Advanced Environmental Dynamics

Specialist Consultants

RED HILL MINING LEASE PROJECT
AIR QUALITY ASSESSMENT

TECHNICAL APPENDICES

Report # 503001

Prepared for:

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Table of Contents

Abbreviations ix

Units xi

Appendix A Introduction 12

A.1 Project Background 12

A.2 Overview of the Assessment Methodology 15

A.2.1 Pollutants Considered in the Assessment 16

A.2.2 Air Quality Assessment Components 16

A.2.3 Emissions Inventories 18

A.2.4 Dispersion Modelling 18

A.2.5 Presentation of Results 18

A.3 Air Quality Assessment Limitations 19

A.3.1 Uncertainties Associated with the Information used as Inputs into the Assessment 19

A.3.2 Uncertainties Associated with the Emissions Estimation 20

A.3.3 Uncertainties Associated with the Modelling Methodology 21

Appendix B Comparison of Ambient Air Quality Goals, Objectives, Standards and Criteria. 22

B.1 National Guidelines 22

B.2 Queensland Legislation 22

B.3 Comparison with Internationally Recognised Ambient Air Quality Criteria 23

Appendix C Ambient Air Monitoring Data and Estimate of Background Levels 25

Appendix D Emission Factors and Controls 26

D.1 Material Parameters 26

D.2 Equipment Data 27

D.3 Emission Factors 27

D.3.1 Drilling 28

D.3.2 Blasting 28

D.3.3 Draglines 28

D.3.4 Excavators/Shovels/Front-End Loaders 29

D.3.5 Bulldozers 29

D.3.6 Truck Unloading 29
D.3.7 Wheel Generated Dust 30
D.3.8 Graders 30
D.3.9 Loading and Unloading Stockpiles 30
D.3.10 Loading of Trains 30
D.3.11 Miscellaneous Transfer and Conveying Points 31
D.3.12 Wind Speed Dependent Wind Erosion 31
D.3.13 Ventilation Outlets 32
D.4 Activities and Emission Factors 33
D.4.1 Current Operations 33
D.4.2 Red Hill Mine 35
D.4.3 Eaglefield Mine 36
D.4.4 Grosvenor and Moranbah North Mines 36
Appendix E Summary of PM_{10} Emissions Inventories 37
E.1 Current Operations 37
E.2 Red Hill Mine 39
Appendix F Surrounding Land Use and Receptors 40
F.1 Surrounding Land Use and Terrain 40
F.2 Receptors 41
Appendix G Goonyella Riverside and Broadmeadow Mines Meteorological Monitoring Locations 43
Appendix H Development of Numerically Simulated Meteorological Fields 47
H.1 TAPM 47
H.2 CALMET 48
H.2.1 Geophysical dataset 49
H.2.2 Upper Air Dataset 52
H.2.3 Surface Observations Dataset 53
H.2.4 CALMET Configuration 55
Appendix I Comparison of Observed Site-Specific and Numerically Simulated Wind Fields 56
I.1 Northern Meteorological Monitoring Station 56
I.2 Broadmeadow, Riverside and Southern Meteorological Monitoring Stations 58

Appendix J Dispersion Modelling Methodology 59
J.1 Dispersion Model 59
J.2 Emission Sources 59
J.3 Discrete Receptor Grid 60
J.4 Modelled Scenarios 61
J.5 Pollutants Modelled 61
J.6 Particle Size Distribution 61
Appendix K Existing Mining Emission Sources 63
K.1 Goonyella Riverside and Broadmeadow Mine Complex 63
Appendix L Red Hill Mine Emission Sources 68
Appendix M Cumulative Future Mining Emission Sources 71
M.1 Eaglefield Expansion Project 71
M.2 Grosvenor and Moranbah North Mine 72
Appendix N Contour Plots 73
N.1 Total Suspended Particulates 74
N.1.1 Annual Average 74
N.2 Contour Plots – Particulate Matters as PM_{10} 78
N.2.1 Maximum 24-Hour Average 78
N.3 Contour Plots – Particulate Matters as $PM_{2.5}$ 82
N.3.1 Maximum 24-Hour Average 82
N.3.2 Annual Average 86
N.4 Dust Deposition 90
N.4.1 Monthly Average 90
Appendix O Results at Receptor Locations 94
O.1 Total Suspended Particulates Annual Averaging Period 97
O.2 Particulate Matter as PM_{10} – Twenty Four-Hour Averaging Period 99
O.3 Particulate Matter as $PM_{2.5}$ – Twenty Four-Hour Averaging Period 102
O.4 Particulate Matter as $PM_{2.5}$ – Annual Averaging Period 105
O.5 Dust Deposition – Monthly Average 107
Appendix P Document Limitations 109
Appendix Q References 110

Tables

Table 1: Modelled Scenarios 16
Table 2: Relevant Appendices for each of the Air Quality Assessment Components 17
Table 3: Comparison of Regulatory Standards, Goals and Objectives (µg/m^3) 24
Table 4: Estimate of Background Levels 25
Table 5: Material Parameters 26
Table 6: Equipment Data 27
Table 7: Activity, Uncontrolled Emission Factors and Controls for GRB Mine Complex 33
Table 8: Activity, Uncontrolled Emission Factors and Controls for Red Hill Mine 35
Table 9: Emission Rates for Eaglefield Mine (Source: Table 7, Eaglefield, 2011) 36
Table 10: Emissions Inventory (t/year) for GRB Mine Complex 37
Table 11: Emissions Inventory (kg/year) for Red Hill Mine (Maximum Emissions Scenario) 39
Table 12: Receptors 41
Table 13: Coordinates and Siting of Site-Specific Meteorological Stations 43
Table 14: TAPM Configuration 48
Table 15: Coordinates of Upper Air Stations Included in CALMET 52
Table 16: Coordinates of Surface Observation Stations Included in CALMET 53
Table 17: CALMET Configuration 55
Table 18: CALPUFF Configuration 59
Table 19: Modelled Scenarios 61
Table 20: Geometric Characteristics of Particle Size Intervals used in the Dispersion Modelling 62
Table 21: Receptor Numbers Exceeding Pollutant Criteria 96
Table 22: Red Hill Mine 97
Table 23: Existing Mining 97
Table 24: Future Mining 98
Table 25: Cumulative Future Mining 98
Table 26: Red Hill Mine 99
Table 27: Existing Mining 99

Table 28: Future Mining 100
Table 29: Cumulative Future Mining 101
Table 30: Red Hill Mine 102
Table 31: Existing Mining 102
Table 32: Future Mining 103
Table 33: Cumulative Future Mining 104
Table 34: Red Hill Mine 105
Table 35: Existing Mining 105
Table 36: Future Mining 106
Table 37: Cumulative Future Mining 106
Table 38: Red Hill Mine 107
Table 39: Existing Mining 107
Table 40: Future Mining 108
Table 41: Cumulative Future Mining 108

Figures

Figure 1: Current and Future Mining Operations 14
Figure 2: Example – Hourly Wind Speed Dependent Emission Factors for a 20 m Stockpile 32
Figure 3: Breakdown of Emissions Inventory - Current Operations (All of Site) 38
Figure 4: Breakdown of Emissions Inventory - Pit-Related Activities (left) and Transport of Material (right) 38
Figure 5: Breakdown of Emissions Inventory – Red Hill Mine 39
Figure 6: Terrain Surrounding Project Site 40
Figure 7: Receptor Locations 42
Figure 8: Location of Site-Specific Meteorological Stations 44
Figure 9: Broadmeadow Meteorological Station 45
Figure 10: Northern Meteorological Station 45
Figure 11: Riverside Meteorological Station 46
Figure 12: Southern Meteorological Station 46
Figure 13: Terrain data for CALMET Geophysical Dataset 49

Figure 14: User Defined Land Use Categories for CALMET Modelling domain 50
Figure 15: Geotechnical Parameters for User Defined CALMET Land Use Classification .. 51
Figure 16: Location of Upper Air Stations in Reference to CALMET Modelling Domain..... 52
Figure 17: Location of Surface Stations in Reference to CALMET Modelling Domain 54
Figure 19: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2007. CALMET (left) and Observations (right) 56
Figure 20: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2008. CALMET (left) and Observations (right) 57
Figure 21: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2009. CALMET (left) and Observations (right) 57
Figure 22: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2007-2009. CALMET (left) and Observations (right) 58
Figure 23: Location of Discrete Receptors for Regional Contour Plot 60
Figure 24: Calpuff Sources Locations – Haul Roads, In-Pit, Blasting, Topsoil Stripping and Exposed Topsoil 64
Figure 25: Calpuff Sources Locations – Constant Emissions Sources for Goonyella CHPP and Riverside CHPP 65
Figure 26: Calpuff Sources Locations – Wind Speed Dependent Emissions Sources for Goonyella CHPP and Riverside CHPP 66
Figure 27: Calpuff Sources Locations – Wind Speed Dependent Overburden Exposed Areas for a Typical Year (2030) Corresponding to Overburden Dumping Areas 67
Figure 28: Calpuff Sources Locations – Redhill CHPP Related 24/7 Emission Sources 69
Figure 29: Calpuff Sources Locations – Redhill CHPP Related Wind Speed Dependent Emission Sources 70
Figure 30: Representative location of Eaglefield Expansion Project Dust emission Sources 71
Figure 31: Representative location of Grosvenor Project Dust emission Sources 72
Figure 32: Total Suspended Particulates – Red Hill Mine Only Impacts 74
Figure 33: Total Suspended Particulates - Existing Mining 75
Figure 34: Total Suspended Particulates - Future Mining 76
Figure 35: Total Suspended Particulates - Cumulative Future Mining 77
Figure 36: Particulate Matter as PM_{10} – Red Hill Mine Only Impacts 78
Figure 37: Particulate Matter as PM_{10} - Existing Mining 79
Figure 38: Particulate Matter as PM_{10} - Future Mining 80

Figure 39: Particulate Matter as PM_{10} - Cumulative Future Mining 81
Figure 40: Particulate Matter as $PM_{2.5}$ – Red Hill Mine Only Impacts 82
Figure 41: Particulate Matter as $PM_{2.5}$ - Existing Mining 83
Figure 42: Particulate Matter as $PM_{2.5}$ - Future Mining 84
Figure 43: Particulate Matter as $PM_{2.5}$ - Cumulative Future Mining 85
Figure 44: Particulate Matter as $PM_{2.5}$ – Red Hill Mine Only Impacts 86
Figure 45: Particulate Matter as $PM_{2.5}$ - Existing Mining 87
Figure 46: Particulate Matter as $PM_{2.5}$ - Future Mining 88
Figure 47: Particulate Matter as $PM_{2.5}$ - Cumulative Future Mining 89
Figure 48: Dust Deposition – Red Hill Mine Only Impacts 90
Figure 49: Dust Deposition - Existing Mining 91
Figure 50: Dust Deposition - Future Mining 92
Figure 51: Dust Deposition - Cumulative Future Mining 93
Figure 52: Receptor Locations 94

Abbreviations

AED	Advanced Environmental Dynamics Pty Ltd
AGD	Australian Geodetic Datum
AQCS	Air Quality Control System AQCS
AQMP	Air Quality Management Plan
AS	Standards Australia
bkg	Background
BMA	The BHP Billiton Mitsubishi Alliance
BoM	Australian Bureau of Meteorology
BRM	Broadmeadow Mine
c.	Circa, approximately
CALMET	California Meteorological Model
CALPUFF	California Plume Dispersion Model
CRM	Caval Ridge Mine
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Department of Environment and Heritage Protection
EETM	Emission Estimation Technique Manual
EF	Emission Factor
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPP	Environmental Protection Policy
EPP(Air)	Environmental Protection (Air) Policy 2008
ESA	European Space Agency
FEL	Front End Loader
FY	Financial Year
GRM	Goonyella Riverside Mine
NAAQO	National Ambient Air Quality Objectives
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPC	National Environment Protection Council

NEPM	National Environment Protection Measure
NPI	National Pollution Inventory
NSW	New South Wales
NSW DECCW	New South Wales Department of Environment, Climate Change and Water
PM_{10}	Particulate Matter less than 10 micrometres in diameter
$PM_{2.5}$	Particulate Matter less than 2.5 micrometres in diameter
QLD	Queensland
R	Receptor
RHM	Red Hill Mine
ROM	Run-of-Mine
SRTM	Shuttle Radar Topography Mission
TAPM	The Air Pollution Model
TEOM	Tapered Element Oscillating Microbalance
TPM	Total Particulate Matter
TSP	Total Suspended Particulates
UTM	Universal Transverse Mercator
USEPA	United States Environmental Protection Agency
VIC	Victoria
WD	Wind Direction
WHO	World Health Organisation
WS	Wind Speed
WSD	Wind Speed Dependent

Units

#/year	Number(s) per year
%	Percentage
ºC	Degrees Celsius
g/m^2/month	Gram per square meter per month
g/s	Gram per second
hr/ha	Hours per hectare
kg	Kilograms
kg/ha/yr	Kilograms per hectare per year
kg/hr	Kilograms per hour
kg/t	Kilogram per tonne
kg/vkt	Kilograms per vehicle kilometre travelled
kg/year	Kilograms per year
km	kilometre
km/hr	Kilometres per hour
m	Metre
m3	Cubic meters
mg/m^2/day	Milligrams per square meter per day
m/s	Metres per second
Mtpa	Million tonnes per annum
µg	Micrograms
µg/m3	Micrograms per cubic metre
t/y	Tonnes per year

Appendix A Introduction

Advanced Environmental Dynamics Pty Ltd (AED) was commissioned by URS Australia Limited (URS) to undertake an air quality assessment of the potential impacts of emission of pollutants associated with BHP Billiton Mitsubishi Alliance's (BMA) Red Hill Mining Lease Project (the Project) on local air quality at receptor locations.

The presentation of the air quality assessment has been separated into two main components: the Red Hill Project Environmental Impact Statement (EIS) Chapter 11: *Air Quality* and this set of technical appendices.

The EIS chapter has been written for a more general audience with a brief summary of the methodology, key inputs and findings presented.

Within these supporting technical appendices are the details of the assessment. These appendices have in general, been designed to be stand-alone with the information provided for the reader interested in the details of (for example) the pollution data analysis, development of the regional meteorological fields, the set-up of the dust dispersion and model results.

A.1 Project Background

Red Hill Mine (RHM) is a proposed new underground mine to be located adjacent to BMA's Goonyella Riverside and Broadmeadow (GRB) mine complex in the Bowen Basin, Central Queensland (Figure 1).

The Project will increase BMA's local coal production rate by 14 million tonnes per annum (mtpa) to approximately 32.5 mtpa over an estimated life of mine (LOM) of 25 years.

BHP Billiton Mitsubishi Alliance (BMA), through its joint venture manager, BM Alliance Coal Operations Pty Ltd, proposes to convert the existing Red Hill mining lease application (MLA70421) to a mining lease and thus enable the continuation and potential future expansion of existing mining operations associated with the GRB mine complex. Specifically, the mining lease conversion will allow for:

1. An extension of three longwall panels (14, 15 and 16) of the existing Broadmeadow underground mine (BRM).
2. A future incremental expansion option of the existing Goonyella Riverside Mine (GRM).
3. A future Red Hill Mine (RHM) underground expansion option located to the east of the GRB mine complex.

The project includes the following components:

1. The extension of BRM longwall panels 14, 15, and 16 into MLA70421. Key elements include;

   - No new mining infrastructure is proposed other than infrastructure required for drainage of incidental mine gas (IMG) to enable safe and efficient mining.
   - Management of waste and water produced from drainage of IMG will be integrated with the existing BRM waste and water management systems.
   - The mining of the BRM panel extensions is to sustain existing production rates of the BRM mine and will extend the life of mine (LOM) by approximately one year.
   - The existing BRM workforce will complete all work associated with the extensions.

2. The incremental expansion of the Goonyella Riverside Mine including:

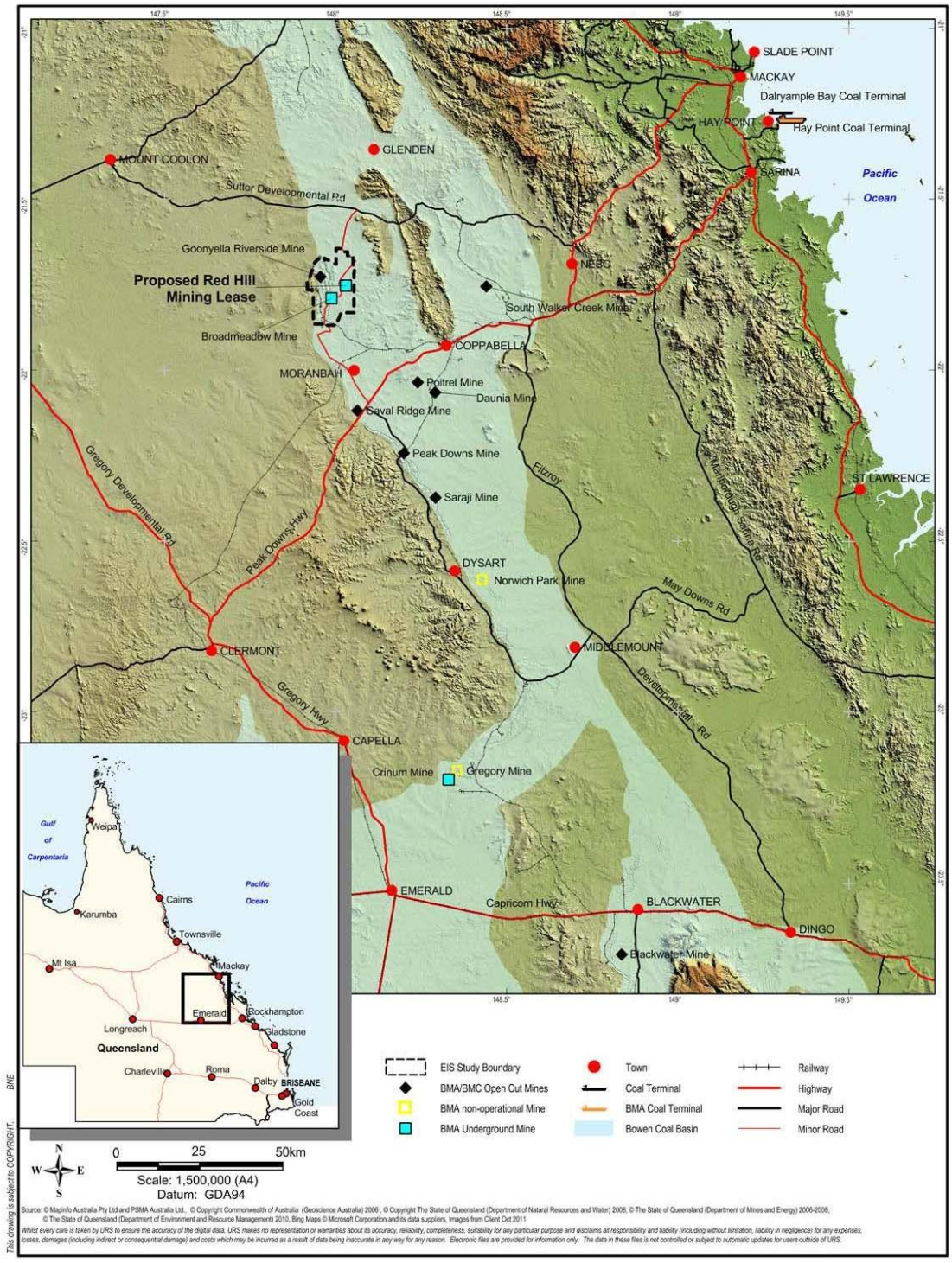
   - Underground mining associated with the RHM underground expansion option to target the GMS on ML 1763;
   - A new mine industrial area (MIA);
   - A CHPP adjacent to the Riverside MIA on MLA 1764 and ML 1900 − the Red Hill CHPP will consist of up to three 1,200 tonne per hour (tph) modules;
   - Construction of a drift for mine access;
   - A conveyor system linking RHM to the Red Hill CHPP;
   - Associated coal handling infrastructure and stockpiles;
   - A new conveyor linking product coal stockpiles to a new rail load-out facility located on ML 1900;
   - Means for providing flood protection to the mine access and MIA, potentially requiring a levee along the west bank of the Isaac River.

