile 24-hour average			Annual average		
	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill
2016	68.9	52.3	NM	18.2	20.6	NM	15.2	16.4	NM
2017	58.8	53.8	48	26	20.9	25	19.5	15.5	19.9
2018	143.1	77.8	64.4	27.1	18.9	30.3	19.9	13.4	22.6
2019	84.5	84.6	95.2	28.3	30.9	27.8	22	23	22.4
Standard	**50 µg/m³**			**50 µg/m³**			**25 µg/m³**		

Table 4 Summary of 24-hour average $PM_{2.5}$ concentrations measured by NT EPA

Year	Max 24-hour average			75th %tile 24-hour average			Annual average		
	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill	Palmerston	Winnellie	Stokes Hill
2016	58.7	40.8	NM	8.7	8.8	NM	7.2	6.5	NM
2017	42.3	40.8	28.5	10.4	10.1	10.6	7.3	6.7	7.3
2018	111.7	57.3	43.6	11.8	12.9	12.3	8.7	9.1	8.3
2019	62.5	49.0	42.8	13.4	12.5	12.6	9.7	9.0	9.2
Standard	**25 µg/m³**			**25 µg/m³**			**8 µg/m³**		

3.3.4 Climate and meteorology

This section presents an analysis of the climate and local meteorology in the Project area. The closest monitoring station operated by the BoM is located at the Douglas River Research Farm (Station number 014901), approximately 50 kilometres southwest of the Project. This monitoring station has been in operation since 1968. Monitoring data from this station has been used to provide a summary of the climate and meteorology near the Project site in the following sections. The summary includes an analysis of the meteorological parameters that are important for the dispersion of air pollutants from the Project site and includes temperature and solar exposure, rainfall, relative humidity, wind speed and wind direction.

The climate of the region is largely dominated by the tropical weather patterns that lead to distinct wet and dry seasons. The wet season occurs in the late spring through summer and into early autumn (November to April) and is characterised by hot humid conditions. The wet season features monsoonal rains and tropical cyclones. The dry season occurs from May through October when days are typically dry and sunny.

3.3.4.1 Temperature and solar exposure

The average monthly distribution of maximum and minimum temperatures measured at Douglas River Research Farm from 1968 to 2019 is illustrated in Figure 4. The seasonal temperature profile is typical of the tropical Northern Territory climate, with relatively warm temperatures year-round. The warmest months are October through to April, while the months of May through to August are slightly cooler. The highest average maximum daily temperature of 37.9°C occurred during October, while the lowest average minimum temperature of 12.9°C occurred during July.

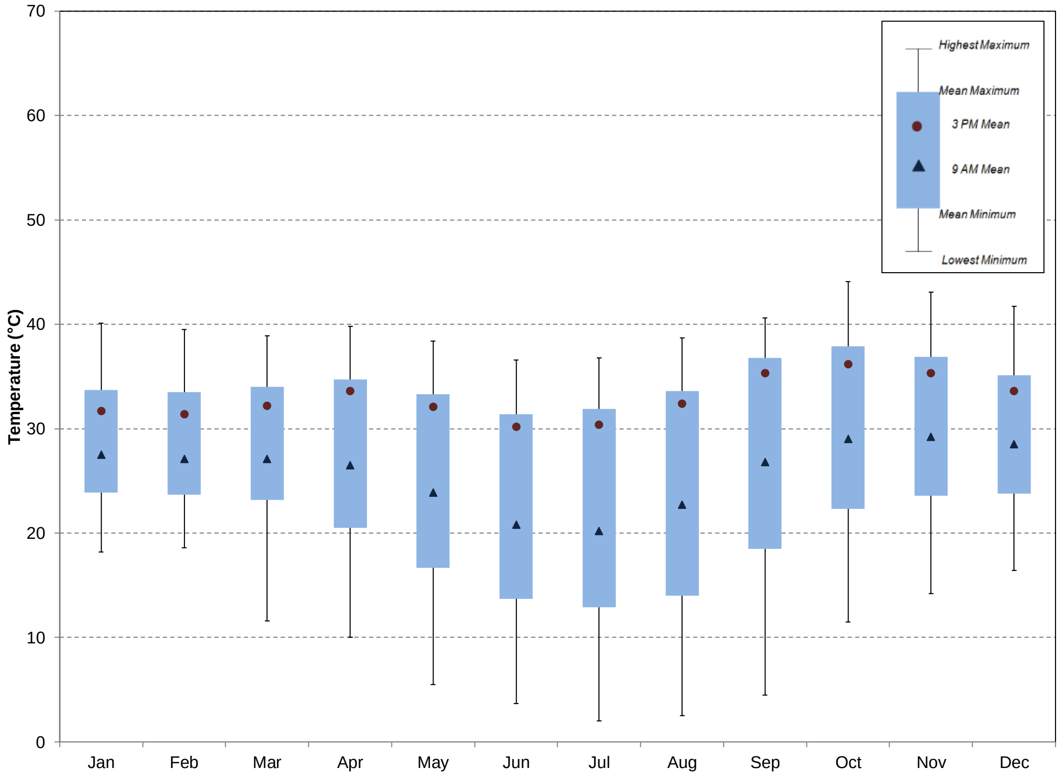

Figure 4 **Range of temperature measured at Douglas River Research Farm BoM station from 1968 to 2019**

The amount of solar radiation at the surface of the Earth is a primary driver for the weather patterns and climatic cycles. Average daily solar exposure, measured in megajoules per square metre (MJ/m²) at BoM's Douglas River Research Farm monitoring station for the 1990 to 2020 period is presented as a time-series chart in Figure 5. The analysis illustrates the typical Northern Territory climate, with similar levels of solar exposure year-round and minimal variation between seasons.

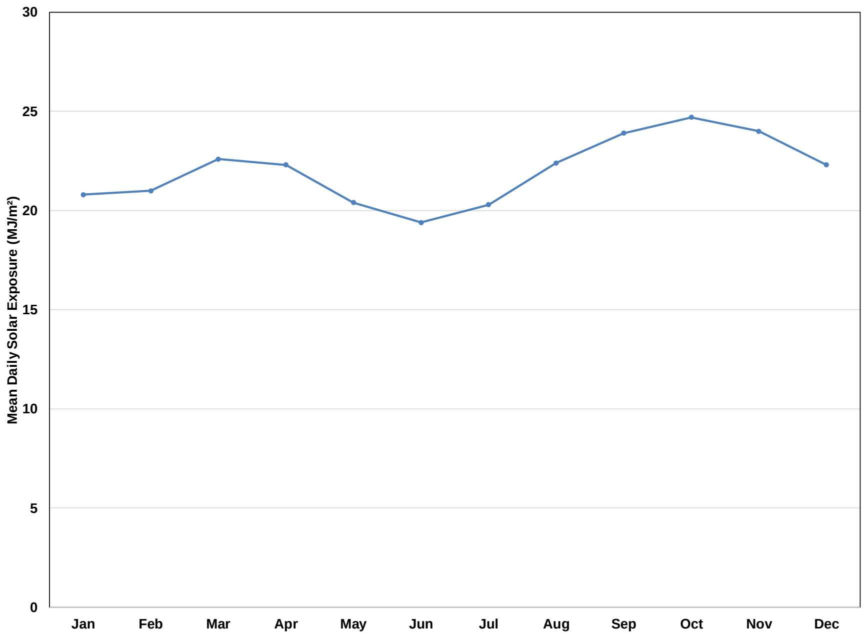

Figure 5 **Mean daily solar exposure (MJ/m²) for Douglas River Research Farm BoM station from 1990 to 2020**

3.3.4.2 Rainfall

The average monthly rainfall for 1968 to 2020 measured at BoM's Douglas River Research Farm monitoring station is illustrated in Figure 6. The annual average rainfall measured at this station is 1,246 mm. The annual pattern illustrates the tropical climate in the region, with 91% of the annual rainfall occurring during November to March. Just 0.5% of the rainfall occurs in the winter months of June to August.

As dust emissions are influenced by rainfall, these data indicate that dust levels are more likely to be moderated between November and March during periods of high rainfall.