3. A potential new Red Hill underground mine expansion option to the east of the GRB mine complex, to target the GMS on MLA 70421. Key aspects include:

   - The proposed mine layout consists of a main drive extending approximately west to east with longwall panels ranging to the north and south;
   - A network of bores and associated surface infrastructure over the underground mine footprint for mine gas pre-drainage (IMG) and management of goaf methane drainage to enable the safe extraction of coal;
   - A ventilation system for the underground workings;
   - A bridge across the Isaac River for all-weather access. This will be located above the main headings, and will also provide a crossing point for other mine related infrastructure including water pipelines and power supply;
   - A new accommodation village (Red Hill accommodation village) for the up to 100% remote construction and operational workforces with capacity for up to 3,000 workers;

- Potential production capacity of 14mtpa of high quality hard coking coal over a life of 20 to 25 years.

Figure 1: Current and Future Mining Operations



A.2 Overview of the Assessment Methodology

The air quality assessment for the Project considered the release of dust due to earth moving and mining activities associated with the construction and operation of the GRM incremental expansion and RHM underground expansion option. The BRM panel extensions will not generate any significant dust impacts and is not considered further in this assessment.

In particular, three particle sizes of dust that are of concern for their potential to impact upon human health and amenity were considered namely, total suspended particulates (TSP), particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). Additionally, dust deposition has been estimated in consideration of its potential to impact on environmental amenity.

The existing air quality environment has been described based on estimates of background levels of dust in combination with predicted impacts due to current mining operations at the GRB mine complex.

Meteorology plays an important role in the transport and dispersion of dust away from the Project site and three years of meteorological parameters were developed for use in the dispersion modelling (2007, 2008, 2009).

Dispersion modelling was conducted using the Department of Environment and Heritage Protection (DEHP) approved CALMET/CALPUFF modelling package. A detailed emissions inventory was established using Project information in conjunction with emission factors from both the Australian National Pollutant Inventory (NPI) emission estimation manual for mining and the USEPA AP-42.

Predicted impacts from dust associated with the Project on local air quality that have incorporated BMA's proposed air quality control methods, are presented in this assessment.

Specifically, four scenarios were considered (Table 1):

- **Red Hill Mine Scenario**: Red Hill Mine (RHM) based on a single worst-case dust emissions scenario.
- **Existing Mining Scenario**: Goonyella Riverside Broadmeadow (GRB) mine complex based on current approvals for FY2015, FY2030, FY2040 and FY2050 mining operations. Included in the existing mining scenario is an estimate of naturally occurring dust levels based on continuous monitoring data from BMA's Moranbah Airport monitoring station.
- **Future Mining Scenario**: GRB mine complex, RHM and an estimate of naturally occurring background levels of dust. Results for the four mine configurations for GRB mine complex (i.e. FY2015, FY2030, FY2040, and FY2050) are presented.
- **Cumulative Future Mining Scenario**: GRB mine complex, RHM, and naturally occurring dust levels, have been considered in combination with impacts associated with non-BMA

emission sources: Eaglefield Mine (Peabody Energy), Grosvenor Mine (Anglo Coal), and Moranbah North Mine (Anglo Coal).

Table 1: Modelled Scenarios

Scenario	RHM	GRM	BRM	EFM	Gros & MNM
Red Hill Mine	√	x	x	x	x
Existing Mining(1)	x	√	√	x	x
Future Mining(1)	√	√	√	x	x
Cumulative Future mining(1)	√	√	√	√	√

Note (1): Consists of 4 scenarios, one each for FY2015, FY2030, FY2040, FY2050.

A.2.1 Pollutants Considered in the Assessment

Emissions from the Project are generated primarily from activities that move overburden and coal, and to a lesser extent from combustion of diesel fuel in mobile equipment. The emissions and impacts of dust comprising total suspended particulates (TSP), particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM_{10}), particulate matter with an aerodynamic diameter equal to or less than 2.5 microns ($PM_{2.5}$), and dust deposition have been assessed in detail.

Air pollutants from diesel combustion may release other air pollutants such as sulphur dioxide, nitrogen dioxide and trace quantities of volatile organic compounds. These substances are not considered to be emitted from Project-related sources in sufficient quantities to affect air quality off-site; therefore impacts from pollutants generated by combustion were not considered in the air quality assessment.

A.2.2 Air Quality Assessment Components

The air quality assessment consisted of the following key components:

1. **Identification of national and state air quality objectives.** This component of the assessment defines the ambient air quality objectives for dust against which the results of the dispersion modelling at receptor locations will be interpreted. Relevant appendices are summarised in Table 2.
2. **Quantification of background levels of pollutants.** This component of the assessment involved the collection and review of ambient air monitoring data for the purposes of quantifying the current background level of dust. Here background refers to natural background levels i.e. those due to non-anthropogenic dust emission sources. Relevant appendices are summarised in Table 2.
3. **A description of the existing air quality environment.** This component of the assessment provides a description of the existing air quality environment within the local

airshed. The description included a quantification of background creep (i.e. the incremental contribution to the 70th percentile 24-hour concentration of PM_{10} and $PM_{2.5}$) due to operations at the GRB mine complex. Dust dispersion modelling based on three years of regional meteorology was used to predict the temporal and spatial variation in the air quality environment based on four snap-shots of air quality (FY2015, FY2030, F2040 and FY2050) assuming that GRB mine complex operations develop along the lines of their current approval. Relevant appendices are summarised in Table 2.

4. **An estimate of the Project-related impacts on air quality**. This component of the assessment investigated the nature and extent of potential impacts of the emission of dust from Project-related activities on the surrounding environment in isolation from other BMA owned and operated significant dust emission sources. Relevant appendices are summarised in Table 2.

5. **Description of the future air quality environment:** This component of the assessment describes the future air quality environment based on the impacts of the Project in combination with those from the GRB mine complex. Relevant appendices are summarised in Table 2.

6. **Description of the cumulative future air quality environment:** This component of the assessment involved an investigation of cumulative impacts of dust emissions from the Project and other BMA and non-BMA significant sources of dust that operate within the local airshed. Relevant appendices are summarised in Table 2.

Table 2: Relevant Appendices for each of the Air Quality Assessment Components

Appendix	Description	Component					
		1	2	3	4	5	6
Appendix B	Comparison of Ambient Air Quality Goals, Objectives, Standards and Criteria.	√					
Appendix C	Ambient Air Monitoring Data and Estimate of Background Levels		√				
Appendix D	Emission Factors and Controls			√	√	√	√
Appendix E	Summary of PM10 Emissions Inventories			√	√	√	√
Appendix F	Surrounding Land Use and Receptors			√	√	√	√
Appendix G	Goonyella Riverside and Broadmeadow Mines Meteorological Monitoring Locations			√			
Appendix H	Development of Numerically Simulated Meteorological Fields			√	√	√	√
Appendix I	Comparison of Observed Site-Specific and Numerically Simulated Wind Fields			√			
Appendix J	Dispersion Modelling Methodology			√	√	√	√
Appendix K	Existing Mining Emission Sources			√		√	√
Appendix L	Red Hill Mine Emission Sources				√	√	√
Appendix M	Cumulative Future Mining Emission Sources						√

Appendix	Description	Component					
		1	2	3	4	5	6
Appendix N	Contour Plots			√	√	√	√
Appendix O	Results at Receptor Locations			√	√	√	√

A.2.3 Emissions Inventories

Estimates of the quantity of dust that is emitted in association with the Project as well as that associated with the GRB mine complex, Eaglefield Mine, Moranbah North Mine and Grosvenor Mine were based on the following sources of information:

- NPI (2011): *NPI Emission Estimation Technique Manual for Mining,* Version 3, June 2011
- USEPA (1995): *AP-42 - Compilation of Air Pollutant Emission Factors,* Fifth Edition, Volume 1 (Chapter 11) including updates October 1998 and October 2002.
- Peabody (2011): *Eaglefield Expansion Project* EIS Air Quality Appendix
- Anglo Coal (2010): *Grosvenor Project EIS* Air Quality Appendix
- Vale Australia (2009): *Ellensfield Coal Mine Project*, EIS Technical Appendix I1: Air Quality.

A.2.4 Dispersion Modelling

The dispersion modelling was based on the use of the regulatory approved CALMET/CALPUFF modelling system. The CSIRO model TAPM was used to generate upper air and surface files for use as inputs into CALMET.

Three years of three-dimensional hourly meteorological wind fields corresponding to 2007, 2008 and 2009 were produced in order to capture variability in the annual wind fields.

A comparison of CALMET generated wind speed and wind direction data and observed monitoring data at GRM North Meteorological monitor is presented in Appendix I.

A.2.5 Presentation of Results

The presentation of results focuses on predicted ground-level concentrations for:

- The 15th highest 24-hour average concentration of PM_{10} based on three years of meteorology and is presented as the 5th highest per year.
- The annual average concentration of TSP.
- The maximum 24-hour average concentration of $PM_{2.5}$ based on three years of meteorology. Results for $PM_{2.5}$ were not explicitly modelled but developed from the results for TSP based on the conservative assumption that 10% of TSP is in the form of $PM_{2.5}$. (Note that Table 11.9-2 of the US EPA AP42 Chapter 11 *Western Surface Mining*,

suggests that for a number of activities the ratio of $PM_{2.5}$ to TSP ranges from 1.7% (dragline handling overburden) to 10.5% for dozers operating on overburden.)

- The annual average concentration of $PM_{2.5}$ developed from the results for TSP based on a conservative assumption that 10% of TSP is in the form of $PM_{2.5}$.
- The maximum monthly dust deposition based on 30 day block averages and reported in units of $mg/m^2/day$.

Results are presented both in tabular form and as regional contour plots.

Tabulated results also include the predicted number of exceedences of the relevant EPP(Air) objectives and DEHP criterion for dust deposition.

Estimates of background creep (ie incremental contribution to the 70^{th} percentile concentration) of PM_{10} and $PM_{2.5}$ are presented at receptor locations complementing the contour plots presented in the Red Hill Project EIS Chapter 11: *Air Quality* and highlighting the persistent nature of elevated levels of dust to the west of the GRM mine complex for the Existing and Cumulative Future Mining scenarios.

The contour plots focus on the extent of the area that is proposed to exceed the relevant EPP(Air) objectives with a comparison of the different emissions scenarios.

A.3 Air Quality Assessment Limitations

This section outlines the limitations associated with the air quality assessment. These include limitations associated with:

- The data sets used as inputs into the assessment such as information provided by the client, third party information and information that is publically available.
- The estimation of emissions associated with the Project as well as those for the GRB mine complex, Eaglefield Mine, Moranbah North Mine and Grosvenor Mine.
- The modelling methodology and the use of numerical tools to simulate physical systems.
- The presentation of results including the use of contour plots.

A.3.1 Uncertainties Associated with the Information used as Inputs into the Assessment

In addition to the general limitations outlined in Appendix P of this report, uncertainties in the study-specific information include (but may not be limited to) the following:

The accuracy and representativeness of third-party supplied data sets including (but not limited to):

- Land use data from the default TAPM V4.0.5 database which consists of Australian vegetation and soil type data on a longitude/latitude grid at 3-minute grid spacing (approximately 5 km) provided by CSIRO Wildlife and Ecology (Hurley, 2008);
- Terrain data from the default TAPM V4.0.5 database which is derived from Australian terrain height data on a longitude/latitude grid at 9-second grid spacing (approximately 0.3 km) from Geoscience Australia (Hurley, 2008);
- Terrain data for CALMET (Scire, 2000a) from the Shuttle Radar Topography Mission (SRTM) dataset at 3 arc second downloaded from TRC website (SRTM, 2000);
- Land use or land cover data from European Space Agency (ESA, 2010) Globcover land cover map at 300 m resolution; and
- Regulatory supplied meteorological data.

The completeness, accuracy and representativeness of Client-supplied emissions information including (but not limited to):

- Spatial information including 5-yearly pit progression plans and overburden dumping locations;
- Material volumes;
- Material handling methods;
- Engineering controls;
- Pollution and meteorological data from the Moranbah Airport monitoring location.

The completeness, accuracy and representativeness of publically available information including (but not limited to):

- Grosvenor Environmental Impact Statement (Anglo Coal, 2010)
- Moranbah North Mine information contained in the Grosvenor Environmental Impact Statement (Anglo Coal, 2010)
- Eaglefield Expansion Project Environmental Impact Statement (Peabody, 2011)

A.3.2 Uncertainties Associated with the Emissions Estimation

Uncertainty in the estimated emission factors arise from limitations which include (but may not be limited to):

- The use of default values which are based on a limited number of samples at mines for which representativeness in relation to the Project site is not able to be assessed.
- The use of emission factor formulas which are based on a limited number of samples at mines for which representativeness in relation to the Project site is not able to be assessed.
- The lack of site-specific data for the material properties of percentage silt and moisture content of overburden and haul roads in particular.

A.3.3 Uncertainties Associated with the Modelling Methodology

With respect to the modelling methodology the following are notes:

- In general, when conducting an air quality assessment a conservative methodology is adopted where inputs are biased towards the higher end of the anticipated range of values. This approach has evolved in part due to the uncertainties associated with the representativeness of the model inputs and in part due to the difficulties in verifying the accuracy of the model output. In general, if the results of the assessment based on a conservative approach do not highlight the potential for significant adverse impacts from a given Project, then the requirement to refine the level of conservatism that has been adopted may not be warranted. However, should potential issues be suggested, a review and refinement of the conservative assumptions that have been incorporated in the assessment should be considered. Following the changes in the EPP(Air) that came into enforcement on 1 January 2009, there has been an increasing pressure on those undertaking air quality assessments to reduce the level of conservatism that is incorporated into the modelling methodology, this must be balanced however by the level of uncertainty and the representativeness of the model inputs on timescales as suggested by the relevant ambient air quality objectives.
- Although very important, model validation and/or calibration is rarely undertaken due to the complexity of the physical system that is being modelled as well as the timeframes and costs associated with the collection of data at a temporal and spatial resolution required to undertake a statistically meaningful study. Thus at best, the model output should be used as a guide to highlight potential air quality issues, provide valuable input into the development of ambient air monitoring programs, and to highlight to the proponent the level of mitigation that may be required in order to protect environmental values.

Appendix B Comparison of Ambient Air Quality Goals, Objectives, Standards and Criteria.

This appendix defines the relevant ambient air quality objectives that are designed to ensure the protection of national and state recognised environmental values.

B.1 National Guidelines

National air quality guidelines are specified by the National Environment Protection Council (NEPC). The National Environment Protection Measure (NEPM) (Ambient Air Quality) was released in 1998 (with an amendment in 2003), and sets standards for ambient air quality in Australia.

The NEPM (Ambient Air Quality) specifies national ambient air quality standards and goals for the following common air pollutants: carbon monoxide, nitrogen dioxide, sulphur dioxide, ozone, particulates (as PM_{10} and $PM_{2.5}$), and lead.

Ambient concentrations of $PM_{2.5}$ are addressed only by advisory reporting standards in the NEPM, which are not applied as goals. Potential particulate emissions and impacts are addressed through consideration of the impacts of total suspended particulates and PM_{10}.

The NEPM standards are intended to be applied at monitoring locations that represent air quality for a region or sub-region of more than 25,000 people, and are not used as recommendations for locations near industrial facilities (NEPM, Clause 14(1)).

B.2 Queensland Legislation

In Queensland, air quality is managed under the *Environment Protection Act 1994* (the Act), the *Environmental Protection Regulation 2008* (the Regulation) and the *Environmental Protection (Air) Policy 2008* (EPP (Air)) which came into effect on January 1, 2009.

The Act provides for long-term protection for the environment in Queensland in a manner that is consistent with the principles of ecologically sustainable development. The primary purpose of the EPP(Air) is to achieve the objectives of the Act in relation to Queensland's air environment. This objective is achieved by the EPP (Air) through:

- Identification of environmental values to be enhanced or protected;
- Specification of air quality indicators and goals to protect environmental values; and
- Provision of a framework for making consistent and fair decisions about managing the air environment and involving the community in achieving air quality goals that best protect Queensland's air environment.