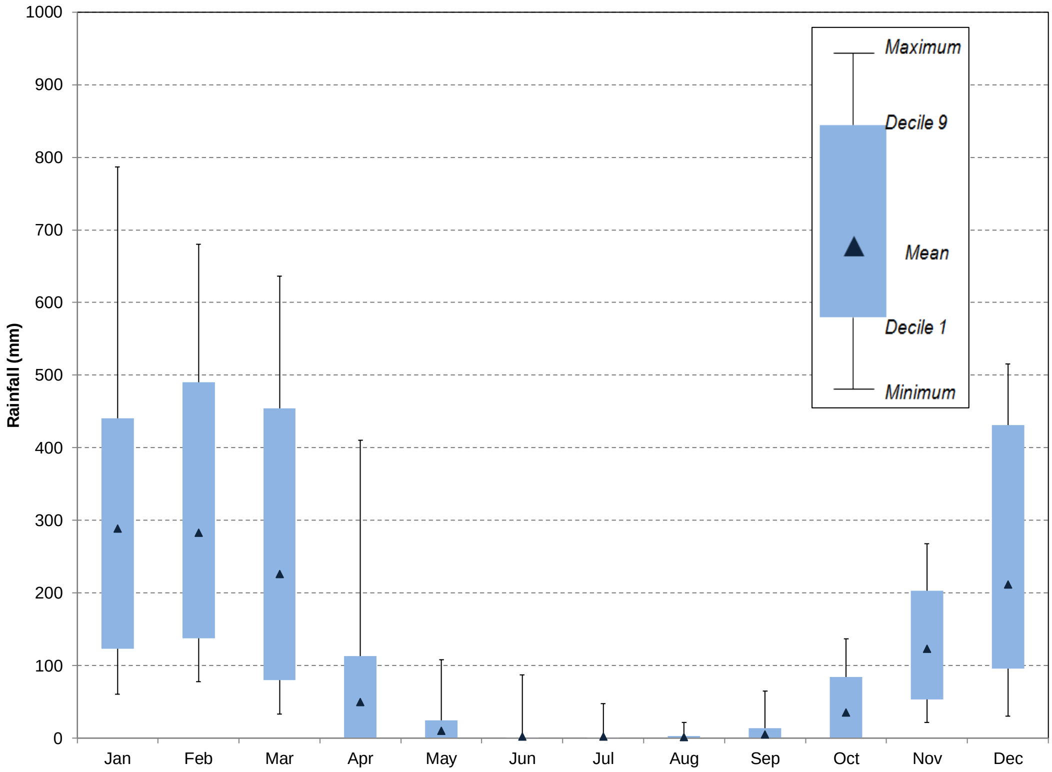

Figure 6 **Average monthly rainfall measured at Douglas River Research Farm BoM station from 1968 to 2020**

3.3.4.3 Relative humidity

The availability of atmospheric moisture is an important factor that influences the climate by affecting the transfer of heat in the atmosphere through the balance between sensible and latent heat fluxes, and the occurrence of precipitation. Relative humidity is one of several measures used to describe the amount of moisture in the atmosphere and is the ratio of the actual amount of moisture in the atmosphere to the amount that could be held, at a given temperature.

Relative humidity has been analysed from long-term averages based on daily measurements collected at 9am and 3pm at BoM's Douglas River Research Farm monitoring station between 1968 and 2010 (Figure 7). Typically, relative humidity at 9am is higher than at 3pm due to the drying effect of the sun as the day progresses.

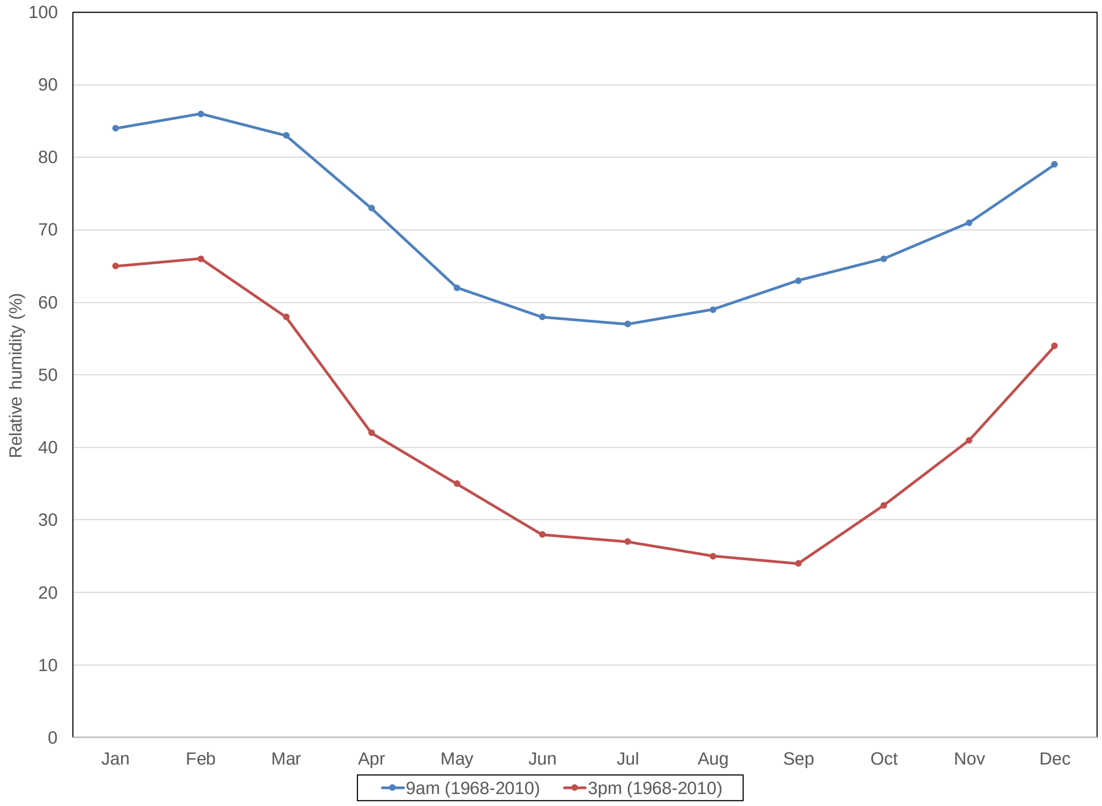

Figure 7 **Monthly averaged 9am and 3pm measurements of relative humidity (%) for Douglas River Research Farm station**

3.3.4.4 Wind speed and wind direction

Wind speed and wind direction are important aspects that can influence the emission rates and dispersion of dust. Exposed dust sources, such as unrehabilitated waste rock stockpile areas, will have higher dust emissions during strong winds than during light winds, whilst activities such as dust generated by vehicle movements on unsealed roads will be dependent on activity rates. During periods of stronger wind speeds greater dilution of dust will occur, which is typically the case during the day. The seasonal and diurnal variability in the wind speed and wind direction at the Project site would result in variation in the concentration of dust in the air due to emissions from the Project, and variations in the areas where dust is transported.

The wind distributions measured at the BoM's Douglas River Research Farm monitoring station during the dry and wet seasons are presented as wind roses in Figure 8 and Figure 9. Two dominant wind directions are evident. During the wet season, winds predominantly occur from the northwest. During the dry season, winds predominantly occur from the southeast. Wind directions during the dry season would result in dispersion of dust away from the nearest sensitive receptor the majority of the time.

The diurnal distribution of winds (Figure 10) illustrates that the northwest sector winds dominate during the night, while the winds from the southeast sector dominate during the day (particularly during the afternoon period). The strongest winds are those from the southeast sector, during the day.