The EPP (Air) applies "…to Queensland's air environment" but the air quality objectives specified in the EPP (Air) do not extend to workplaces covered by the Workplace Health and Safety Act (1995) (Section 8 of the EPP (Air)).

The air quality assessment presented in this report addresses off-site ambient air quality impacts only and does not cover workplace health and safety exposure.

Schedule 1 of the EPP (Air) specifies the air quality objectives that are to be (progressively) achieved though no timeframe for achievement of these objectives is specified. The Schedule includes objectives designed to protect the environmental values of:

- Health and well-being;
- Aesthetic environment;
- Health and biodiversity of ecosystems; and
- Agriculture.

DEHP has also adopted a guideline for dust deposition of 120 milligrams per square metre per day (mg/m^2/day) to ensure adequate protection from nuisance levels of dust. This level was derived from ambient monitoring of dust conducted in the Hunter Valley, NSW in the 1980's. The former NSW State Pollution Control Commission set the level to avoid a loss of amenity in residential areas, based on the levels of dust fallout that cause complaints (NSW, 2005).

It is noted that the NSW's guideline for dust deposition was based on an annual average of dust deposition reported in g/m^2/month. This is in contrast to the application of the dust nuisance guideline adopted by Queensland for which a monthly average is calculated and reported in mg/m^2/day.

B.3 Comparison with Internationally Recognised Ambient Air Quality Criteria

Presented in Table 3 is a summary of regulatory standards, goals and objectives for total suspended particulates (TSP) and particulate matter as PM_{10} and $PM_{2.5}$ from:

- Australia
  - National Environment Protection Measure (NEPM) for ambient air
  - Queensland Environmental Protection (Air) Policy
  - Victorian Environmental Protection Agency

- Canada
  - Province of Ontario
- United States of America
  - National Ambient Air Quality Standards (NAAQS)
  - Texas Commission on Environmental Quality
- World Health Organisation

Information contained in Table 3 highlights the wider range of accepted ambient air criteria for the 24-hour average concentration of PM_{10} (50 µg/m^3 compared with 150 µg/m^3) than that for $PM_{2.5}$ (25 µg/m^3 to 35 µg/m^3). With exception of the US EPA NAAQs, all other agencies listed have adopted a criterion for the 24-hour average of PM_{10} of 50 µg/m^3.

Table 3: Comparison of Regulatory Standards, Goals and Objectives (µg/m^3)

Pollutant	Averaging Period	Environmental Value	Value	Source
TSP	3 minute	amenity	330	Vic EPA
	annual	health	90	Qld EPP(Air)
PM_{10}	1 hour	toxicity	80	Vic EPA
	24 hour	health	150	US EPA NAAQs
	24 hour	health	50	Ontario
	24 hour	health	50	Air NEPM
	24 hour	health	50	Qld EPP(Air)
	24 hour	health	50	WHO
	annual	health	20	WHO
$PM_{2.5}$	1 hour	toxicity	50	Vic EPA
	24 hour	health	30	Ontario
	24 hour	advisory	25	Air NEPM
	24 hour	health	25	Qld EPP(Air)
	24 hour	health	35	US EPA NAAQs
	24 hour	health	25	WHO
	annual	health	10	WHO
	annual	health	15	US EPA NAAQs
	annual	advisory	8	Air NEPM
	annual	health	8	Qld EPP(Air)

Appendix C Ambient Air Monitoring Data and Estimate of Background Levels

This appendix presents the results of the data analysis for data collected at BMA's Moranbah airport monitoring location, Moranbah, Central Queensland. Originally sited in an isolated location, more recent land use conflicts has resulted in an increasing contribution to measured levels of dust at this location from localised sources thereby reducing the representativeness of the site's current location as a 'background' monitoring site.

In theory, background levels of pollutants are the concentrations that would occur in the absence of anthropogenic emission sources. In practice, the practicalities and limitations associated with the establishment of an ambient air monitoring stations means that they are rarely sited at locations which are not influenced to some degree by anthropogenic sources.

Additionally, although the Victorian EPA recommend the use of the 70th percentile as an estimate for the background level, in reality the actual background level will be spatially and temporally varying as the emission rate of pollutants from natural sources are often functions of a number of factors including for example, frequency of rain, wind speed, atmospheric stability etc.

For this assessment and with limitations in the data set as noted above, data from the Moranbah Airport monitoring location has been used to estimate background levels. Data for the period January 2011 through January 2013 were analysed to estimate background levels of TSP, particulate matter as PM_{10}, and particulate matter as $PM_{2.5}$.

Due to the lack of dust deposition data at this location, a background estimate of dust deposition has been sourced from Caval Ridge Mine Project Environmental Impact Statement (BMA, 2010).

Adopted background levels are summarised in the following table. Details of the data analysis are presented in AED (2013): *Caval Ridge Mine Ambient Air Monitoring Network Baseline Data Summary. Report #101008*. Prepared for BMA and dated 11 March 2013.

Table 4: Estimate of Background Levels

Pollutant	Averaging Period	Project Goal	Estimated Background Level	Source
TSP	Annual	90 µg/m^3	39.8 µg/m^3	Moranbah Airport
PM_{10}	24 hour(1)	50 µg/m^3	29.6 µg/m^3	Moranbah Airport
$PM_{2.5}$	24 hour(2)	25 µg/m^3	7.0 µg/m^3	Moranbah Airport
	Annual	8 µg/m^3	6.6 µg/m^3	Moranbah Airport
Dust deposition	Monthly	120 mg/m^2/day	50 mg/m^2/day	CRM EIS

Note (1): Based on the 70th percentile 24-hour average concentration.
Note (2): Based on the 70th percentile 24-hour average concentration.

Appendix D Emission Factors and Controls

Emission factors used to estimate the emission of dust from mining activities were developed from those contained in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (EETM) for Mining version 3.0, June 2011. The reader is directed to the NPI EETM for Mining (2011) for details.

D.1 Material Parameters

Presented in Table 5 is a summary of the assumed values for the moisture content, silt content and density of coal, overburden and topsoil as required as input in the development of the emission factors. Note that there was no site-specific data pertaining to the silt and moisture content of overburden at the time of the assessment. Values have been assumed based on information contained in the US EPA AP42. It is acknowledged that the lack of site-specific material parameter information may limit the representativeness of the emission factors developed for this study.

Table 5: Material Parameters

Material	units	Value	Reference
Moisture Content			
Topsoil	%	3.2	Assumed based on overburden
Overburden	%	3.2	Assumed based on US EPA AP42 table 11.9.3
Coal - in situ	%	3.6	BMA
Coal – ROM (OC)	%	4	BMA
Coal – ROM (UG)	%	4	BMA
Coal - Raw	%	6	BMA
Coal - Product	%	9	BMA
Silt Content			
Topsoil	%	6.9	Assumed based on overburden silt content
Overburden	%	6.9	Assumed based on US EPA AP42 table 11.9.3
Road	%	4.3	Assumed based on US EPA AP42 table 11.9.3
Coal	%	5	BMA
exposed areas	%	6.9	Assumed based on overburden silt content
Tailings Dam	%	60	URS
Density			
Overburden	g/cm^3	2.2	BMA
Coal	g/cm^3	1.51	BMA

D.2 Equipment Data

Presented in Table 6 is a summary of the equipment data used to develop the emission factors.

Table 6: Equipment Data

Parameter	units	Value	Reference
Draglines			
Average drop height	m	15	Based on information provided by BMA
Graders			
Average speed	km/hr	5	Based on information provided by BMA
Scrapers			
Average speed	km/hr	20	Based on information provided by BMA
Gross mass (empty)	tonnes	72	Based on information provided by BMA
Gross mass (full)	tonnes	115	Based on information provided by BMA
Water Trucks			
Average speed	km/hr	10	Assumed
Weighted average Mass (empty)	tonnes	110	Based on information provided by BMA
Weighted average Mass (full)	tonnes	176	Based on information provided by BMA
Coal Trucks			
Gross mass (empty)	tonnes	166	Based on information provided by BMA
Gross mass (full)	tonnes	384	Based on information provided by BMA
Overburden Trucks			
Gross mass (empty)	tonnes	283	Based on information provided by BMA
Gross mass (full)	tonnes	610	Based on information provided by BMA
Rejects Trucks			
Gross mass (empty)	tonnes	132	Based on information provided by BMA
Gross mass (full)	tonnes	318	Based on information provided by BMA

D.3 Emission Factors

The National Pollutant Inventory (NPI) has a series of Emission Estimation Technique Manuals that are intended to provide data on emissions of air pollutants during typical operations. The NPI Emission Estimation Technique Manual for Mining V3.0 (NPI, 2011) has been used to provide data to estimate the amount of TSP and PM_{10} emitted from the various activities on a mine site, based on the amount of coal and overburden material mined as provided by the Proponent. Emission factors from the NPI EETM for Mining were supplemented with those from the US EPA's AP42 (USEPA, 1995) as required and/or considered appropriate.

D.3.1 Drilling

The default emission factor for drilling of holes of 0.59 kg/hole (TSP) and 0.31 kg/hole (PM_{10}) was used as recommended within table 11.9-4 of the US EPA AP 42 Chapter 11.9 Western *Surface Coal* Mining and Appendix A of the NPI EETM for Mining v 3.0 (July 2011).

D.3.2 Blasting

The following formula sourced from the NPI EETM V2.3 (2001) has been used to estimate emissions from blasting:

- $EF_{TSP} = 344 \times A^{0.8} \times M^{-1.9} \times D^{-1.8}$ (kg/blast) (A)
- $EF_{PM10} = 0.52 \times 344 \times A^{0.8} \times M^{-1.9} \times D^{-1.8}$ (kg/blast)

where A is the area of the blast, D is the depth of the holes and M is the material moisture content (%).

Note that the area blasted as well as the depth of the holes is dependent on the type of material blasted.

This equation has since been updated as

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

in latter versions of the NPI EETM for mining, following the findings in the Improvement of NPI fugitive particulate matter emission estimation techniques report by SKM (2005) in which '*it was recommended that Equation 18 (A) be replaced with Equation 19 (B) as it was believed that Equation 18 (A) overestimated the TSP from blasting activities'* (NPI EETM June 2011).

The key disadvantage of (B) is that it no longer differentiates between the nature of the material blasted (in terms of moisture content) nor the manner in which the material will be handled. For example the depth of the holes used in blasting overburden when the handled by dragline is typically deeper than that used when blasting overburden for removal by truck and shovel. Thus equation B predicts the same amount of dust generated per square hectare when blasting either overburden or coal.

Although the approach adopted is potentially conservative, the model results do not highlight dust emissions from blasting as a significant contributor to ground-level impacts at receptor locations during model-predicted adverse meteorological conditions. Thus the conclusions of the assessment are not significantly influenced by the application of the adopted methodology.

D.3.3 Draglines

The emission factor for dragline activity has been sourced from the US EPA AP 42 Chapter 11.9 *Western Surface Coal* Mining and is given as follows:

- $EF_{TSP} = 0.0046 \times (d^{1.1}) \times (M^{-0.3})$ (kg/bcm)
- $EF_{PM10} = 0.75 \times 0.0029 \times (d^{0.7}) \times (M^{-0.3})$ (kg/bcm)

where d is the dragline drop height (m) and M is the material moisture content (%).

D.3.4 Excavators/Shovels/Front-End Loaders

For the loading of trucks with overburden the default emission factor for TSP of 0.018 kg/tonne as recommended in table 11.9-4 of the US EPA AP42 has been used. Based on the PM_{10}/TSP ratio for dozer activities (Table 11.9-2 *Dozers on overburden*), gives an emission factor for PM_{10} of 0.0135 kg/tonne.

For the loading of coal, the US EPA AP42 and NPI EETM for Mining V3.0 recommended emission factor formulas have been used:

- $EF_{TSP} = 0.58 \times M^{-1.3}$ (kg/tonne)
- $EF_{PM10} = 0.75 \times 0.0596 \times M^{-0.9}$ (kg/tonne)

where M is the material moisture content (%).

D.3.5 Bulldozers

The TSP and PM_{10} emission factors for dozers on coal were sourced from the US EPA AP42 which is in agreement with that recommended by the NPI EETM for Mining V3.0:

- $EF_{TSP} = 35.6 \times (s^{1.2}) \times (M^{-1.4})$ (kg/hr)
- $EF_{PM10} = 0.75 \times 8.44 \times (s^{1.5}) \times (M^{-1.4})$ (kg/hr)

The TSP and PM_{10} emission factors for dozers on overburden were sourced from the US EPA AP42 which is in agreement with that recommended by the NPI EETM for Mining V3.0:

- $EF_{TSP} = 2.6 \times (s^{1.2}) \times (M^{-1.3})$ (kg/hr)
- $EF_{PM10} = 0.75 \times 0.45 \times (s^{1.5}) \times (M^{-1.4})$ (kg/hr)

where s is the material silt content (%) and M is the material moisture content (%).

D.3.6 Truck Unloading

The default TSP and PM_{10} emission factor for truck unloading of overburden has been sourced from the NPI EETM for Mining V3.0 (2011)

- $EF_{TSP} = 0.012$ (kg/tonne)
- $EF_{PM10} = 0.0043$ (kg/tonne)

The default TSP and PM_{10} emission factor for truck unloading of coal has been sourced from the NPI EETM for Mining V3.0 (2011)

- EF_{TSP} = 0.01 (kg/tonne)
- EF_{PM10} =0.0042 (kg/tonne)

D.3.7 Wheel Generated Dust

The emission factors for wheel generated dust were taken from the NPI EETM for Mining V3.0 (2011):

- $EF_{TSP} = 1.38 \times (s/12)^{0.9} \times (W/3)^{0.45}$ (kg/vkt)
- $EF_{PM10} = 0.42 \times (s/12)^{0.9} \times (W/3)^{0.45}$ (kg/vkt)

where s is the haul road silt content (%) and W is the vehicle mass (t).

D.3.8 Graders

The emission factors for grading have been sourced from the US EPA AP42 and the NPI EETM for Mining V3.0 (2011) as:

- $EF_{TSP} = 0.0034 \times S^{2.5}$ (kg/vkt)
- $EF_{TSP} = 0.6 \times 0.0056 \times S^{2.0}$ (kg/vkt)

Where S is the speed of the grader (kph)

D.3.9 Loading and Unloading Stockpiles

Default emission factors for the loading of coal stockpiles were sourced from the NPI EETM for Mining V3.0 (2011) as:

- EF_{TSP} = 0.004 (kg/tonne)
- EF_{PM10} = 0.0017 (kg/tonne)

Default emission factors for the unloading of coal stockpiles were sourced from the NPI EETM for Mining V3.0 (2011) as:

- EF_{TSP} = 0.03 (kg/tonne)
- EF_{PM10} = 0.013 (kg/tonne)

Note that for the unloading of stockpiles by reclaimer the emission factors for miscellaneous transfer points have been used. Also note that reclaiming using dozers has been explicitly accounted for based on dozer hours allocated to CPPs.

D.3.10 Loading of Trains

Default emission factors for the unloading of trains were sourced from the NPI EETM for Mining V3.0 (2011) as:

- EF_{TSP} = 0.0004 (kg/tonne)

- EF_{PM10} = 0.00017 (kg/tonne)

D.3.11 Miscellaneous Transfer and Conveying Points

Emission factors for miscellaneous transfer points have been sourced from the NPI EETM for Mining V3.0 (2011) as

- $EF_{TSP} = 0.74 \times 0.0016 \times (U/2.2)^{1.3} \times (M/2)^{-1.4}$ (kg/tonne)
- $EF_{PM10} = 0.35 \times 0.0016 \times (U/2.2)^{1.3} \times (M/2)^{-1.4}$ (kg/tonne)

where U is the mean wind speed (m/s) and M is the material moisture content (%).

D.3.12 Wind Speed Dependent Wind Erosion

Following the recommendations of SKM (2005), for the purposes of estimating wind erosion from stockpiles and exposed areas, the US EPA AP42 formula. In contrast to the default emission factor of 0.4 kg/ha/hr for TSP recommended in the NPI EETM for Mining v 3.0 (2011), Equation 1 has been used in order to account for the climate variations across Australia while it is recognised that there is uncertainty in the representativeness of the equation.

$$E = 1.9\left(\frac{s}{1.5}\right)365\left(\frac{365-p}{235}\right)\left(\frac{f}{15}\right) \quad \text{(Equation 1)}$$

Where: s is the silt content (%), f is the percentage of time that wind speed is greater than 5.4 m/s at the mean height of the stockpile, and p is the number of days when rainfall is greater than 0.25 mm.

Equation 1 is used to provide an estimate for the annual total emissions of dust (TSP) associated with wind erosion. The local meteorological data was then used to distribute the total annual emissions equally to those hours for which the wind speed is greater than a critical wind speed using the methodology outlined in the following sections.

Wind Erosion for Stockpiles

The annual total emissions of TSP calculated using equation 1 were distributed on an hourly basis in accordance with equation 2 (SKM, 2005)

$$F = ku^3\left(1-\frac{u^2}{u_o^2}\right) \text{ when } u > u_o, \text{ otherwise } F = 0 \quad \text{(Equation 2)}$$

Where k is a constant, u is hourly average wind speed at root mean square height of the stockpile (m), u_0 is a wind speed threshold velocity.

The critical wind speed u_0 is calculated based on a critical wind speed of 5.4 m/s at the root mean square height of the stockpile, corrected to 10 m based on logarithmic wind speed profile as shown in Equation 3.