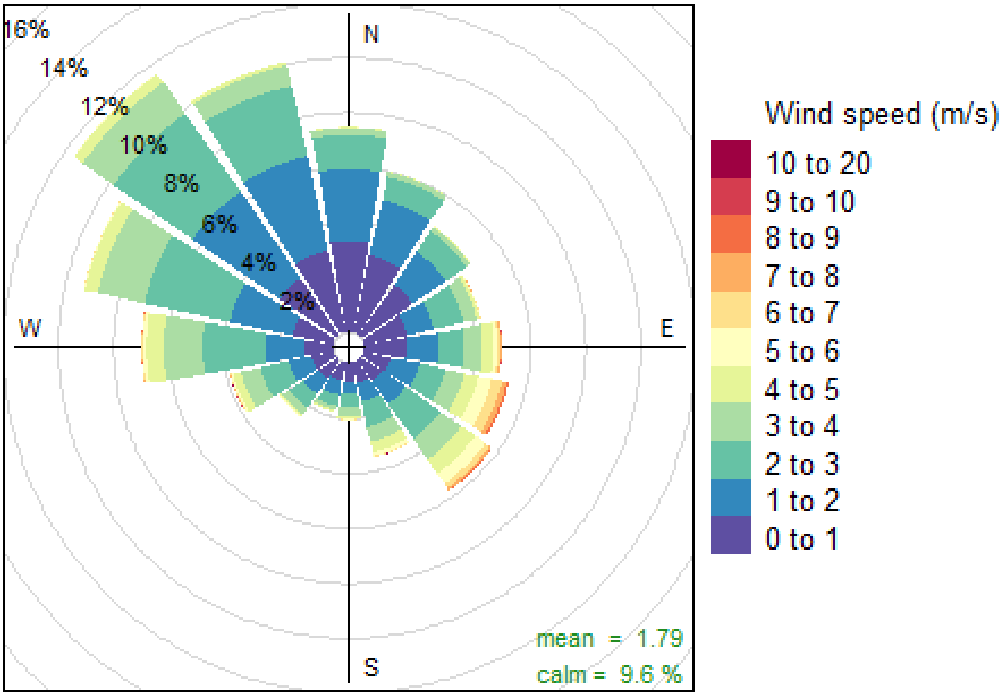

Figure 8 **Distribution of winds measured at BoM Douglas River Research Farm during the wet season (2015 to 2019)**

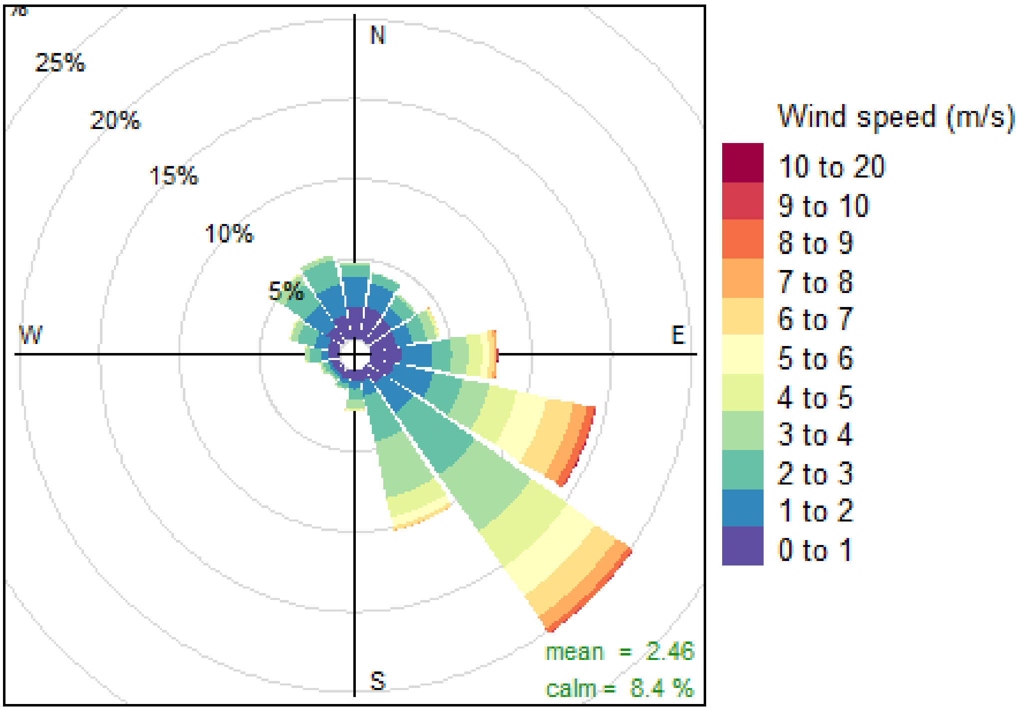

Figure 9 **Distribution of winds measured at BoM Douglas River Research Farm during the dry season (2015 to 2019)**

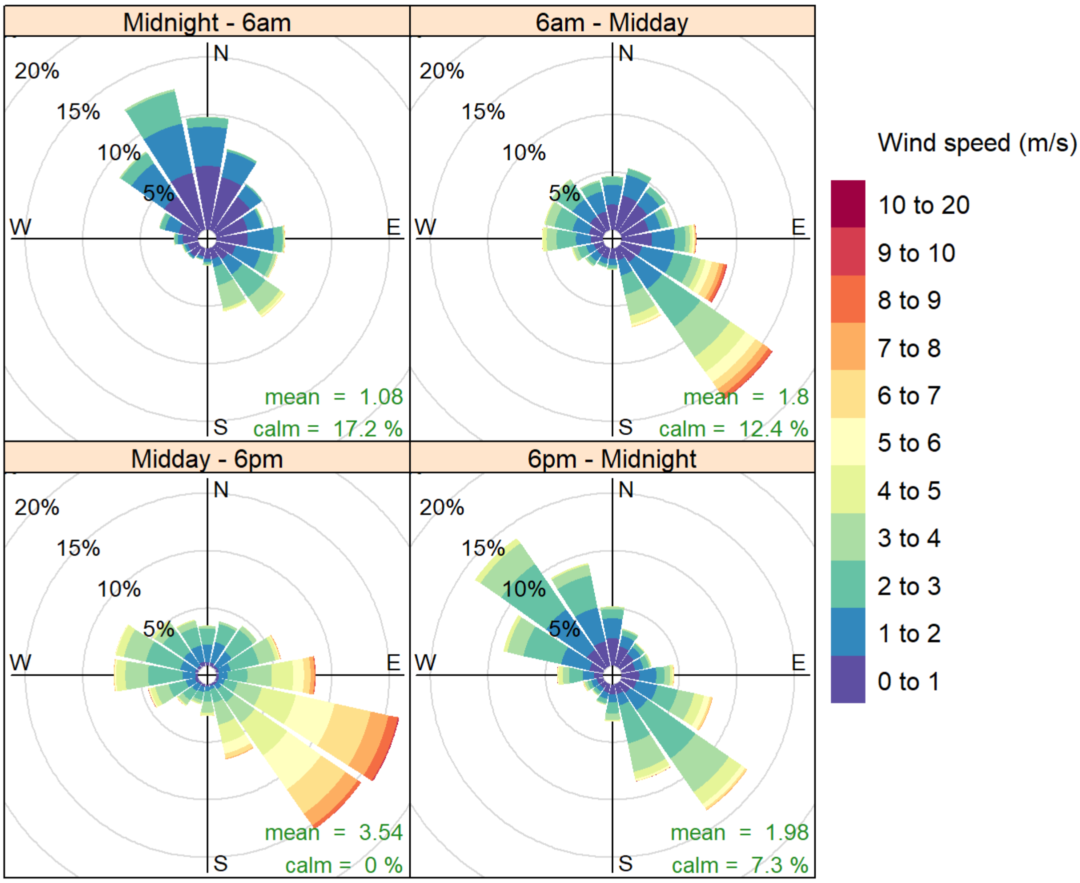

Figure 10 **Diurnal distribution of winds measured at BoM Douglas River Research Farm (2015 to 2019)**

3.4 Emissions to the atmosphere

3.4.1 Construction

Table 5 presents the dust emission rates calculated for the construction period. It has been assumed that diligent watering or chemical stabilisation, where water is not an appropriate technique, would be applied to haul routes during construction, , and that water carts would continuously operate to mitigate dust emissions from operational areas. These measures have been accounted for in the emissions inventory presented in Table 5. The most significant sources of dust during construction are:

- Wheel generated dust from haulage of material and grading.
- Wind erosion of exposed areas and stockpiles.