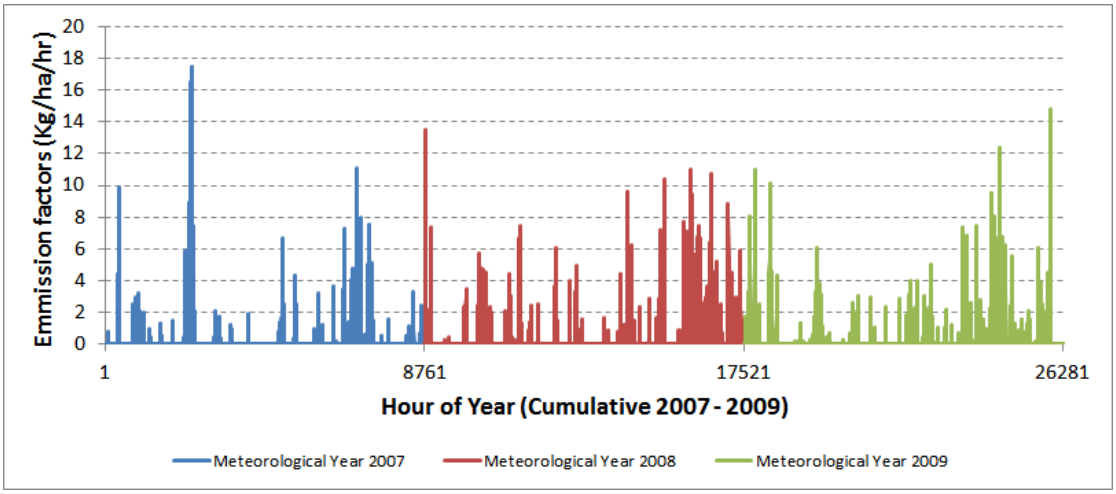
$$u_o = 5.4ln\left(\frac{10-z_0}{z-z_o}\right)$$ (Equation 3)

Where z is the root mean square height of a stockpile (m), z_0 is the surface roughness (0.3 m).

The constant k in Equation 2 is obtained based on the relationship that the cumulative hourly emissions calculated from Equation 2 are equal to the total annual emissions calculated from Equation 1.

Presented in Figure 2 is an example of the wind speed dependent wind erosion emission factors used for a 20 m stockpile for the three year period 2007 through 2009.

Figure 2: Example – Hourly Wind Speed Dependent Emission Factors for a 20 m Stockpile



Wind Erosion for Exposed Areas

The methodology for the development of wind speed dependent dust emissions for exposed areas is identical to that for stockpiles with a critical wind speed of 5.4 m/s at 10 m height used in Equation 2.

D.3.13 Ventilation Outlets

In the absence of site-specific information, emissions from the two Project ventilation outlets were estimated from concentration data provided in the Ellensfield EIS (Vale Australia, 2009) to be 4,520 kg/year/Mtpa of ROM coal for TSP and 2,260 kg/year/Mtpa ROM coal for PM_{10}.

D.4 Activities and Emission Factors

Presented in this section are the emission factors and controls used in the air quality assessment.

D.4.1 Current Operations

Table 7: Activity, Uncontrolled Emission Factors and Controls for GRB Mine Complex

Activity	Units	TSP	PM_{10}	TSP Control (%)	PM_{10} Control (%)	Nature of Control
Topsoil						
Dozers	kg/hr	5.82	1.21	0	0	No control
Drilling and blasting						
Holes	kg/hole	0.59	0.31	70	70	Water sprays
Blasting of OB	kg/blast/(area^0.8)	0.29	0.15	0	0	No control
Blasting of Coal	kg/blast/(area^0.8)	0.58	0.30	0	0	No control
Overburden - T&S						
Scrapers	kg/VKT	8.25	2.79	0	0	No control
Shovel/FEL	kg/t	0.03	0.01	0	0	No control
WDG Truck: Pit - Dump	kg/VKT	5.99	1.82	75	75	Level 2 watering
In-Pit Dumping of Overburden	kg/t	0.01	0.00	0	0	No controls
Out-of-Pit Dumping of Overburden	kg/t	0.01	0.00	0	0	No controls
WDG Truck: Dump - Pit	kg/VKT	4.24	1.29	75	75	Level 2 watering
Overburden - Dragline						
Dozers	kg/hr	5.82	1.21	50	5	Pit retention
Dragline	kg/bcm	0.06	0.01	50	5	Pit retention
Coal - in pit activities						
Excavator/FEL	kg/t	0.03	0.01	50	5	Pit retention
Dozers	kg/hr	35.26	10.16	50	5	Pit retention
Transport of Coal						
WGD Truck: Pit to CPP1	kg/VKT	4.86	1.48	75	75	Level 2 watering
Dumping of coal at CPP1	kg/t	0.01	0.004	0	0	No control
WGD Truck: CPP1 to Pit	kg/VKT	3.33	1.01	75	75	Level 2 watering
WGD Truck: Pit to CPP2	kg/VKT	4.86	1.48	75	75	Level 2 watering
Dumping of coal at CPP2	kg/t	0.01	0.004	0	0	No control
WGD Truck: CPP2 to Pit	kg/VKT	3.33	1.01	75	75	Level 2 watering
Road Maintenance						
Graders	kg/VKT	0.19	0.09	75	75	Level 2 watering
Water Trucks	kg/VKT	3.42	1.04	75	75	Level 2 watering

Activity	Units	TSP	PM_{10}	TSP Control (%)	PM_{10} Control (%)	Nature of Control
Rehandle						
Truck Dumping of Coal	kg/t	0.01	0.004	0	0	No controls
FEL into Truck	kg/t	0.11	0.13	0	0	No controls
WGD Truck: Stockpile to CPP	kg/VKT	4.86	1.48	75	75	Level 2 watering
WGD Truck: CPP to Stockpile	kg/VKT	3.33	1.01	75	75	Level 2 watering
Broadmeadow UG Mine						
Conveyor - ROM coal from below surface to in-pit conveyor	kg/ha/year	2.1×10^{4}	1.0×10^{4}	50	50	U-shaped conveyor
Conveyor - transfer point	kg/t	6.5×10^{-4}	3.1×10^{-4}	75	75	Chute with water sprays
Conveyor - ROM coal on in-pit conveyor	kg/ha/year	2.1×10^{4}	1.0×10^{4}	50	50	U-shaped conveyor
Conveyor - transfer point	kg/t	6.5×10^{-4}	3.1×10^{-4}	75	75	Chute with water sprays
Conveyor - to out-of-pit stockpile	kg/ha/year	2.1×10^{4}	1.0×10^{4}	50	50	U-shaped conveyor
Loading of stockpile	kg/t	4×10^{-3}	1.7×10^{-3}	25	25	Variable height stacker
FEL loading trucks	kg/t	0.11	0.13	0	0	No control
WGD: from out-of-pit stockpile to ROMs	kg/VKT	4.86	1.48	75	75	Level 2 watering
WGD: from ROMs to out-of-pit stockpile	kg/VKT	3.33	1.02	75	75	Level 2 watering
unloading of ROM coal at CPP1	kg/t	0.01	0.004	0	0	No controls
unloading of ROM coal at CPP2	kg/t	0.01	0.004	0	0	No controls
ROM #1 and ROM #2 at CPP #1 (Broadmeadows)						
Dozers on ROM coal (Picked up by underground conveyors)	kg/hr	35.3	10.2	0	0	No control
Conveyor - ROM coal to breaker station	kg/ha/year	4.2×10^{3}	2.1×10^{3}	50	50	U-shaped conveyor
Rotary Drum Crushing	kg/tonne	1.5×10^{-2}	5.5×10^{-3}	50	50	Water sprays
Conveyor - raw coal from breaker station to raw coal stockpile	kg/ha/year	4.2×10^{3}	2.1×10^{3}	50	50	U-shaped conveyor
Loading raw coal stockpiles	kg/t	4.0×10^{-3}	1.7×10^{-3}	25	25	Variable height stacker
Dozers on raw coal (picked up by underground conveyors)	kg/hr	20.0	5.8	0	0	No control
Conveyor - raw coal to CPP #1	kg/ha/year	4.2×10^{3}	2.1×10^{3}	50	50	U-shaped conveyor
Conveyor - product coal from CPP #1 to product stockpile	kg/ha/year	4.2×10^{3}	2.1×10^{3}	100	100	Material sufficiently wet
Loading product coal stockpiles - radial stacker	kg/t	4.0×10^{-3}	1.7×10^{-3}	100	100	Material sufficiently wet
Dozers on product coal (picked up by underground conveyors)	kg/hr	11.0	3.3	100	100	Material sufficiently wet
Conveyor - product coal to train load-out hopper	kg/ha/year	4.2×10^{3}	2.1×10^{3}	100	100	Material sufficiently wet
Loading of hopper - product coal	kg/t	2.1×10^{-4}	9.9×10^{-5}	100	100	Material sufficiently wet
Loading of trains from hopper - product coal	kg/t	4.0×10^{-4}	1.7×10^{-4}	100	100	Material sufficiently wet

Activity	Units	TSP	PM_{10}	TSP Control (%)	PM_{10} Control (%)	Nature of Control
Rejects						
Conveyor from CPP #1 to rejects bin	kg/ha/year	4.2×10^{3}	2.1×10^{3}	100	100	Material sufficiently wet
Conveyor - transfer point (assumed only 1)	kg/t	2.1×10^{-4}	9.9×10^{-5}	100	100	Material sufficiently wet
Dumping of rejects into bin	kg/t	2.1×10^{-4}	9.9×10^{-5}	100	100	Material sufficiently wet
Loading of trucks from rejects bin	kg/t	2.1×10^{-4}	9.9×10^{-5}	100	100	Material sufficiently wet
WGD: Rejects bin to rejects dump	kg/VKT	4.5	1.4	75	75	Level 2 watering
Dumping of rejects	kg/t	1.0×10^{-2}	4.2×10^{-3}	100	100	Material sufficiently wet
WGD: Rejects dump to rejects bin	kg/VKT	3.0	0.92	75	75	Level 2 watering

D.4.2 Red Hill Mine

Table 8: Activity, Uncontrolled Emission Factors and Controls for Red Hill Mine

Activity	Units	TSP	PM_{10}	TSP Control (%)	PM_{10} Control (%)	Reason For Control
Primary Breaker Station	kg/tonne	0.015	0.006	70	70	Water sprays, partially enclosed
Dozers	kg/hour	35.3	10.2	0	0	No control
Rotary Breaker Station	kg/tonne	0.015	0.006	70	70	Water sprays, partially enclosed
Surge Bin	kg/tonne	0.001	0.000	70	70	Water sprays, partially enclosed
Tertiary breaker station	kg/tonne	0.015	0.006	70	70	Water sprays, partially enclosed
Bin	kg/tonne	0.001	0.000	70	70	Water sprays, partially enclosed
Transfer points	kg/tonne	0.001	0.000	70	70	Water sprays, partially enclosed
conveyor	kg/ha/year	2.1×10^{4}	1.0×10^{4}	50	50	Water sprays
Stacking	kg/tonne	0.004	0.002	50	50	Water sprays
Reclaiming	kg/tonne	0.001	0.000	50	50	Water sprays
WSD Stockpiles	kg/ha/year	1372.4	686.2	50	50	Water sprays
Ventilation Outlets	kg/year/Mtpa	4520	2260	0	0	No control

D.4.3 Eaglefield Mine

For the purposes of the cumulative impact assessment dust emission rates were derived from information contained in the Eaglefield EIS (Table 7 of Eaglefield, 2011) which suggested a dust loading of 0.657 kg of TSP per tonne of ROM coal and 0.2409 kg of PM_{10} per tonne of ROM coal.

Presented in Table 9 are the emission rates for dust emission sources for Eaglefiled mine that have been used in this assessment.

Table 9: Emission Rates for Eaglefield Mine (Source: Table 7, Eaglefield, 2011)

Activity	TSP Emission Rate (tonnes/year)	PM_{10} Emission Rate (tonnes/year)
In pit sources	6410	2354
Out of pit sources	0	0
Above pit sources	0	0
CHPP & Plant	158	54
Conveyor	2	1
Total (tonnes)	6570	2409

D.4.4 Grosvenor and Moranbah North Mines

Emission rates for the dust emission sources associated with Grosvenor Mine (underground mine) and Moranbah North Mine (underground mine) were based on those provided in the Grosvenor EIS Air Quality technical report (Grosvenor, 2011). The dust loading for emissions from both mines was estimated to be 0.0306 kg of TSP per tonne of ROM coal and 0.0153 kg of PM_{10} per tonne of ROM coal.

Appendix E Summary of PM_{10} Emissions Inventories

E.1 Current Operations

Table 10: Emissions Inventory (t/year) for GRB Mine Complex

Activity	FY15	FY30	FY40	FY50	FY15	FY30	FY40	FY50
Production - ROM tonnes (Mtpa)	14.0	16.6	14.1	9.4				
Pit-Related								
Topsoil	3	8	9	2	0.0%	0.1%	0.1%	0.0%
Drilling & Blasting	150	171	155	94	1.9%	2.0%	1.8%	2.2%
Overburden by T&S	887	912	911	386	11.2%	10.6%	10.6%	8.9%
Dragline	548	440	449	426	6.9%	5.1%	5.2%	9.9%
Dozers on Overburden	73	96	93	46	0.9%	1.1%	1.1%	1.1%
Dumping of Overburden	1,019	1,048	1,048	444	12.9%	12.1%	12.2%	10.3%
Coaling	209	260	238	178	2.6%	3.0%	2.8%	4.1%
					36.4%	**34.0%**	**33.8%**	**36.5%**
Transport of Material								
Overburden	2,386	2,722	2,778	1,197	30.1%	31.5%	32.4%	27.7%
Coal	389	440	419	287	4.9%	5.1%	4.9%	6.6%
Rejects	23	95	21	32	0.3%	1.1%	0.2%	0.7%
					35.3%	**37.7%**	**37.5%**	**35.1%**
Road Maintenance								
Road Maintenance	80	136	130	67	1.0%	1.6%	1.5%	1.6%
					1.0%	**1.6%**	**1.5%**	**1.6%**
CPP's								
CPP1	167	183	173	143	2.1%	2.1%	2.0%	3.3%
CPP2	267	292	278	-	3.4%	3.4%	3.2%	0.0%
					5.5%	**5.5%**	**5.3%**	**3.3%**
Rehandle								
Rehandle	36	36	36	13	0.5%	0.4%	0.4%	0.3%
					0.5%	**0.4%**	**0.4%**	**0.3%**
Underground Mining								
Broadmeadow	240	122	-	-	3.0%	1.4%	0.0%	0.0%
					3.0%	**1.4%**	**0.0%**	**0.0%**
Wind Blown Dust								
Stockpiles	35	38	35	11	0.4%	0.4%	0.4%	0.3%
Exposed Areas	1,138	1,355	1,536	716	14.4%	15.7%	17.9%	16.6%
Tailings Dams	278	278	278	278	3.5%	3.2%	3.2%	6.4%
					18.3%	**19.4%**	**21.5%**	**23.3%**
Total (kg/year)	**7,929**	**8,631**	**8,586**	**4,321**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Dust Loading (kg/ROM tonne)	**0.56**	**0.52**	**0.61**	**0.46**				

Figure 3: Breakdown of Emissions Inventory - Current Operations (All of Site)

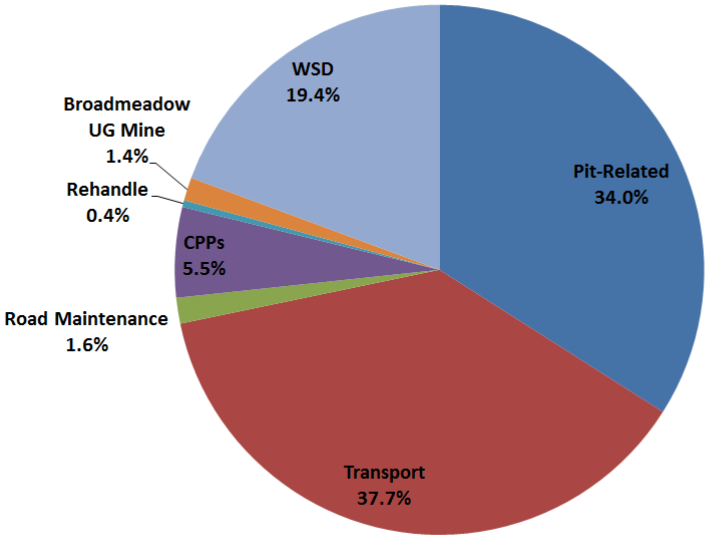
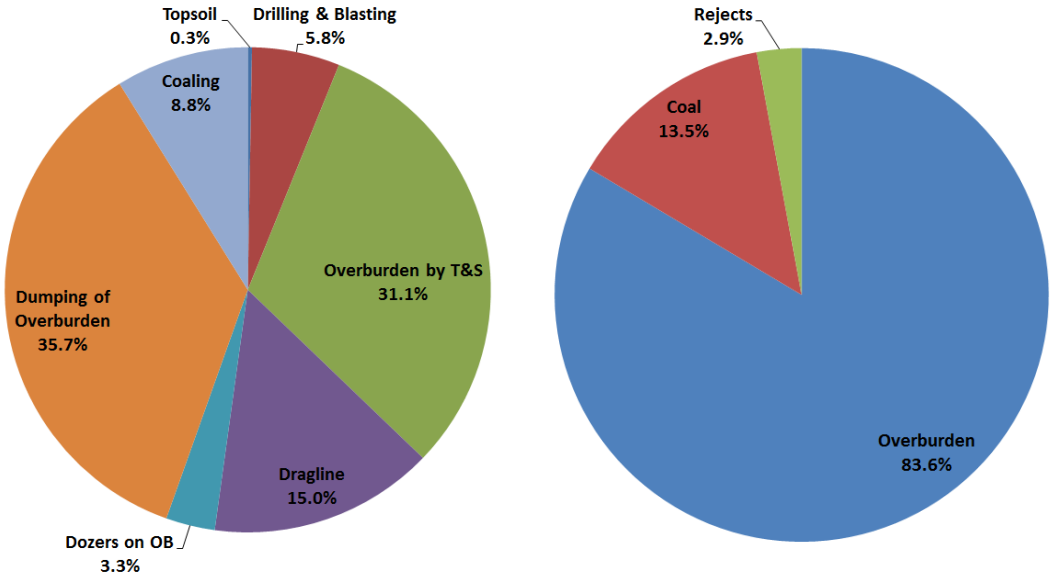


Figure 4: Breakdown of Emissions Inventory - Pit-Related Activities (left) and Transport of Material (right)



E.2 Red Hill Mine

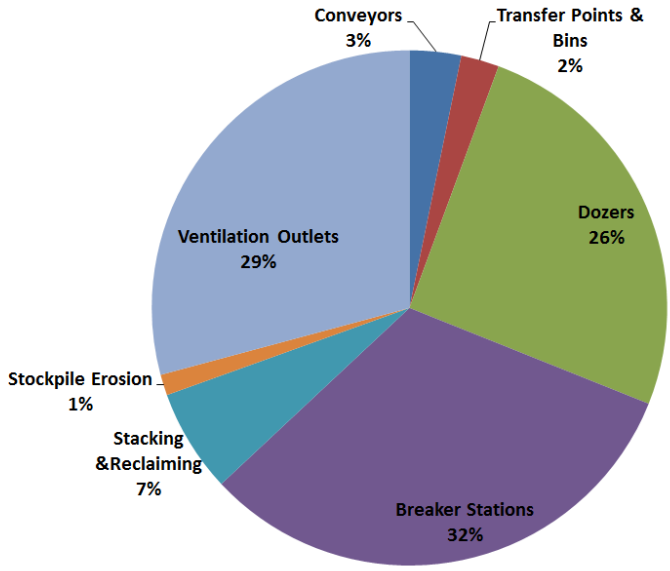
Presented in Table 11 and depicted in Figure 5 is a summary of the PM_{10} emissions inventory for Red Hill Mine based on a worst-case emissions profile corresponding to the maximum production of ROM tonnes of 15.5 Mtpa. As the relative contribution of emissions from Red Hill Mine are small compared with those of the current operations, a worst-case approach to the development of the emissions inventory as opposed to an annual varying emissions profile, was adopted. An annual total of 240 tonnes of PM_{10} corresponds to a dust loading of 0.015 kg of PM_{10} per tonne of ROM coal.