Activity data and methodologies used to determine the emissions inventory are provided in Appendix A.

Table 5 Emission rates of dust during construction

Activity	Emission rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Excavation and material transfers	0.24	0.09	0.02
Haulage	0.64	0.18	0.02
Grading	0.71	0.21	0.02
Dozing	0.58	0.11	0.06
Wind erosion	4.19	2.09	0.31
Total	**6.36**	**2.68**	**0.43**

3.4.2 Operations

3.4.2.1 Dust

Emissions of dust have been estimated for one worst-case scenario. Year 3 has been selected as likely to be worst-case in terms of dust emissions as the total amount of ore extracted and handled during Year 3 is the highest of the operational years. The control measures that will be implemented are presented in Table 6. The dust emissions are presented in Table 7 and account for the dust mitigation measures. The most significant sources of dust emissions during operations are:

- Wheel generated dust from haulage
- Ore processing (transfers, screening, crushing and stacking)
- Wind erosion of exposed areas and stockpiles
- Overburden excavation and handling.

Emission rates during operation are higher than during construction.

Activity data and methodologies used to determine the emissions inventory are provided in Appendix A.

Table 6 Dust mitigation measures to be implemented during operations

Measure	Reduction efficiency
Watering or chemical suppressant on haul roads	84% [1]
Watering of topsoil, ore and overburden stockpiles	50% [2]
Water sprays on screening and crushing	50% [2]
Progressive rehabilitation	30% [2]

Table notes:

[1] NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining (Katestone, 2011).

[2] Reduction efficiencies from the NPI for Mining, Table 4 (NPI, 2012)

Table 7 Emission rates of dust during Year 3 of operations

Activity	Emission rate (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Drilling and blasting	1.24	0.65	0.04
Overburden excavation and handling	2.07	0.75	0.15
Dozing	0.29	0.06	0.03
Ore excavation and handling	0.77	0.28	0.06
Haulage	7.79	2.22	0.22
Grading	1.33	0.39	0.04
Ore processing	3.65	1.86	0.22
Wind erosion	3.94	1.97	0.30
Rehabilitation activities	0.29	0.06	0.03
Total	**21.38**	**8.22**	**1.08**

3.4.2.2 Hydrogen cyanide

The use of CN in the CIL process can result in emissions of hydrogen cyanide (HCN) to the air by volatilisation from the CIL and ore processing area, storage and mixing. HCN may also be released to the atmosphere through carbon regeneration and electrowinning.

The NPI Emission Factor Estimation Manual for Gold Ore Processing (NPI, 2006) provides an estimate of 1% for volatilisation of HCN. It also provides an example calculation for a gold processing facility based on a mass balance approach that includes emissions to air from all sources. This example estimated a total loss of 35% of the CN added to the system to the air. It is known that pH will alter volatilisation rates, with volatilisation being enhanced by acidic conditions, however it is unclear how this could be accounted for in the emission rate estimate.

Based on an estimate of 35% total CN added to the system, and the expected usage of 750 tpa of CN (1 kg CN per tonne of ore processed), an emission rate of approximately 8.6g/s of HCN into the air has been estimated.

ERIAS Group has advised that the leaching solution will be dosed with lime to maintain a pH of 10. This practice will minimise volatilisation of HCN.

3.5 Assessment of potential impacts

3.5.1 Summary of Mount Todd results

The air quality assessment for the Mount Todd project presented ground-level concentrations of key dust metrics at sensitive receptors, and as contour plots across the wider area. The nearest receptor (Werenbun Community) in the Mount Todd assessment is located 5.5-6km southeast of dust-generating operational areas of the mine in the scenario assessed. Tabulated results were presented showing predicted ground-level concentrations of pollutants at this receptor. These results are presented in Table 8.

These receptor results have been used to infer the likely magnitude of concentrations of these pollutants due to the Project at the nearest sensitive receptor (the Grove Hill Historic Hotel, which is approximately 5.5km southeast of the operational areas of the Project).

Table 8 Ground-level concentrations due to Mount Todd (extracted from the Mount Todd air quality assessment (GHD, 2013)

Pollutant	Averaging period	Predicted ground-level concentration at Werenbun Community ($\mu g/m^3$)		Air quality criteria/standard ($\mu g/m^3$)
		Project	Project + background	
Total Suspended Particulates	1-year	6.9	48.9	90
Particulate matter as PM_{10}	24-hour	49.7	70.5	50
Particulate matter as $PM_{2.5}$	24-hour	21.6	32.8	25 [4]
	Annual	1.4	12.6	8 [4]
Deposited Dust (incremental)	1-year	0.4 g/m²/month	-	2 g/m²/month [3]

3.5.2 Air quality results for the Project

Table 10 presents a comparison of key operating parameters and total emission rates from both the Mount Todd gold mine and the Project. The Project extraction and processing rates for Year 3 are approximately 6% of those expected at the Mount Todd gold mine. The emission inventories similarly demonstrate that the Project is significantly smaller in scale, with emissions ranging from 3% - 12% of those estimated for the Mount Todd gold mine.

Table 9 Comparison of key parameters from the Mount Todd gold mine with the Project

Parameter	Mount Todd	Fountain Head Gold Project	% of Mount Todd Project
Total material extracted	102 Mtpa	6.4 Mtpa	6.3%
Ore processed	17.8 Mtpa	1.0 Mtpa	6%
TSP emission rate (tonnes/year)	5,469 tonnes/year	668 tonnes/year	12%
PM_{10} emission rate (tonnes/year)	2,569 tonnes/year	256 tonnes/year	10%
$PM_{2.5}$ emission rate (tonnes/year)	1,030 tonnes/year	34 tonnes/year	3%

The estimated ground-level concentrations due to the Project at the Grove Hill Historic Hotel are presented in Table 10.

Table 10 Estimated ground-level concentrations at the Grove Hill Historic Hotel due to the Project

Pollutant	Averaging period	Predicted ground-level concentration at the Grove Hill Historic Hotel ($\mu g/m^3$)		Air quality criteria/standard ($\mu g/m^3$)
		Project	Project + background [1]	
Total Suspended Particulates	1-year	0.8	46.8	90 [3]
Particulate matter as PM_{10}	24-hour	4.9	35.8	50 [4]
	Annual	0.3 [2]	23.3	25 [4]
Particulate matter as $PM_{2.5}$	24-hour	0.7	14.1	25 [4]
	Annual	0.05	9.8	8 [4]
Deposited Dust (incremental)	1-year	0.05 g/m^2/month	-	2 g/m^2/month [3]
Hydrogen cyanide	1-year	0.34 [5]	-	9 [6]

Table note:

[1] Background concentrations have been determined as the highest 75th percentile or annual average measurement from the monitoring data presented in Section 3.3.3.2, and the background for TSP has been taken to be twice the annual average PM_{10} background concentration

[2] Calculated from the estimated annual average $PM_{2.5}$ concentration using the $PM_{2.5}/PM_{10}$ ratio of emission rates from the Project

[3] NSW Approved Methods

[4] Air NEPM

[5] Calculated from the estimated annual average TSP concentration and the HCN/TSP ratio of emission rates from the Project

[6] Protocol for Environmental Management: Mining and Extractive Industries

The assessment shows:

- Ground-level concentrations of all key pollutants, with the exception of annual average $PM_{2.5}$, are expected to comply with the relevant air quality criteria at the nearest receptor. This is primarily due to elevated background levels, which exceed the air quality criteria, and the contribution of the Project to ground-level concentrations of $PM_{2.5}$ is minimal (0.5% of the total concentration).
- Ground-level concentrations of hydrogen cyanide are estimated to be below the air quality criteria at the nearest sensitive receptors.
- Ground-level concentrations of all pollutants at all other sensitive receptors, which are located significantly further from the Project, are also expected to comply with the relevant air quality criteria.
- Dust emissions during construction are significantly lower than those estimated for operations and, therefore, would be unlikely to result in adverse impacts on air quality at any sensitive receptors in the region.