Note that due to the high moisture content of product coal, it has been assumed that the handling of materials post the CPP is not associated with emissions of dust.

Table 11: Emissions Inventory (kg/year) for Red Hill Mine (Maximum Emissions Scenario)

Source	Control	Reason for Control	Emission rate (kg/year)	Percentage of total
Conveyors	50%	Partially enclosed	7,741	3.2%
Transfer points & Bins	70%	Water sprays partially enclosed	5,744	2.4%
Dozers	0%	No control	60,971	25.4%
Breaker stations	70%	Water sprays, partially enclosed	76,598	32.0%
Stacking/Reclaiming	50%	Water Sprays	15,547	6.5%
Wind speed erosion	50%	Water sprays	3,130	1.3%
Ventilation Outlets	0%	No control	69,947	29.2%
Total	-	-	**239,678**	**100.0%**

Figure 5: Breakdown of Emissions Inventory – Red Hill Mine



Appendix F Surrounding Land Use and Receptors

F.1 Surrounding Land Use and Terrain

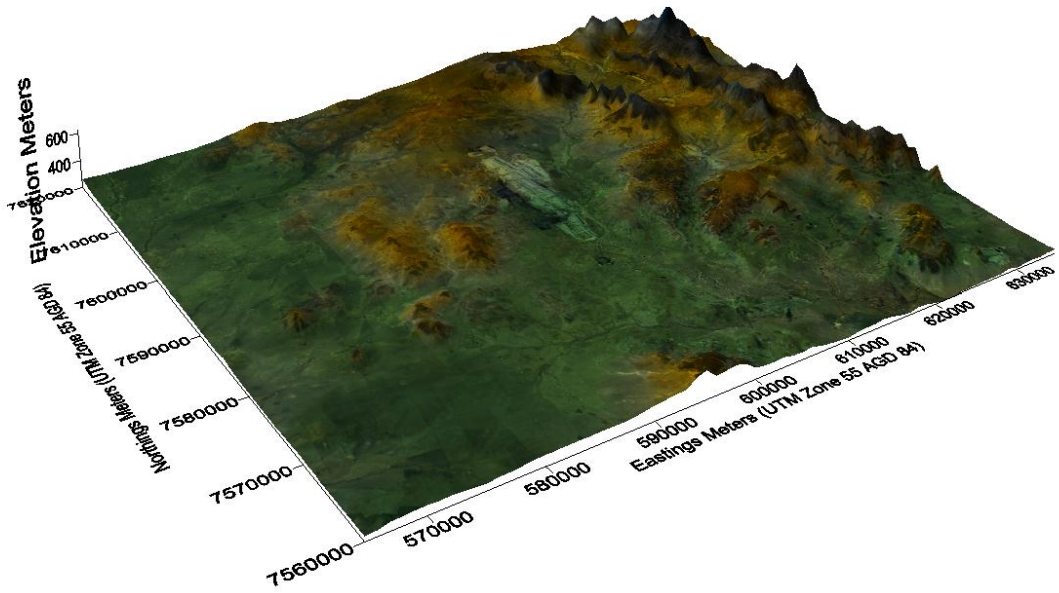
The Project site is located within the northern region of the Bowen basin, approximately 135 kilometres southwest of Mackay. The closet urban centre, Moranbah is approximately 20 kilometres south-southeast of the Project site.

Cattle grazing, agricultural land use, isolated homestead and mining activities constitute the surrounding land use for the Project site.

The region surrounding the Project site has predominantly been a cattle grazing and agricultural area. Coal mining became an important land use in late 1960s and early 1970s with the construction of Goonyella-Riverside and Peak Downs mines. Adjacent to the existing GRM southern boundary is the Moranbah North Mine (underground mine producing hard coking coal). The northern boundary of the GRB mine complex adjoins the North Goonyella Mine and Eaglefield Mine.

Terrain elevation in the vicinity of Project site is shown in Figure 7.

Figure 6: Terrain Surrounding Project Site



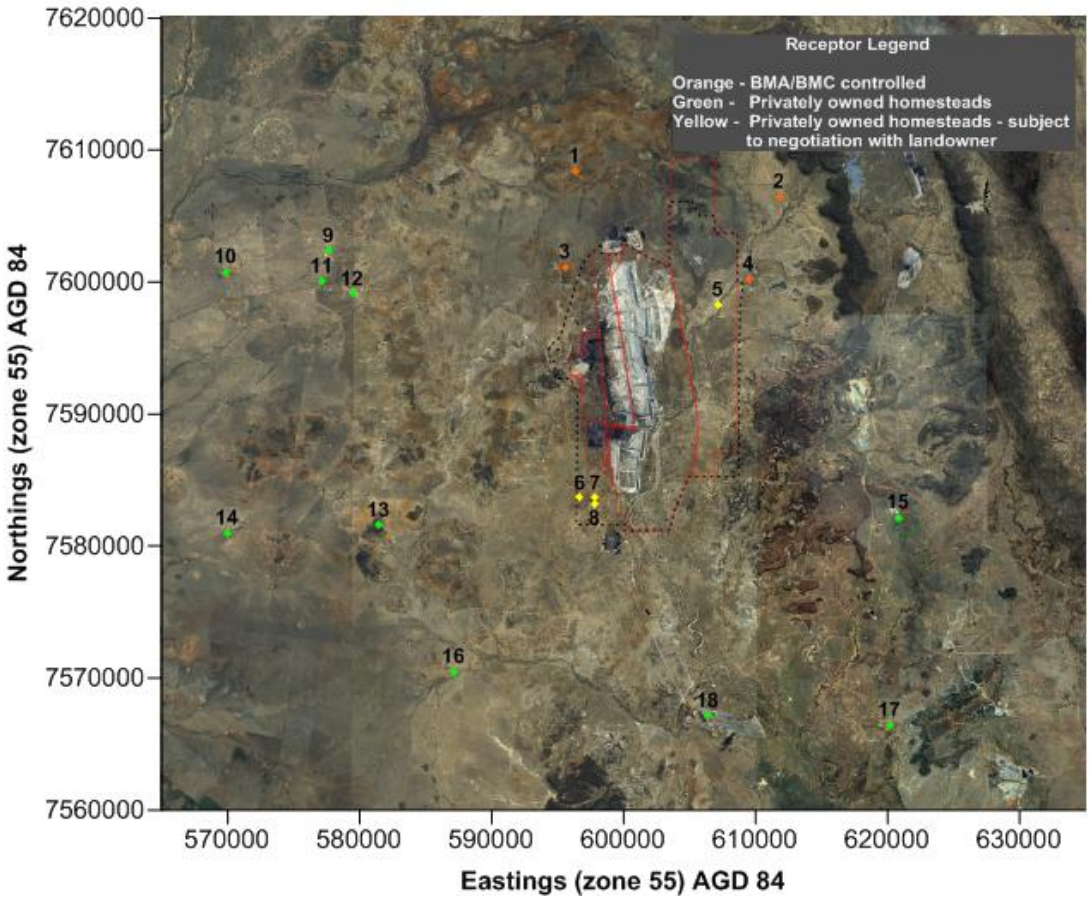
F.2 Receptors

Sensitive receptors (R) that have been identified in the vicinity (0 km to 10 km) of the Project site include isolated homesteads. The Moranbah Water Treatment Plant (R18) and a few isolated homesteads are located between 10 km and 30 km from the Project boundary. Sensitive receptors are listed in Table 12 and illustrated in Figure 7. The term 'sensitive place' used in the DEHP model conditions do not include places that are within the boundaries of the mining lease, nor places that are owned or leased by the holder of the authority or its related companies . For example, a mining camp operated by the holder of the authority would not be a sensitive place. Note that in accordance with the Department of Environment and Heritage Protection Guideline for Mining *Model Mining Conditions* (130626 EM944 Version 4), BMA's existing accommodation village (Eureka Village) and the proposed Red Hill accommodation village are not considered to be sensitive receptors for the purposes of this air quality assessment.

Table 12: Receptors

Receptor ID	Eastings (AGD 84)	Northings (AGD 84)	Receptor Name
1	596331	7608426	Denham Park
2	611792	7606475	Burton Downs
3	595590	7601155	Lapunyah
4	609497	7600256	Red Hill
5	607143	7598302	Riverside Homestead
6	596709	7583644	Broadmeadow Cottage 2
7	597877	7583646	Broadmeadow Homestead
8	597839	7583212	Broadmeadow Cottage 1
9	577672	7602403	Kimberley
10	569879	7600794	Wavering Downs
11	577172	7600079	Sondells
12	579459	7599114	Nibbereena
13	581461	7581598	Pretoria
14	569986	7580990	Wyena
15	620833	7582199	Broadlea
16	587155	7570494	Rugby
17	620183	7566455	Watunga
18	606409	7567155	Moranbah water treatment plant

Figure 7: Receptor Locations



Appendix G Goonyella Riverside and Broadmeadow Mines Meteorological Monitoring Locations

AED conducted a site visit on 14 April 2011 to review the existing meteorological stations at the GRB mine complex. The meteorological monitoring network consists of four meteorological stations: Northern Station, Broadmeadow Station, Riverside Station and Southern Station. The location of these four stations is illustrated in Figure 8. Figure 9 through to Figure 12 presents photos of the four stations. Table 13 provides the geographical coordinates and observations recorded for these meteorological stations in terms of siting and location with reference to their surrounding environment.

A comparison of on-site met data with modelled met data including wind rose is provided in Appendix I.

Table 13: Coordinates and Siting of Site-Specific Meteorological Stations

Meteorological Station	Eastings (AGD84)	Northings (AGD84)	Observations during Site Visit	Compliant with AS 2922-1987 for Siting (DEHP, 1997)
Northern Weather Station	600651	7601515	• Height above ground ≅ 3 m • No large obstacles to wind from N, NE,E and SE side, however 30-50 m high stockpiles in NW directions	• Partial
Broadmeadow Weather Station	602764	7589718	• Height above ground ≅ 3 m • Partially surrounded by trees from Southern side, Sparse low height vegetation on all other sides	• No
Riverside Weather Station	597974	7593282	• Height above ground ≅ 2.2 m • Surrounded by high trees (8 m-12 m) from all sides. Separation distance between instrument and trees range from 15 m to 25 m. • Surrounding fencing may shield wind.	• No
Southern Weather Station	599192	7585933	• Height above ground ≅ 3 m • Surrounded by dense high trees from eastern side, low height vegetation on all other sides	• No

Figure 8: Location of Site-Specific Meteorological Stations

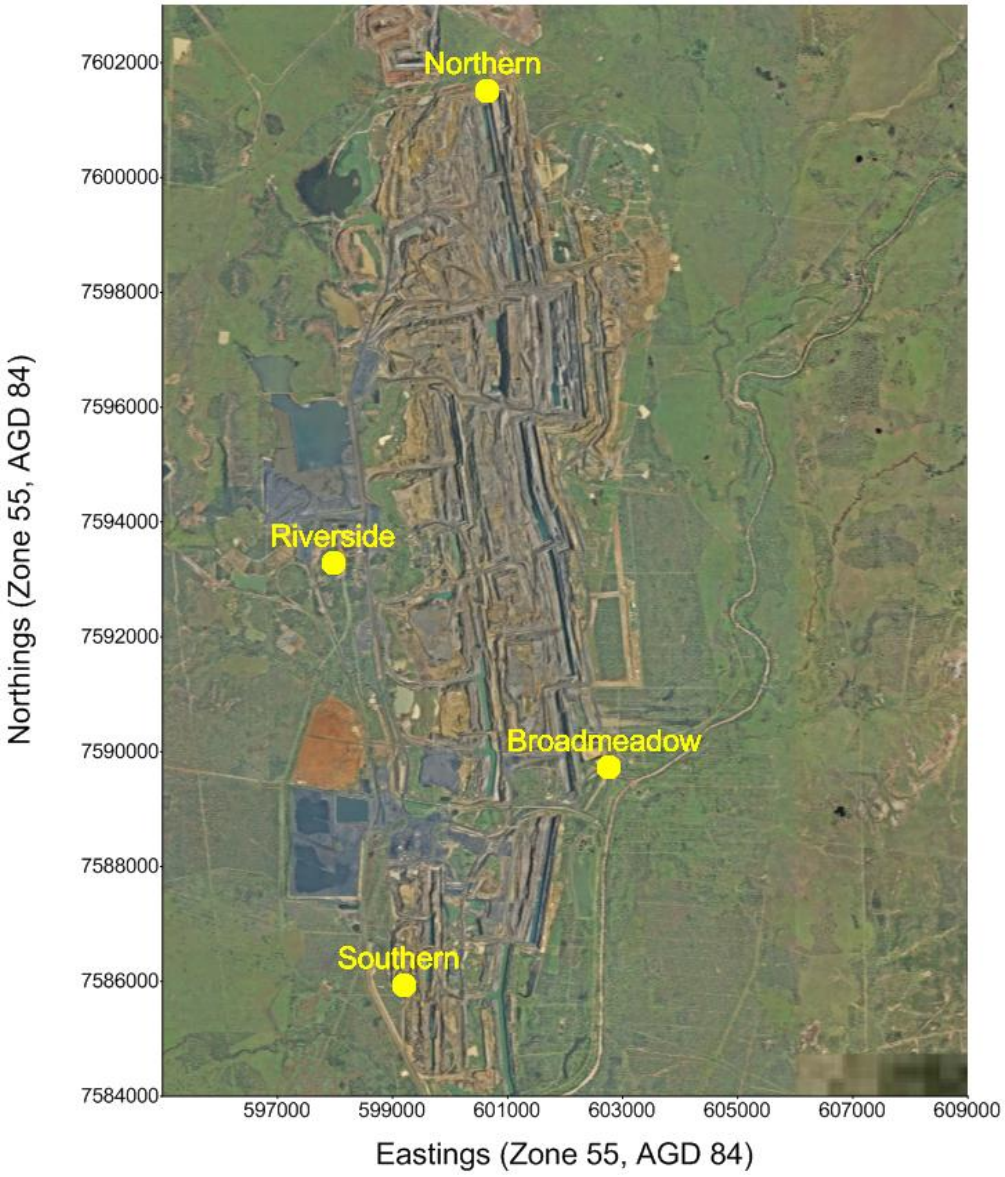


Figure 9: Broadmeadow Meteorological Station

Figure 10: Northern Meteorological Station

Figure 11: Riverside Meteorological Station

Figure 12: Southern Meteorological Station

Appendix H Development of Numerically Simulated Meteorological Fields

Dispersion modelling typically requires a meteorological dataset representative of the local airshed. Parameters required include wind speed, wind direction, temperature, atmospheric stability and mixing height. In general, meteorological observations recorded by weather stations (BoM, DEHP or client operated) include hourly wind speed, wind direction, temperature, rainfall and humidity. However additional parameters like atmospheric stability class and mixing height are difficult to measure and are often generated through the use of meteorological models.

H.1 TAPM

The meteorological model 'The Air Pollution Model' (TAPM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was used to predict initial three-dimensional meteorology for the local airshed. TAPM is a prognostic model used to predict three dimensional meteorological observations, with no local inputs required. The model develops a numerically simulated meteorological dataset consisting of parameters like wind speed, wind direction, temperature, water vapour, cloud, rain, mixing height, atmospheric stability classes etc. that are required for dispersion modelling.

Additionally TAPM includes the option to assimilate local observations (of wind speed and wind direction) in order to nudge the predicted solution towards the observed records. For this assessment, only the upper air data of TAPM is used in CALMET and thus the data assimilation functionality of TAPM was not used.

Technical details of the model equations, parameterisations and numerical methods are described in the technical paper by Hurley (2008).

The details of TAPM configuration are summarised in Table 14.

Table 14: TAPM Configuration

Parameter	Units	Value
TAPM version	-	v4.0.5
Years modelled	-	2007, 2008, 2009
Grid centre	Lat.(degrees), Lon. (degrees)	-21.75833, 147.9667
Local centre coordinates	UTM zone 55 S (m)	599951 , 7593609
Number of nested grids	-	3
Grid dimensions (nx, ny)	-	41,41
Number of vertical grid levels (nz)	-	25
Grid 1 spacing (dx, dy)	km	30,30
Grid 2 spacing (dx, dy)	km	10,10
Grid 3 spacing (dx, dy)	km	3,3
Local hour	-	GMT + 10
Synoptic wind speed maximum	m/s	30
Local Met Assimilation	-	No
Surface vegetation database	-	Default TAPM V4 database at 3-minute grid spacing (Australian vegetation and soil type data provided by CSIRO Wildlife and Ecology.
Terrain database	-	Default TAPM V4 database at 9-second grid spacing (Australian terrain height data from Geoscience Australia)

H.2 CALMET

CALMET (version 6.326) was used to simulate meteorological conditions for the local airshed. CALMET is a diagnostic three dimensional meteorological pre-processor for the CALPUFF modelling system (developed by Earth Tech, Inc.).

Prognostic output from TAPM was used as an initial guess field for the CALMET model. Using high resolution geophysical datasets CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation as well as differential heating and surface roughness associated with different land uses across the modelling domain.

The CALMET model requires three input files along with the control file where the CALMET run parameters are specified and involve:

- Geophysical data
- Upper air meteorological data

- Surface meteorological data

The inputs to these files are discussed in detail in the following.

H.2.1 Geophysical dataset

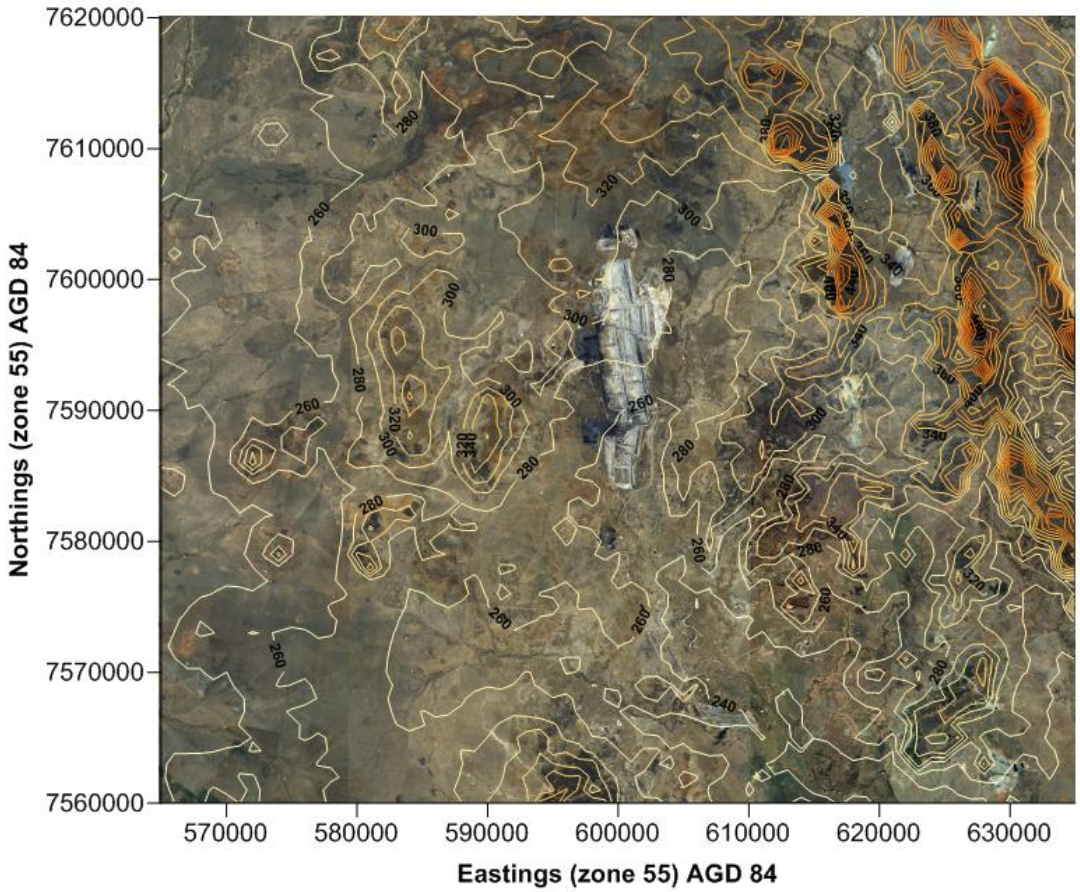
The Geophysical dataset contain terrain and land use information for the modelling domain.

Traditionally, TAPM generated terrain information and land use data are used as an input in CALMET. However TAPM V4 datasets are coarser than other publically available and hence these datasets were replaced by high resolution datasets as input for CALMET.

The terrain information for the Project was extracted from 3-arc second (90m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000. (Downloaded from USGS website http://dds.cr.usgs.gov/srtm/version2_1/SRTM3/Australia/)

Final terrain data for Geophysical dataset for CALMET is shown in Figure 13.

Figure 13: Terrain data for CALMET Geophysical Dataset



The land use or land cover data for the modelling domain was derived from 300 m resolution Globcover land cover map (© ESA 2010 and UCLouvain, published by European Space science, Dec 2010). Manual edits were performed to take into account the latest mine progressions and urban development within the modelling domain. The ESA classification system was mapped to adopt the user defined CALMET classification system. The Geotechnical parameters for the user defined land use classification were adopted from a combination of closest CALMET and AERMET land use categories.

User defined land use classification and geotechnical parameters used in CALMET are shown in figures below.

Figure 14: User Defined Land Use Categories for CALMET Modelling domain

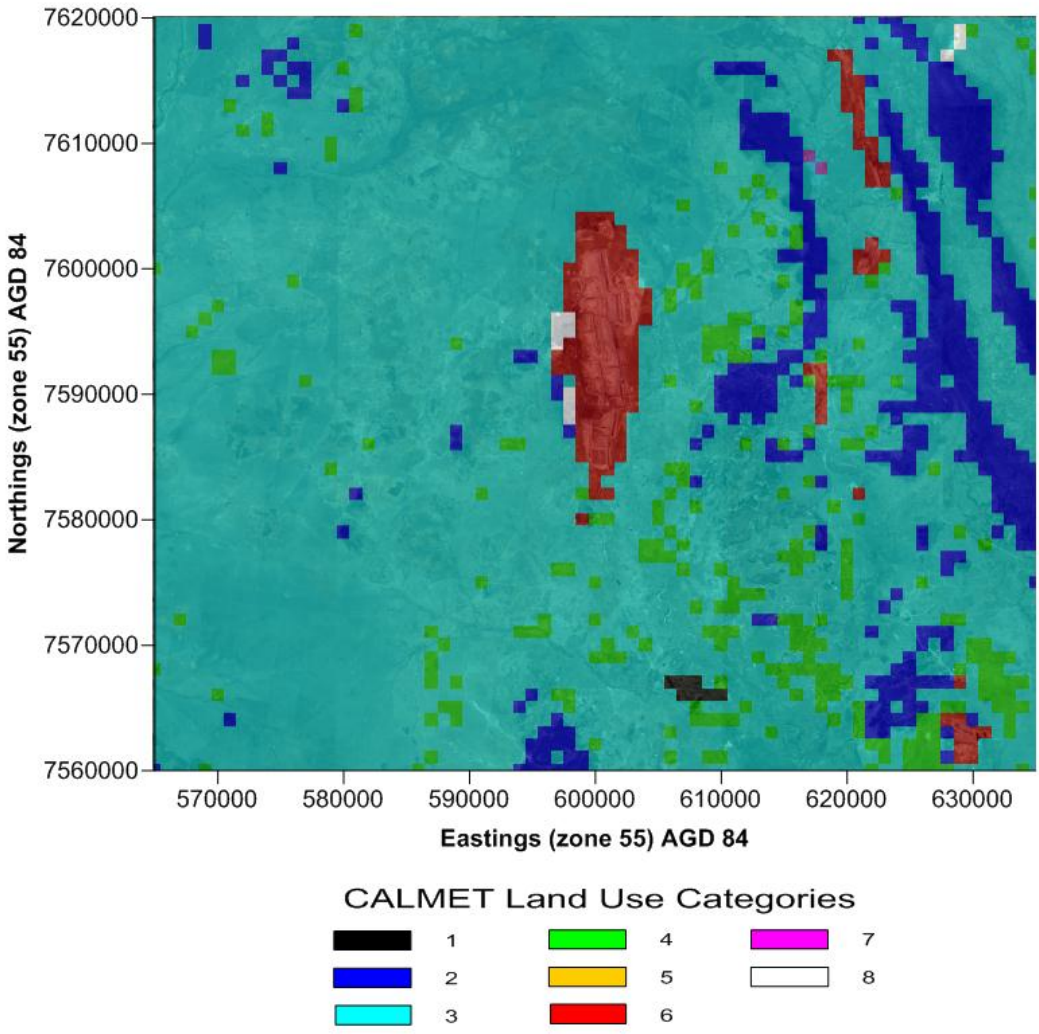


Figure 15: Geotechnical Parameters for User Defined CALMET Land Use Classification

CALMET User defined Category	ESA category	Aermet Category	Surface roughness (a)	Bowen ratio (a)	Albedo (a)	Soil heat flux parameter (b)	Anthropogenic heat flux (b)	Leaf Area Index (b)
1	17 Artificial surfaces and associated areas (Urban areas >50%)	Low intensity residential	0.54	0.8	0.16	0.25 (Calmet – Urban)	0	0.2 (Calmet – Urban)
2	3 Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)	Mixed Forest	1.3	0.3	0.14	0.15 (Calmet – Forestland)	0	6 (modified from Calmet – Forestland, 7)
	5 Open (15-40%) broadleaved deciduous forest/woodland (>5m)							
3	9 Mosaic forest or shrubland (50-70%) / grassland (20-50%)	Shrubland (Non-arid)	0.3	1	0.18	0.15 (Calmet – Forestland)	0	4.5 (average of modified Calmet forestland (above) and agriland un-irrigated)
	10 Mosaic grassland (50-70%) / forest or shrubland (20-50%)							
	11 Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)							
	12 Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)							
	2 Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)							
4	13 Sparse (<15%) vegetation	Grassland / Herbaceous	0.1	0.8	0.18	0.15 (Calmet – Rangeland)	0	0.5 (Calmet – Rangeland)
5	1 Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)	Small grains	0.15	0.5	0.2	0.15 (Calmet – Agriland irrigated)	0	3 (Calmet – Agriland irrigated)
	0 Rainfed croplands							
6	----------	Quarries/strip mine/gravel	0.3	1.5	0.2	0.15 (Calmet – Barren)	0	0.05 (Calmet – Barren)
7	Water Bodies	Open water	0.001	0.1	0.1	1 (Calmet – small water body)	0	0 (Calmet – small water body)
8		Bare rock /sand/clay non-arid	0.05	1.5	0.2	0.15 (Calmet – Barren)	0.0	0.05 (Calmet – Barren)

(a) EPA (2008), *AERSURFACE User's Guide*, developed by the Air Quality Modelling Group, USEPA office of Air Quality Planning and Standards.
(b) CALPUFF version 6, USER guide.

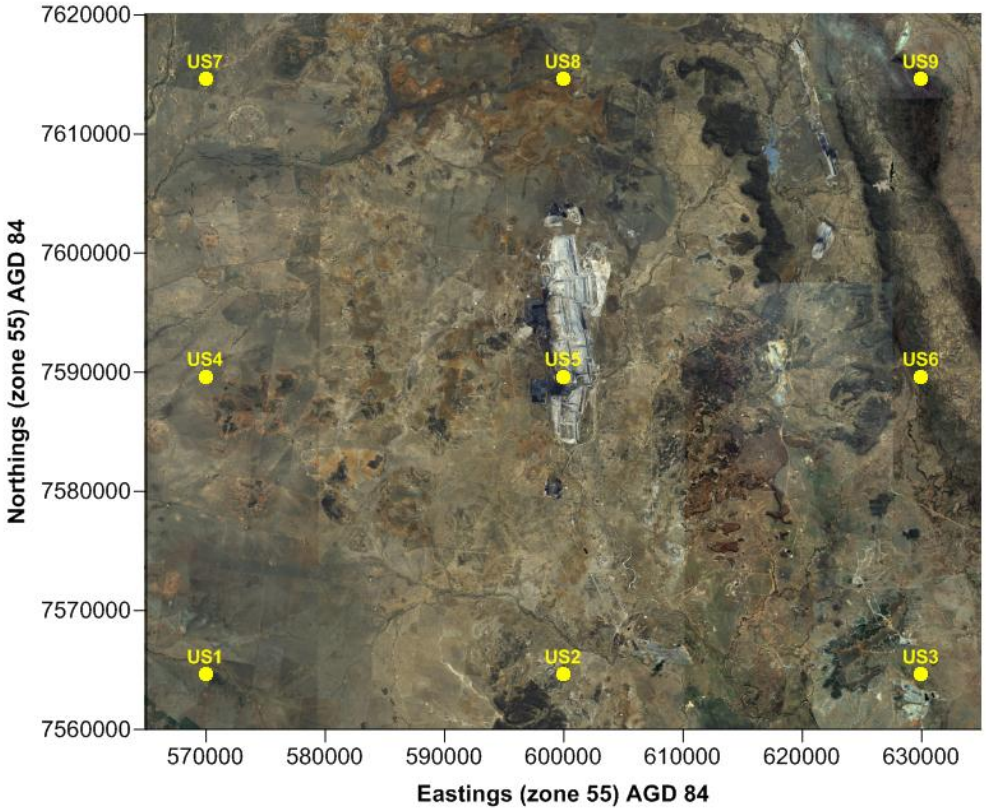
H.2.2 Upper Air Dataset

Upper air data were extracted from TAPM output for the innermost grid at nine points corresponding to shown in Figure 16. Coordinates of these upper air stations are presented in Table 15.

Table 15: Coordinates of Upper Air Stations Included in CALMET

Station Name	Source	Easting(m) AGD 84	Northing (m) AGD 84
US1	TAPM	569951	7564609
US2	TAPM	599951	7564609
US3	TAPM	629951	7564609
US4	TAPM	569951	7589609
US5	TAPM	599951	7589609
US6	TAPM	629951	7589609
US7	TAPM	569951	7614609
US8	TAPM	599951	7614609
US9	TAPM	629951	7614609

Figure 16: Location of Upper Air Stations in Reference to CALMET Modelling Domain



H.2.3 Surface Observations Dataset

Surface data were extracted from TAPM output for the innermost grid at thirteen points corresponding to shown in Figure 17. Coordinates of these upper air stations are presented in Table 16.

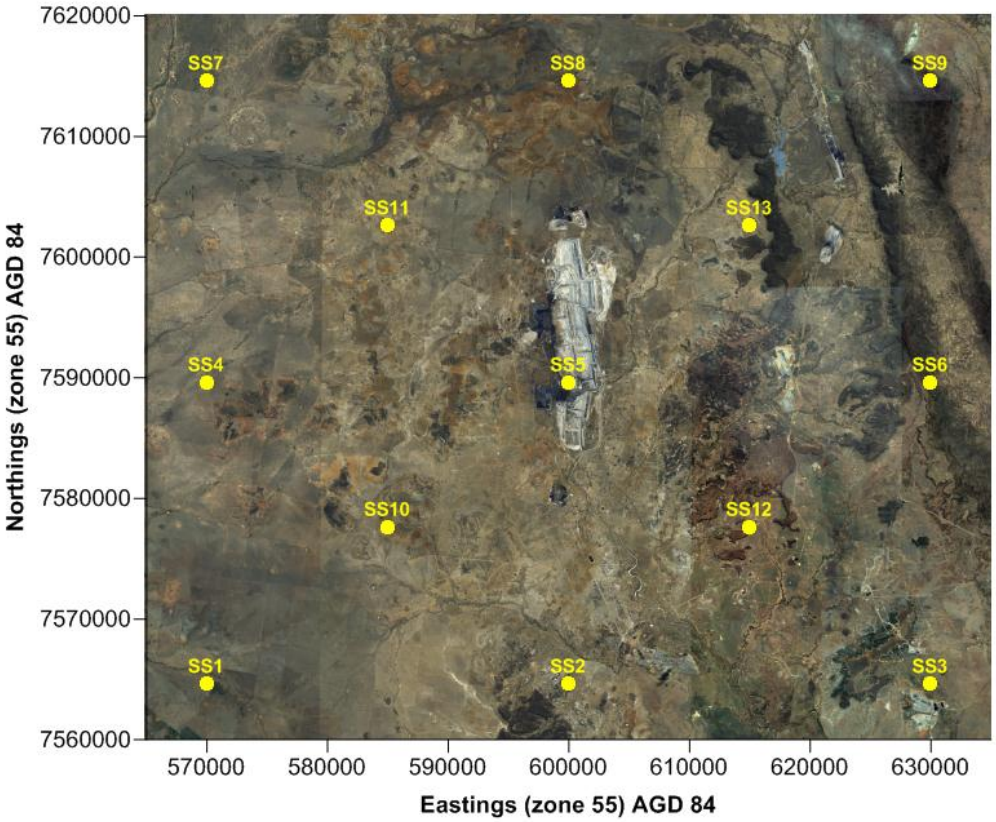
Moranbah water treatment plant records surface observations twice a day. No hourly surface observations were available from BoM or QLD DEHP monitoring stations within CALMET modelling domain for assimilation into CALMET.

Site-specific meteorological observations were available for the Project site. However as discussed in Appendix G the noncompliance of the siting of the meteorological monitoring stations was the main reason that surface observations were not assimilated into CALMET. Additionally, observed data for 2008 highlighted unrealistic inter-annual variability in wind direction compared to 2007 and 2009 (Appendix I).

Table 16: Coordinates of Surface Observation Stations Included in CALMET

Station Name	Source	Easting (m) AGD84	Northing (m) AGD84
SS1	TAPM	569951	7564609
SS2	TAPM	599951	7564609
SS3	TAPM	629951	7564609
SS4	TAPM	569951	7589609
SS5	TAPM	599951	7589609
SS6	TAPM	629951	7589609
SS7	TAPM	569951	7614609
SS8	TAPM	599951	7614609
SS9	TAPM	629951	7614609
SS10	TAPM	584951	7577609
SS11	TAPM	584951	7602609
SS12	TAPM	614951	7577609
SS13	TAPM	614951	7602609

Figure 17: Location of Surface Stations in Reference to CALMET Modelling Domain



H.2.4 CALMET Configuration

Details of CALMET configuration are presented in Table 17.