3.6 Assessment of cumulative impacts

The closest industrial operations with the potential for emissions of dust in the vicinity of the Project is the Cosmo Gold Mine, approximately 15km southwest and Union Reefs processing facility 40km southeast of the Project. However, operations at the Cosmo mine and Union Reefs processing facility will cease at the end of March 2020 (ABC, 2020). Due to the closure of the Cosmo mine, cumulative impacts with the Project will not occur.

There are no other known currently operating or approved to operate projects in the vicinity that would contribute to cumulative impacts with the Project. The assessment of potential ground-level concentrations of dust presented above includes an estimate of ambient background levels of dust, which represents the contribution of anthropogenic and natural sources of dust across the wider region.

3.7 Mitigation and Management

3.7.1 Construction

The following mitigation and management measures will be adopted to minimise emissions from the Project during construction:

- Water will be used to suppress dust from the following locations and processes:
  - Wind erosion from stockpiles
  - Wheel generated dust from vehicle movements (or chemical suppressants could be applied).

3.7.2 Operations

The following mitigation and management measures will be adopted to minimise emissions from the Project during operations:

- Water will be used to suppress dust from the following locations and processes:
  - Crushing.
  - Active mining areas.
  - Wheel generated dust from vehicle movements (or chemical suppressants could be applied).
  - Wind erosion from topsoil stockpiles. It is expected that watering will encourage a crust to form, minimising wind erosion, and encouraging the growth of vegetation.
  - Crusher hoppers, transfer chutes and drops.
- The waste rock stockpile will be progressively rehabilitated.

In addition, the majority of crushing activities will occur during day shift, which will result in greater dispersion of dust emissions compared with crushing occurring overnight when dispersion conditions are poorer. The majority of blast holes are expected to be wet due to the high water table in the region. These features will also contribute to minimising dust emissions.

Where possible, these measures have been incorporated into the emissions inventory for the project, as shown in Table 6.

3.8 Air Quality Conclusions

The most important air pollutant emitted from the Project will be particulate matter (dust), generated primarily due to wheel action on the ground during all material transport on-site, and excavation and handling of these materials. Emissions of hydrogen cyanide are also possible due to the use of cyanide in the CIL process.

The Project is located in a relatively remote region, with the nearest sensitive receptor, an isolated rural residence, approximately 5.5km to the east of the Project's operational areas. The meteorological conditions in the region have been inferred from data measured by the Douglas River Research Farm monitoring station operated by the Bureau of Meteorology. Predominant winds are from the northwest during the wet season, and southeast during the dry season. This would result in the nearest sensitive receptor being upwind of the mine during most of the dry season.

A dust emissions inventory was calculated for the Project for the construction stage and Year 3 of operations. Year 3 of operations is expected to be the operational year with the highest dust emissions.

Air quality impacts for the Project have been inferred from an air quality assessment for an approved mining activity that is similar in nature and location to the Project, namely, the Mount Todd gold mine. The air quality assessment prepared in 2013 for the Mount Todd gold mine Environmental Impact Statement included a dispersion modelling study of dust emissions. The results presented in the Mount Todd gold mine study were used to infer likely concentrations of air pollutants due to the Project taking into account the difference in scale of the two projects. The analysis shows that ground-level concentrations of particulate matter and dust deposition rates due to the Project would comply with the relevant air quality criteria at all sensitive receptors, with the exception of annual average $PM_{2.5}$ however that is predominantly due to elevated ambient background concentrations rather than the Project.

Ground-level concentrations of hydrogen cyanide are also expected to be low and below relevant air quality criteria.

Operational management practices will be implemented to ensure ongoing environmental commitments to minimise emissions to air, including:

- Water will be used to suppress dust from haul roads, crushing and material handling, and areas exposed to wind erosion
- The waste rock stockpile will be progressively rehabilitated
- Crushing will predominantly occur during the day shift, during which time wind speeds will typically be stronger and dispersion better than overnight.

4. GREENHOUSE GAS ASSESSMENT

This section outlines the greenhouse gas policy background and regulatory framework, assessment approach, methodology for the greenhouse gas (GHG) assessment associated with the Project.

4.1 Background

Australia is a signatory to United Nations Framework Convention on Climate Change (UNFCCC), the associated Kyoto Protocol, signaling 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 per cent below 2005 levels by 2030, building on the 2020 target of reducing emissions by five per cent below 2000 levels. The objectives of the Paris Agreement include: a goal to limit the increase in global temperatures to well below 2 degrees and pursue efforts to limit the rise to 1.5 degrees; a commitment to achieve net-zero emissions, globally, by the second half of the century; differentiated expectations for developed nations, including Australia, that they will reduce their emissions sooner than developing nations; and a five year review and ratchet process which is likely to lead to more ambitious commitments from countries in the future.

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 longevity in the atmosphere, however a system named Global Warming Potential (GWP) allows them to be described in terms of CO_2 (the most prevalent greenhouse gas) called carbon dioxide equivalents (CO_2-e). A unit of one tonne of CO_2-e is the basic unit used in carbon accounting. In simple terms the greenhouse gas emissions associated with the Proposal can be expressed as the sum of the emission rate of each greenhouse gas multiplied by its associated GWP (denoted in boxes). For example :

$$\text{tonnes } CO_2\text{-e} = \text{tonnes } CO_2 \times \boxed{1} + \text{tonnes } CH_4 \times \boxed{25} + \text{tonnes } N_2O \times \boxed{298}$$

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 upper 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 Proposal can be assessed and understood.

4.2 Legislative framework for greenhouse gas assessment

4.2.1 National Direct Action Plan

Australia proposes to meet its GHG emissions reduction targets through the Government's Direct Action Plan. The Emissions Reduction Fund (ERF) is a central component of the Direct Action policies. The ERF is made up of a fund to purchase emissions reductions, a mechanism to allocate Australia carbon credit units (ACCUs) , and a Safeguard Mechanism.

The Safeguard Mechanism has been put in place to ensure that emissions 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 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 not anticipated to exceed 100,000 tCO_2-e per year for any year of operations. As a result, the Project will not 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 NGER Act is administered by the Clean Energy Regulator with details of the scheme and allowable calculation methodologies contained in the:

- *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulation); and
- *National Greenhouse and Energy Reporting Determination 2008* (NGER Determination).

The *NGER Regulation* 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.

Registration and reporting is mandatory for corporations that have energy production, energy use or GHG emissions that exceed specified thresholds. The GHG emission thresholds include Scope 1 and Scope 2 emissions. Current NGER reporting thresholds are summarised in Table 11.

Table 11 NGER reporting thresholds - energy and GHG

Threshold level	Threshold type		
	GHG ($ktCO_2$-e)	Energy consumption (TJ)	Energy production (TJ)
Facility	25	100	100
Corporate	50	200	200

4.2.3 Northern Territory context

The NT Government released a draft climate change response for comments in late 2019 – Climate Change Response: Towards 2050. Based on this document the NT Government is aligned with the achievement of net zero emissions by 2050 and is depending on solar energy to underpin its progress in GHG emission reductions.

4.3 Assessment methodology

GHG emissions associated with the Project are predominantly associated with mining and ore processing activities. Land clearing and land rehabilitation are also considered. Scope 1 emissions will result from the combustion of fuel for mining equipment, explosives and electricity generation.

This study will assess the emissions of GHG from the Project during construction and operations based on activity data representative of the proposed activities and the methods described in the following resources:

- The National Greenhouse Accounts, July 2019 (Commonwealth Department of the Environment and Energy, 2017)
- *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulations)
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (NGER Determination)
- FullCAM – Full Carbon Accounting Model (used to account for GHG emissions from land clearing) (Commonwealth of Australia, 2020b)

- The Greenhouse Gas Protocol (WRI/WBCSD, 2004).

Greenhouse gases considered for this assessment and their associated global warming potential are summarised in Table 12.

Table 12 Greenhouse gases and their Global Warming Potential (GWP)

Greenhouse Gas	Chemical formula	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
Table notes: Source: NGER Regulations October 2019		

Emissions factors (EF), energy content factors and carbon content factors used for this assessment are summarised in Table 13.