Table 17: CALMET Configuration

Parameter	Units	Value
CALMET version	-	V6.326
Years modelled	-	2007, 2008, 2009
No. X grid cells (NX)	-	71
No. Y grid cells (NY)	-	61
Grid spacing (DGRIDKM)	km	1
X coordinate (XORIGKM)	km	564.500
Y coordinate (YORIGKM)	km	7559.500
No. of vertical layers (NZ)	-	10
Number of surface stations	-	13
Number of upper air stations	-	9
Maximum radius of influence over land in the surface layer (RMAX1)	km	3
Maximum radius of influence over land aloft (RMAX2)	km	30
Maximum radius of influence over water (RMAX3)	km	10
Radius of influence of terrain features (TERRAD)	km	1
Land use database	-	Manually edited 300 m resolution Globcover land cover map (© ESA 2010 and UCLouvain, published by European Space science, Dec 2010).
Terrain database	-	Manually edited 3-arc second (90m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000
Minimum overland mixing height (ZIMIN)	m	50
Maximum overland mixing height (ZIMAX)	m	3000
UTC time zone (ABTZ)	Hours	UTC+1000

Appendix I Comparison of Observed Site-Specific and Numerically Simulated Wind Fields

I.1 Northern Meteorological Monitoring Station

Comparison of observed site-specific meteorological data (wind speed and wind direction) at GRM north meteorological monitoring site and simulated data (extracted from CALMET at nearest location) is shown in figures below.

For all the years observed wind speeds from Northern site-specific monitoring station is generally lower than the simulated CALMET. This could be attributable to the lower height (3 m) of wind anemometer at on-site meteorological station compared to 10 m CALMET data.

Observations for 2007 and 2009 highlight the dominance of winds that are primarily from southeast while CALMET predicts winds from the east-southeast as the dominant direction. Observed site-specific wind direction for the year 2008 shows unrealistically predominant winds from north direction in contrast to 2007 and 2009 highlighting issues with the data during 2008.

Figure 18: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2007. CALMET (left) and Observations (right)

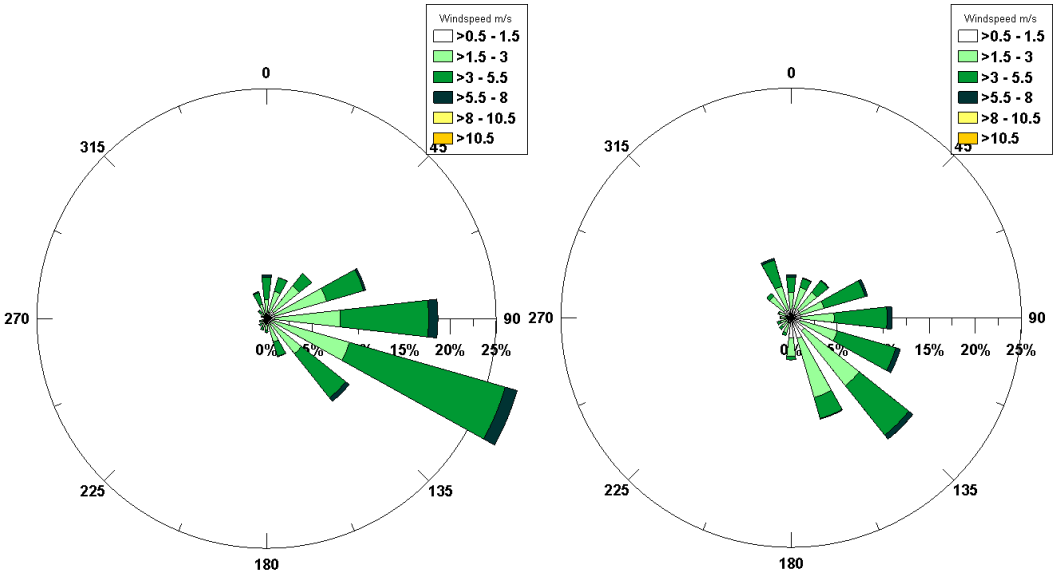


Figure 19: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2008. CALMET (left) and Observations (right)

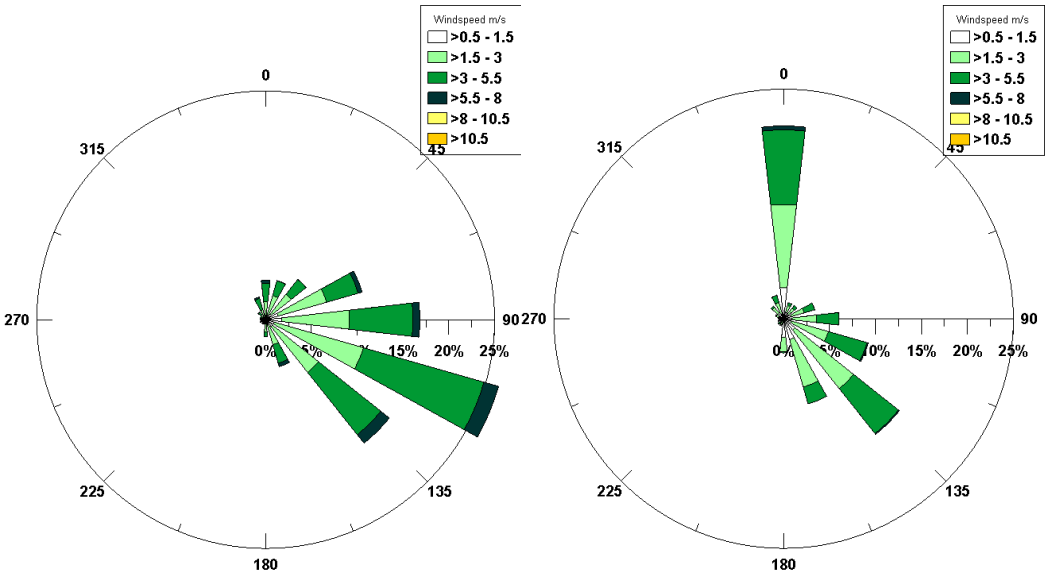


Figure 20: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2009. CALMET (left) and Observations (right)

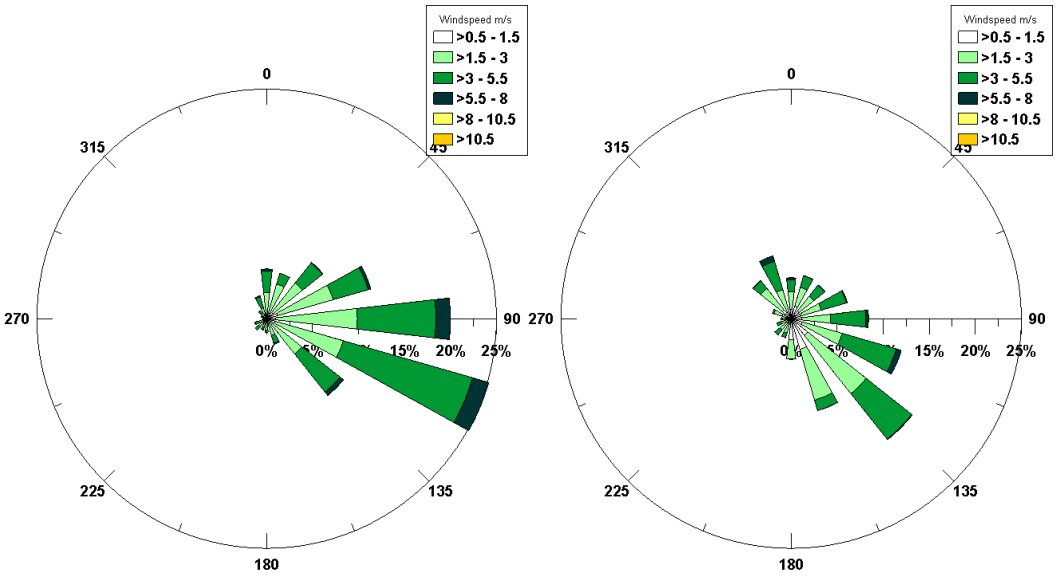
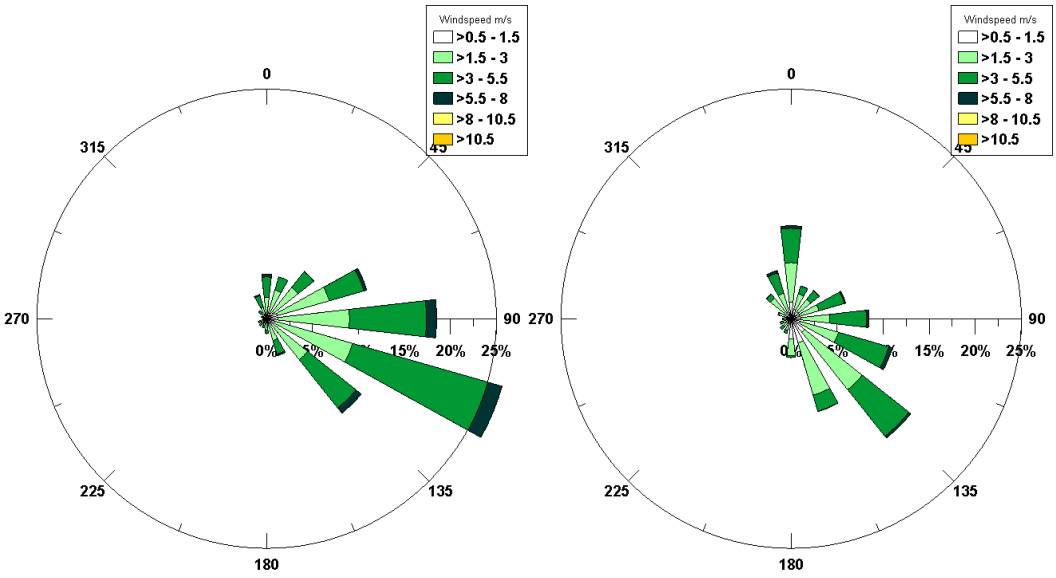


Figure 21: Annual Wind Roses at the Location of the GRM North Meteorological Monitoring Site, 2007-2009. CALMET (left) and Observations (right)



I.2 Broadmeadow, Riverside and Southern Meteorological Monitoring Stations

Observed data for the three meteorological stations (Broadmeadow, Southern and Riverside) were analysed for the years 2005 to 2008 (where available). Analysis showed very low recorded wind speeds at Riverside and Southern monitoring locations. Analysis of the observed wind data for Broadmeadow station showed winds from south and southwest as predominant directions. Due to poor siting of these three on-site meteorological station locations (Broadmeadow, Southern and Riverside) the datasets were not considered reliable and not further analysed and hence excluded from assimilation into CALMET surface dataset.

Appendix J Dispersion Modelling Methodology

This appendix presents an overview of the dispersion modelling methodology.

J.1 Dispersion Model

Dust dispersion modelling was undertaken using the US EPA approved CALPUFF model for three years of meteorological conditions at 1 km resolution wind fields developed using CALMET. General run control parameters and technical options that were selected are presented in Table 18. Defaults were used for all other options.

Table 18: CALPUFF Configuration

Parameter	Units	Value
CALPUFF version	-	V6.263
Years modelled	-	2007, 2008, 2009
No. X grid cells (NX)	-	71
No. Y grid cells (NY)	-	61
Grid spacing (DGRIDKM)	km	1
X coordinate (XORIGKM)	km	564.500
Y coordinate (YORIGKM)	km	7559.500
No. of vertical layers (NZ)	-	10
UTC time zone (XBTZ)	Hours	UTC+1000
Method used to compute dispersion coefficient (MDISP)	-	2 (internally calculated sigma v, sigma w using micrometeorology)
Computational grid size and resolution	-	Identical to CALMET grid
Sampling grid size and resolution	-	Identical to CALMET grid
Gridded receptors used (LSAMP)		False
Discrete receptors modelled	-	21 + 4610
Discrete receptors height above ground	m	1.5
Wet deposition		False
Dry deposition		True

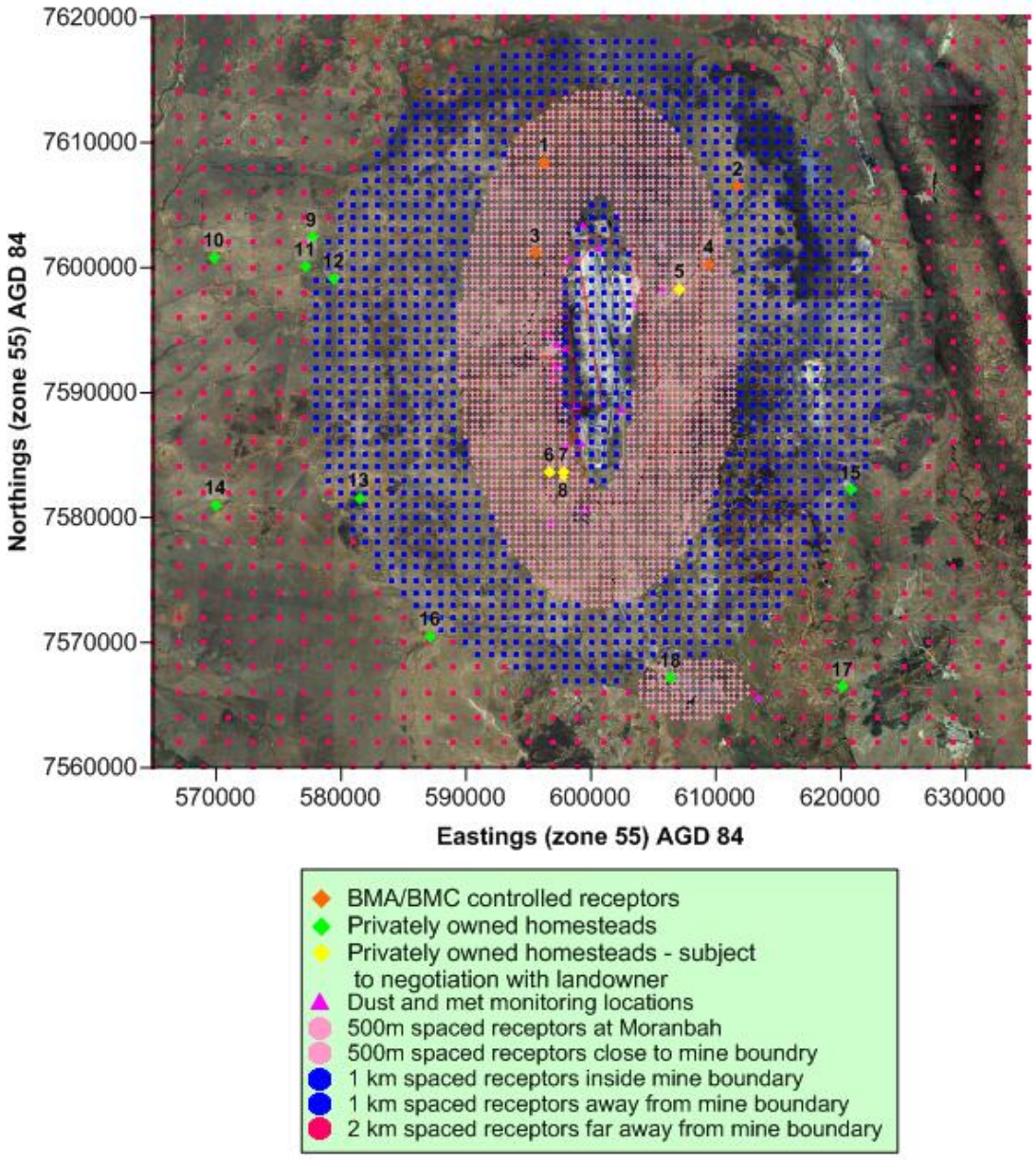
J.2 Emission Sources

Dust emission sources were identified from the information provided by BMA for the GRM, BRM and Redhill Mine. Dust emission sources for Eaglefield and Grosvenor mine were sourced from their respective EIS.

J.3 Discrete Receptor Grid

Dispersion model was used to predict 24-hour average and annual average concentrations of pollutants at 21 discrete receptors in the vicinity of Project. An additional 4610 variably spaced discrete receptors were included to generate contour plots showing the predicted impacts on regional scale. The coordinates of the receptors are presented in Table 12 and geographic location with respect to Project site is shown in Figure 7. The geographic location of the variably spaced discrete receptors is shown in Figure 22.

Figure 22: Location of Discrete Receptors for Regional Contour Plot



J.4 Modelled Scenarios

Four scenarios were considered (Table 1):

- **Project-Only Scenario**: Red Hill Mine (RHM) based on a single worst-case dust emissions scenario.
- **Existing Mining Scenario**: Goonyella Riverside Broadmeadow (GRB) mine complex based on current approvals for FY2015, FY2030, FY2040 and FY2050 mining operations. Included in the existing mining scenario is an estimate of naturally occurring dust levels based on continuous monitoring data from BMA's Moranbah Airport monitoring station.
- **Future Mining Scenario**: GRB mine complex, RHM and an estimate of naturally occurring background levels of dust. Results for the four mine configurations for GRB mine complex (i.e. FY2015, FY2030, FY2040, and FY2050) are presented.
- **Cumulative Future Mining Scenario**: GRB mine complex, RHM, and naturally occurring dust levels, have been considered in combination with impacts associated with non-BMA emission sources: Eaglefield Mine (Peabody Energy), Grosvenor Mine (Anglo Coal), and Moranbah North Mine (Anglo Coal).

Table 19: Modelled Scenarios

Scenario	RHM	GRM	BRM	EFM	Gros & MNM
Red Hill Mine	√	x	x	x	x
Existing Mining(1)	x	√	√	x	x
Future Mining(1)	√	√	√	x	x
Cumulative Future Mining(1)	√	√	√	√	√

Note (1): Consists of 4 scenarios, one each for FY2015, FY2030, FY2040, FY2050.