Table 13 Emission factors, energy content factors and carbon content factors summary

Emission source description	Scope	Energy content / Carbon Content	Units	Emission Factor	Units
Diesel	1	38.6	GJ/kL	70.4	kgCO_2-e/GJ
Forest clearing	1	39.79	tC/ha	3.67	tCO_2-e/tC
Sources: NGER Determination (July 2020), FullCAM (2019) – existing vegetation has been approximated as eucalyptus woodland Table notes: GJ/kL = gigajoules per kilolitres. kg CO_2-e/GJ = kilograms of carbon dioxide equivalent per gigajoule. tC/ha = tonnes of carbon per hectare. tCO_2-e/tC = tonnes carbon dioxide equivalent per tonne of carbon. Diesel emission factor for diesel transport has been applied to diesel use for the project to provide a conservative estimate of GHG emissions.					

4.3.1 Land clearing

The establishment of the Project will require the clearing of vegetation to enable planned mining activities to take place. Land clearing will occur during the construction phase of the Project, with progressive rehabilitation taking place during the operations phase. GHG emissions associated with land clearing do not occur instantaneously but rather over a period of years. To account for this to some extent total GHG emissions associated with land clearing for the life of the Project have been averaged across each year of the Project.

GHG emissions associated with land clearing are Scope 1 emissions and have been estimated based on the Full Carbon Accounting Model (FullCAM) developed by the Australian government to support the estimation of carbon stock change on forest systems. The forest type used for the assessment has been selected based on location specific attributes and approximated as the eucalyptus woodland category available in FullCAM.

Regeneration of eucalyptus woodland is gradual and will be realised in the years following the conclusion of the Project, GHG sequestration associated with land rehabilitation has not been included in the assessment due to its delayed impact on GHG emissions associate with the Project. GHG emissions associated with land clearing are not covered by the NGER scheme.

4.4 Existing environment

GHG emissions from PNX Metals controlled operations contribute to Northern Territory and National GHG inventories. However, energy use and GHG emissions from PNX Metals controlled operations do not currently meet the NGER thresholds (Table 11). Consequently, PNX Metals are not currently required to report on their energy use and GHG emissions under the NGER program.

A summary of Northern Territory and Australia's most recently published GHG emissions inventories including GHG emission categories relevant to the Project are provided in Table 14 (Commonwealth of Australia, 2020a).

Table 14 Summary of GHG emissions for Australia and Northern Territory – 2018

Category	Australia	Northern Territory	
	Emissions ($MtCO_2$-e)	Emissions ($MtCO_2$-e)	Contribution to national emissions
Inventory total*	537.4	16.0	3.0%
Notes: *Including Land Use, Land Use Change and Forestry (LULUCF). Source: Australian Greenhouse and Energy Information System (Commonwealth of Australia, 2020a)			

The Project area is naturally vegetated to varying extents and encompasses a mining void, cleared areas and areas of revegetation as a result of previous mining operations. Based on advice from ERIAS Group, vegetated areas have been classified as eucalyptus shrubland for the purposes of estimating GHG emissions associated with land clearing.

4.5 GHG impact assessment

The Project will process approximately 2.7 Mt of ore over a four year period. Construction operations associated with the Project will be completed over the ten months prior to the commencement of mining operations. GHG emissions associated with the Project are associated with the following activities, organised by project phase:

- Construction
  - Diesel generators
  - Machinery/equipment/vehicles
  - Land clearing and land revegetation (also referred to as LULUCF).
- Operations:
  - Diesel use:
    - Machinery/equipment/vehicles
    - Explosives (diesel content)
  - Diesel power station
  - Land clearing and land revegetation.

Grid electricity is not required by the Project, as a result there will be no Scope 2 emissions.

Annual energy use and GHG emissions associated with the Project have been estimated based on information provided by PNX Metals. A summary of annual GHG emission sources and energy requirements associated with the Project are provided in Table 15.

Table 15 Annual summary of GHG emission source and energy requirements

Emissions Sources	Units	Construction	Operations			
		Year 0	Year 1	Year 2	Year 3	Year 4
Diesel Use - Equipment/machinery/ vehicles	kL/yr	2,500	4,988	4,988	4,988	328
Construction diesel use - diesel generators	kL/yr	11	0	0	0	0
Electricity demand	MWh/yr	44	29,959	29,959	29,959	19,674
Diesel power station	kL/yr	0	7,490	7,490	7,490	4,918
Explosives (diesel content)	kL/yr	0	182	177	166	17
Land cleared	ha	109	0	0	0	0
Notes: kL/y – kilolitres per year, MWh/y – megawatt hours per year, , ha – hectares ANFO and emulsion type explosives will be used for blasting operations. A diesel content of 10% has been applied to provide a conservative estimate of GHG emissions associated with the use of explosives.						

Energy use and GHG emissions associated with the Project have been determined based on the GHG emissions sources and energy requirements as defined in Table 15 combined with energy content factors, emissions factors and carbon content factors in Table 13. Annual energy use and GHG emissions associated with the Project are summarised in Table 16 and Table 17, respectively.

Table 16 Annual energy use for the Project in gigajoules (GJ)

Emissions Sources	Construction	Operations			
	Year 0	Year 1	Year 2	Year 3	Year 4
Diesel Use - Equipment/machinery/vehicles	96,500	192,547	192,547	192,547	12,665
Diesel Use - Generators/power station	423	289,106	289,106	289,106	189,851
Explosives (diesel content)	0	7,038	6,836	6,420	655
Annual energy use	96,923	488,691	488,489	488,073	203,171

Table 17 Annual GHG emissions for the Project in tonnes of carbon dioxide equivalent (tCO_2-e)

Emissions Sources		Construction	Operating years			
		Year 0	Year 1	Year 2	Year 3	Year 4
Diesel	Equipment/machinery/vehicles	6,794	13,555	13,555	13,555	892
	Generators / Power Station	30	20,353	20,353	20,353	13,365
	Explosives (diesel content)	-	495	481	452	46
Land clearing*		3,979	3,979	3,979	3,979	3,979
Annual GHG emissions		10,803	38,383	38,369	38,340	18,282
Annual GHG emissions (excl LULUCF)		6,823	34,404	34,390	34,360	14,303
Notes:All GHG emissions associated with the Project are Scope 1 emissions * As detailed in Section 4.3.1, whilst land clearing occurs during the construction period, emissions of GHG occur progressively over subsequent years. Emissions have been distributed equally over each year of the project life						

The maximum annual GHG emissions for the Project are influenced by LULUCF. GHG emissions from LULUCF are not currently considered by the NGER scheme but do form part of Australia's national GHG inventory. Maximum annual emissions associated with the Project are:

- 38,383 tCO_2-e including LULUCF
- 34,404 tCO2-e excluding LULUCF.

Figure 11 provides a visual comparison of the contribution of each GHG emission source to GHG emissions over the life of the Project

As can be seen from Figure 11, the total GHG emissions for the project are comprised of:

- Diesel equipment and vehicles: 33.6%
- Electricity supply: 51.6%
- Explosives: 1.0%
- Land clearing: 13.8%.

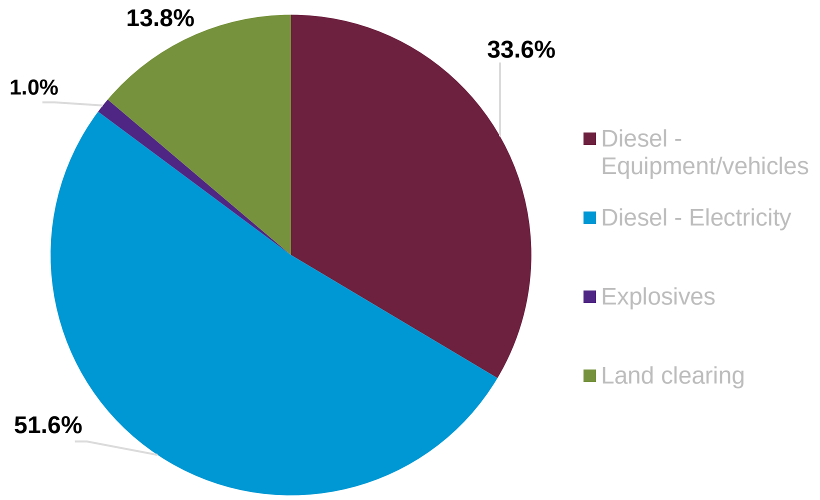

Figure 11 GHG emissions by source contribution (%)

GHG emissions from the Project will contribute to Australia's and the Northern Territory's annual GHG emissions inventories. The maximum annual GHG emissions estimate for the Project of 38,383 tCO_2e (including LULUCF) are not significant on a territory/state or national scale. A summary of the impact of annual GHG emissions from the Project at a territory/state and national scale is provided in Table 18.

Table 18 Project contribution to annual GHG emissions for Australia and Northern Territory – 2018

Inventory Total	Australia		Northern Territory	
	Emissions ($MtCO_2$-e)[1]	Project %	Emissions ($MtCO_2$-e)[1]	Project %
Including LULUCF	537.4	0.01	16.0	0.24
Excluding LULUCF	558.0	0.01	10.5	0.33
Source: Australian Greenhouse and Energy Information System (Commonwealth of Australia, 2020a)				

Annual energy use and GHG emissions (excluding LULUCF) associated with the Project exceed the NGER scheme energy use and GHG facility thresholds of 25,000 tCO_2-e and 100 TJ from Year 1 thru Year 4. Annual energy use and GHG emissions for the construction period do not meet NGER scheme thresholds. As a result, PNX Metals will have NGER scheme reporting obligations associated with the Project, nominally commencing in Year 1 of the project schedule. NGER Scheme reporting requires energy use and GHG emissions to be estimated on an annual basis in line with the requirements of the NGER Act and its associated regulatory instruments.

4.6 GHG mitigation and management

The Project will utilise best practice technology in its mining and minerals processing operations to ensure that the energy efficiency and associated GHG emissions are optimised. There are a range of opportunities that could constitute best practice in energy efficiency and GHG emissions for the Project. The GHG management strategy and best practice initiatives for the Project are described below:

General

- Continuous improvement approach through ongoing monitoring and reporting GHG emissions and identifying opportunities to reduce GHG emissions
- Use of low energy lighting (e.g. LED lighting systems) where practicable.

Diesel

- Reduce mining equipment diesel consumption through equipment selection, load optimisation, route optimisation and production scheduling as well as reduced idle time
- Maintain and operate equipment based on manufacturer/supplier guidelines and recommendation
- Reduce generator diesel consumption through selecting a flexible configuration that allows for electricity output to be adjusted in line with demand.

Electricity

- Production scheduling to energy efficient operations of processing equipment.
- Adjust peak demand through production scheduling to allow for optimal use of electricity.
- Consider alternatives to diesel generated power if practicable.

The use of renewables (solar and wind) have been investigated however PNX Metals has advised that economics are not justified over the short duration of the Project.

PNX will be required to fulfill its obligations under the NGER Scheme. This will include submission of an energy use and greenhouse emissions inventory for each financial year of the project that triggers the thresholds for reporting. It is recommended that PNX review energy use and greenhouse gas emissions on an annual basis to identify further opportunities for optimising energy efficiency and minimising greenhouse gas emissions.

5. REFERENCES

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APPENDIX A EMISSIONS ESTIMATION

A1 ACTIVITY DATA

Table A 1 and Table A2 present the activity data used to estimate dust emissions during construction and Year 3 of operations.

Table A 1 Activity data used to estimate dust emissions during construction

Parameter	Value	Units	Information source
Duration	10	Months	PNX Metals
Topsoil quantity moved	100,000	Tonnes	PNX Metals
Average wind speed	2.2	m/s	BoM monitoring station data from Douglas River Research Farm station
Material for dam construction	280,000	Tonnes	PNX Metals
Material for CIL plant construction	100,000	Tonnes	PNX Metals
Material for road construction	50,000	Tonnes	PNX Metals
Material characteristics			
Overburden/topsoil moisture content	7.9%	%	Mean values for overburden from AP42 Chapter 11.9
Overburden/topsoil silt content	6.9%	%	
Vehicle movements			
777G - Payload	89.4	tonnes	Manufacturer's specifications
777G - Empty weight	75.3	tonnes	Manufacturer's specifications
Trucks for CIL construction - Payload	28	tonnes	Manufacturer's specifications
Trucks for CIL construction - Empty weight	25	tonnes	Manufacturer's specifications
Dozers - number	2	number	PNX Metals
Dozers – operating hours	14	Hours/day	PNX Metals
Graders - number	2	number	PNX Metals
Graders	10	Hours/day	PNX Metals
Graders – average speed	11.8	Km/hour	Assumption

Parameter	Value	Units	Information source
Silt content – unsealed haul routes	8.4	%	Mean value from AP42 Chapter 13.2 for road to/from pit in western surface coal mining
Haul routes			
Hauling for topsoil	700	m	Estimated from site layout provided by PNX Metals
Hauling for dam construction	1200	m	
Hauling for haul construction	1500	m	
Hauling for CIL construction	500	m	
Exposed areas			
Topsoil dump	4	ha	Measured from site layout provided by PNX Metals (Figure A1)
Waste rock stockpile	56	ha	
Other areas (evaporation dam, contractor yard, ROM stockpile area, CIL plant, powerstation)	61	ha	

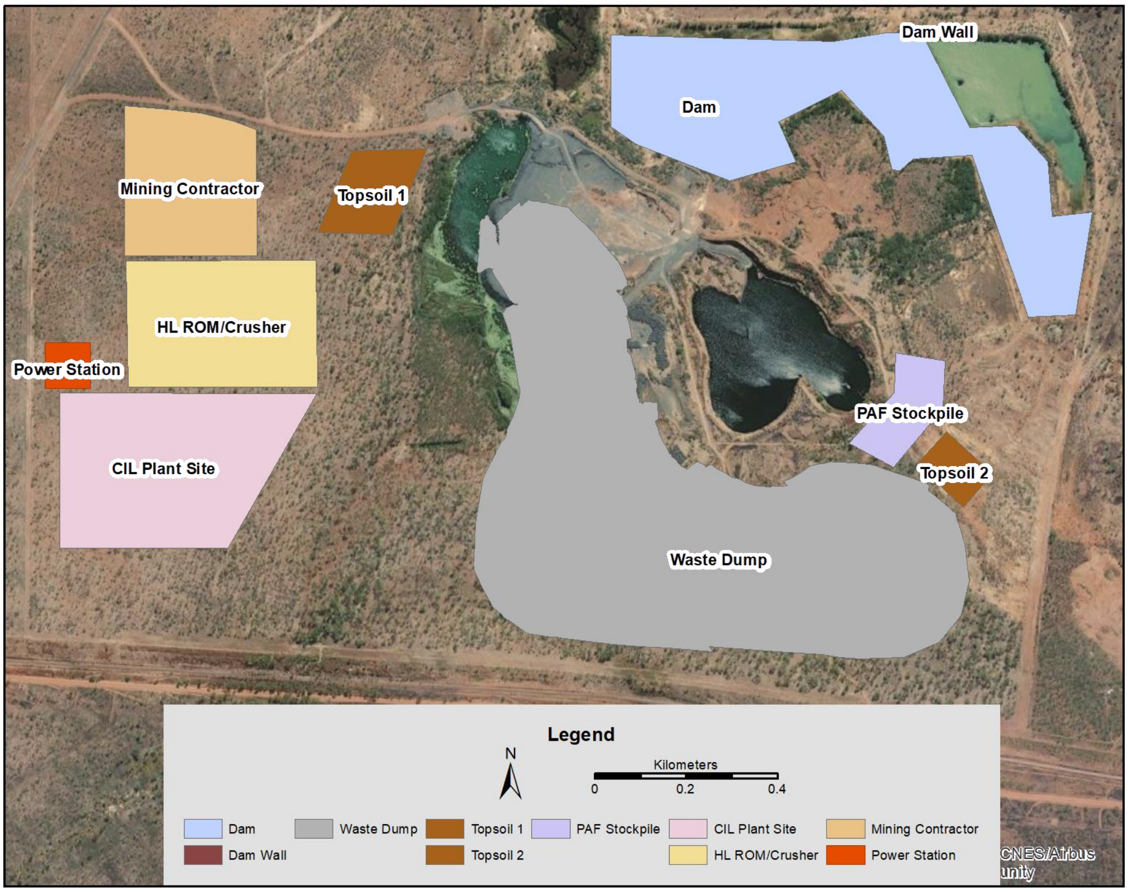

Figure A1 Exposed areas estimated during construction

Table A2 Activity data used to estimate dust emissions during Year 3 of operations

Parameter	Value	Units	Information source
Operating hours	24	Hours/day	PNX Metals
Hours/day – blasting	12	Hours/day	PNX Metals
Hours/day – crushing	12	Hours/day	PNX Metals
Average wind speed	2.2	m/s	BoM monitoring station data from Douglas River Research Farm station
Throughputs			
Overburden	5,373,697	tonnes	PNX Metals
Ore	1,046,750	tonnes	PNX Metals
Material characteristics			
Overburden/topsoil moisture content	7.9%	%	Mean values for overburden from AP42 Chapter 11.9
Overburden/topsoil silt content	6.9%	%	
PAF	25,191	tonnes	Estimated from a total of 75,572 provided by PNX Metals, assumed to be extracted over 3 years
Drilling and blasting			
Blasts per year	65	Blasts/year	PNX Metals
Holes drilled per blast	536	Holes/blast	PNX Metals
Area per blast	7,500	m^2	PNX Metals
Vehicle movements			
777G - Payload	89.4	tonnes	Manufacturer's specifications
777G - Empty weight	75.3	tonnes	Manufacturer's specifications
50t Wet press tailings haul trucks – Payload	50	tonnes	PNX Metals
50t Wet press tailings haul trucks – Empty weight	40	tonnes	Estimated based on comparison with empty weight and payload of a Komatsu truck of similar payload

Parameter	Value	Units	Information source
Dozers - number	2	number	PNX Metals
Dozers – operating hours	14	Hours/day/vehicle	PNX Metals
Graders - number	1	number	PNX Metals
Graders	6	Hours/day	PNX Metals
Graders – average speed	11.8	Km/hour	Assumption (see Section A.27)
Silt content – unsealed haul routes	8.4	%	Mean value from AP42 Chapter 13.2 for road to/from pit in western surface coal mining
Haul routes			
Hauling of overburden	1,200	m	PNX Metals
Haulage of ore	2,200	m	PNX Metals
Hauling for PAF materials	2,100	m	Estimated from aerial imagery and layouts provided by PNX Metals
Hauling for tailings	2,000	m	
Exposed areas			
Active pit	19	ha	PNX Metals
Topsoil dump	4	ha	PNX Metals
Waste rock stockpile	56	ha	PNX Metals
Ore stockpile	12	Ha	PNX Metals
PAF stockpile	3	ha	PNX Metals

A2 EMISSIONS ESTIMATION METHODOLOGIES

A2.1 Drilling

The emission factors for drilling were calculated from the AP42 document, chapter 11.9 "Western Surface Coal Mining" (October 1998). TSP and PM_{10} emission factors are estimated to be 0.59 and 0.31 kg/hole. $PM_{2.5}$ is assumed to be 3% of TSP, based on the ratio of $PM_{2.5}$ to TSP for blasting.

A2.2 Blasting

The emission factors for blasting were calculated from the AP42 document, chapter 11.9 "Western Surface Coal Mining" (October 1998). Emissions for TSP are estimated based on the equation:

$$EF_{TSP} = 0.00022 * \ A^{1.5}$$

where:

EF_{TSP}	emission factor for TSP (kg/blast)
A	area blasted (m²)

PM_{10} and $PM_{2.5}$ are assumed to be 52% and 3% of TSP emissions, as defined in the same document.

A2.3 Dozing

Emission factors for TSP and PM_{10} due to dozing on overburden and ore were calculated from the NPI Emission Estimation Technique for Mining version 3.1 (January 2012). Emission factors for TSP and PM_{10} are calculated based on the following equations:

$$EF_{TSP} = \frac{2.6\ s^{1.2}}{M^{1.3}}$$

$$EF_{PM10} = \frac{0.34\ s^{1.5}}{M^{1.4}}$$

where:

EF_{TSP}	emission factor for TSP (kg/ hr)
EF_{PM19}	emission factor for TSP (kg//hr)
s	silt content (%)
M	moisture content (%)

$PM_{2.5}$ is assumed to be 10.5% of TSP, as per AP42 Chapter 11.9.

A2.4 Truck dumping

The default emission factors for TSP and PM_{10} due to trucks dumping material from the NPI Emission Estimation Technique for Mining version 3.1 (January 2012) have been adopted, of 0.012 kg/t for TSP and 0.0043 kg/t for PM_{10}. The emission factor for $PM_{2.5}$ has been calculated as 7% of the TSP emission factor based on the AP42 particle size multipliers detailed in section A2.5.

A2.5 Material transfers/excavators - overburden

Emissions for materials handling are dependent on the amount of materials being transferred. Emission factors due to materials handling and excavators have been calculated from the AP42 document (US EPA, 2006), using the following equation:

$$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:

EF	emission factor (kg/Mg)
k	particle size multiplier (dimensionless)
U	mean wind speed (m/s)
M	material moisture content (%)

The particle size multiplier in the equation *k*, varies with aerodynamic particle size range, as follows:

k = 0.74	Particle size < 30 µm
k = 0.35	Particle size < 10 µm
k = 0.053	Particle size < 2.5 µm.

A2.6 Material transfers/excavators – ore

The emission factor for material handling including excavation and stacking of ore have been adopted from the NPI Emission Estimation Technique for Mining version 3.1 (January 2012) for high moisture content ore have been adopted. These are 0.005 kg/tonne for TSP, and 0.002 kg/tonne for PM_{10}. The emission factor for $PM_{2.5}$ has been calculated as 7% of the TSP emission factor based on the AP42 particle size multipliers detailed in section A2.5.

A2.7 Grading

The emission factor for grading was based on AP42 Chapter 11.9. In equation form, the emission factors for TSP and PM_{10} are calculated as:

$$EF_{TSP} = 0.0034 * S^{2.5}$$

$$EF_{PM10} = 0.0034 * S^{2}$$

where:

EF_{TSP}	emission factor for TSP (kg/VKT)
EF_{PM10}	emission factor for PM_{10} (kg/VKT)
S	mean grader speed (km/hr)

$PM_{2.5}$ is assumed to be 3.1% of TSP, from the same document.

A2.8 Wheel-generated dust

The emission factors for unpaved roads were calculated from the AP42 document, chapter 13.2.2 titled "unpaved roads" dated December 2003.

The equation included in the assessment is as follows:

$$E = 281.9 \times k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{W}{3}\right)^{b}$$

where

- E emission factor (g/VKT)
- s surface material silt content (%)
- W mean vehicle weight (tons) and the following constants were assumed.

The multiplier of 281.9 converts the units from lb/VMT to g/VKT.

The particle size multiplier in the equation *k* and exponents varies with aerodynamic particle size range, as defined in Table B2.

Table B2 Constants used in calculating emissions from wheel-generated dust

Constant	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
k (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

A2.9 Screening

The emission factor for screening of ore have been adopted from the NPI Emission Estimation Technique for Mining version 3.1 (January 2012) for low moisture content ore have been adopted (as no high moisture emission factors are available). These are 0.08 kg/tonne and 0.06 kg/tonne for TSP and PM_{10}, respectively. The $PM_{2.5}$ emission factor has been determined from the ratio of $PM_{2.5}$ and TSP emission factors for controlled screening from the AP42 documents.

A2.10 Crushing

The emission factor for primary and secondary crushing of ore have been adopted from the NPI Emission Estimation Technique for Mining version 3.1 (January 2012) for high moisture content ore have been adopted. These are 0.01 kg/tonne for TSP, and 0.004 kg/tonne for PM_{10} for primary crushing, and 0.03 kg/tonne for TSP, and 0.004 kg/tonne for PM_{10} for secondary crushing. The $PM_{2.5}$ emission factor has been determined from the ratio of $PM_{2.5}$ and TSP emission factors for controlled crushing from the AP42 documents.