J.5 Pollutants Modelled

The pollutants modelled include TSP, PM_{10} and dust deposition. Model results for PM_{10} were used to predict the impact of emissions of $PM_{2.5}$ from mine-related dust generating activities based on a conservative estimate of 10% of TSP as $PM_{2.5}$ (based on US EPA AP42 Table 11.9-2).

J.6 Particle Size Distribution

In general, dust emitted from an emission source consists of a range of particle sizes that is dependent on the source characteristics.

Dust from overburden and coal handling operations is generated using mechanical means and thus the majority of dust emitted from coal mines consists of larger-sized particles (i.e.

greater than $PM_{2.5}$) when compared with particulate matter generated during combustion processes which contains a higher percentage of particles in the range of $PM_{2.5}$ to ultrafine particles. Dust from roads can be finer than that generated by material handling due to the repeated pulverising of road materials into smaller fragments and the resultant creation of fine particles which can easily become airborne.

For the purposes of the dispersion modelling, two particle size bins were considered. Their ranges and the assumed fraction for the existing and Project dust emission sources is summarised in Table 20.

Table 20: Geometric Characteristics of Particle Size Intervals used in the Dispersion Modelling

Particulate size	Geometric Mass Mean Diameter (µm)	Geometric Standard deviation (µm)
1 µm - 10 µm	3.16	2.19
10 µm – 30 µm	17.32	1.45

Appendix K Existing Mining Emission Sources

K.1 Goonyella Riverside and Broadmeadow Mine Complex

Key sources of dust emission sources associated with the existing operations at Goonyella Riverside Mine and Broadmeadow Mine include:

- In pit activities
- Coal hauling
- Topsoil stripping
- Transport of overburden to dumps
- Drilling and blasting
- Dozers on ROM stockpiles
- Stacking and reclaiming at raw coal stockpiles
- Stacking and reclaiming at product stockpiles
- Wind erosion from tailing storage facility
- Wind erosion from exposed topsoil
- Wind erosion from exposed overburden dumps
- Wind erosion from ROM, raw and product stockpiles
- Goonyella and Riverside CHPP activities (conveyers, transfer points, breaker stations, processing)

Figure 23 through to Figure 26 illustrate the locations of dust emission sources included in dispersion modelling for the existing mining scenario.

Figure 23: Calpuff Sources Locations – Haul Roads, In-Pit, Blasting, Topsoil Stripping and Exposed Topsoil

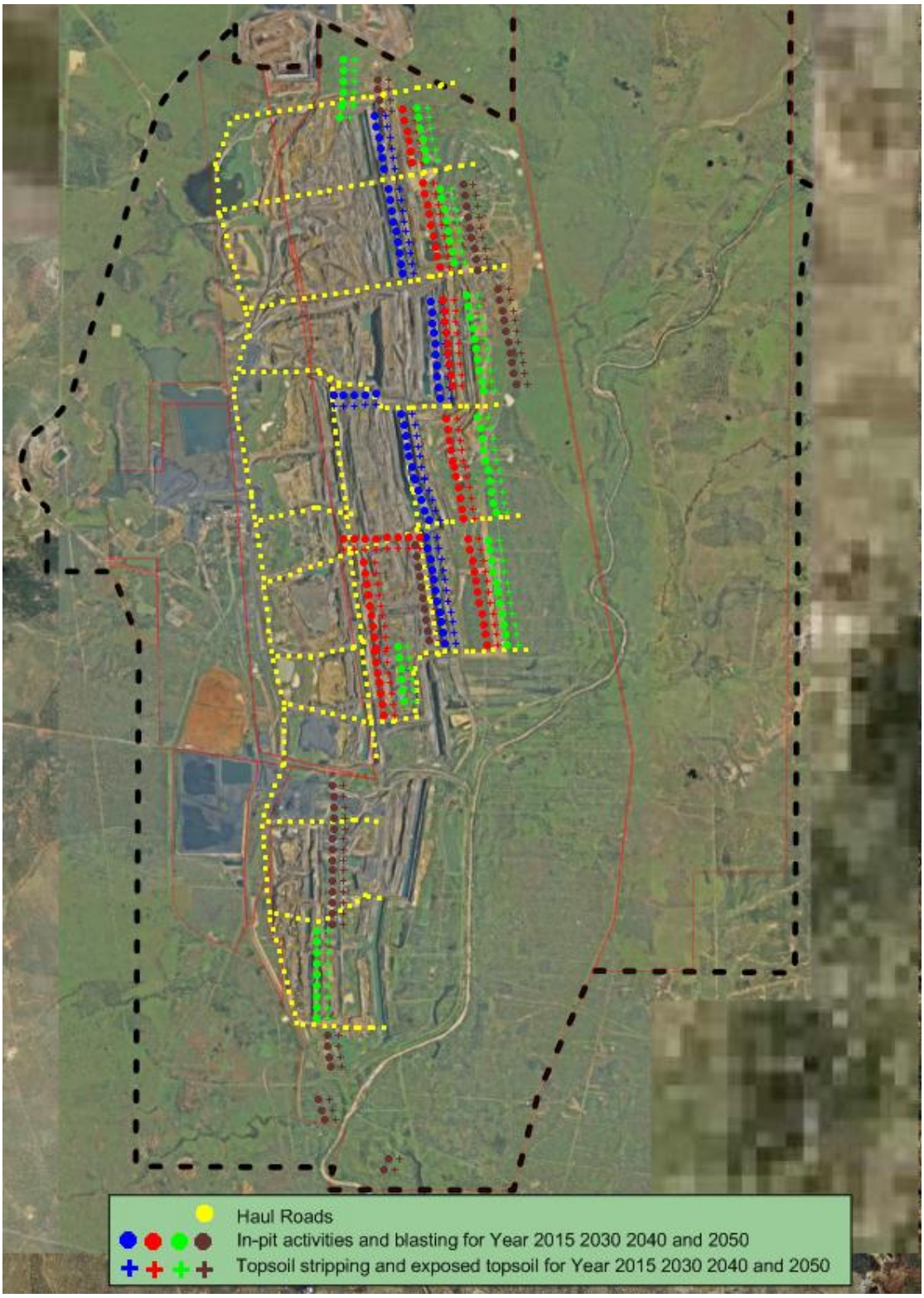


Figure 24: Calpuff Sources Locations – Constant Emissions Sources for Goonyella CHPP and Riverside CHPP

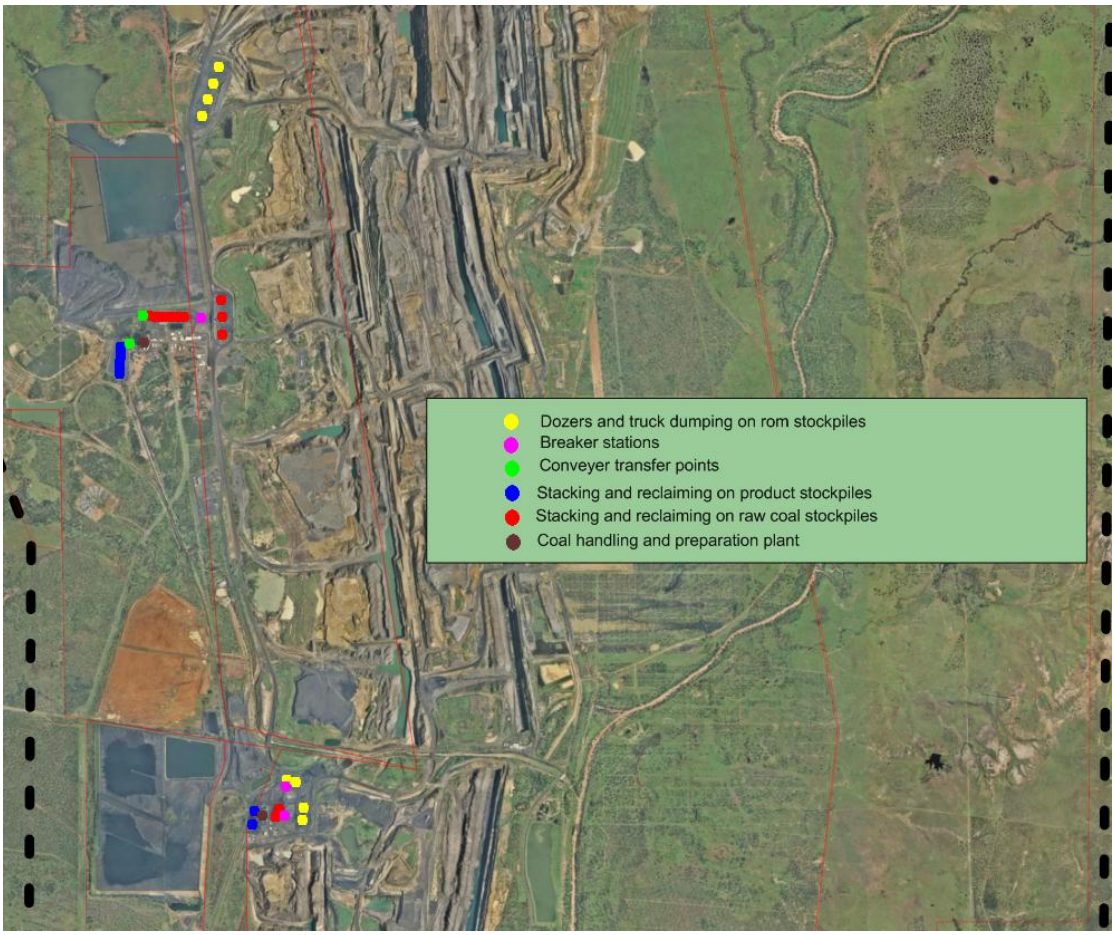


Figure 25: Calpuff Sources Locations – Wind Speed Dependent Emissions Sources for Goonyella CHPP and Riverside CHPP

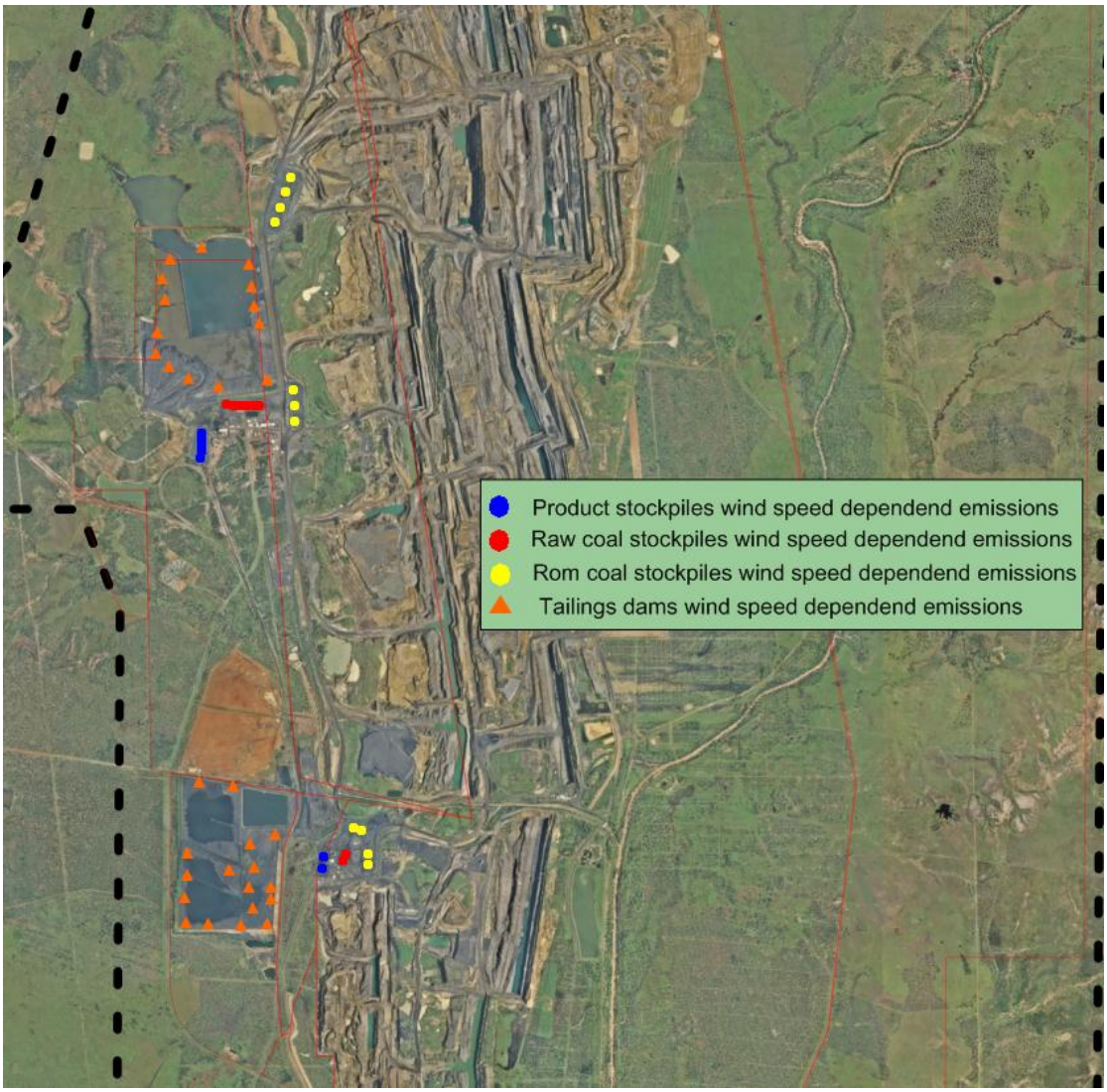
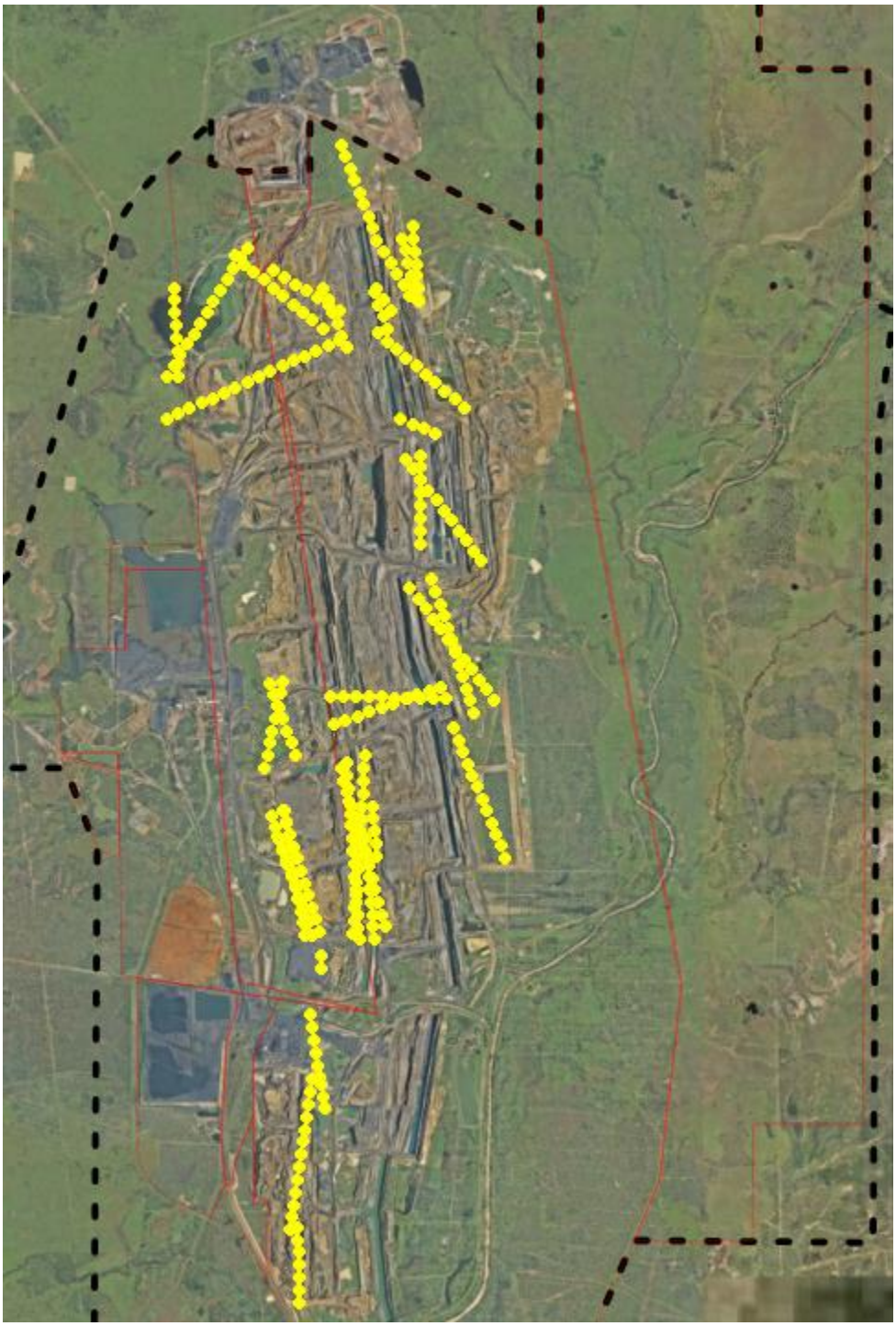


Figure 26: Calpuff Sources Locations – Wind Speed Dependent Overburden Exposed Areas for a Typical Year (2030) Corresponding to Overburden Dumping Areas



Appendix L Red Hill Mine Emission Sources

Key sources of dust associated with Project related operations at Red Hill Mining Lease include:

- Underground ventilation outlets
- Overland conveyers
- Transport of overburden to dumps
- Dozers on ROM stockpiles
- Truck dumping on reject stockpiles
- Stacking and reclaiming at raw coal stockpiles
- Stacking and reclaiming at product stockpiles
- Wind erosion from ROM, raw and product stockpiles
- Redhill CHPP activities (conveyers, transfer points, breaker stations, processing)

Figure 27 and Figure 28 illustrate the locations of dust emission sources included in dispersion modelling for the Project related activities for Red Hill Mining Lease.

Figure 27: Calpuff Sources Locations – Red Hill CHPP Related 24/7 Emission Sources

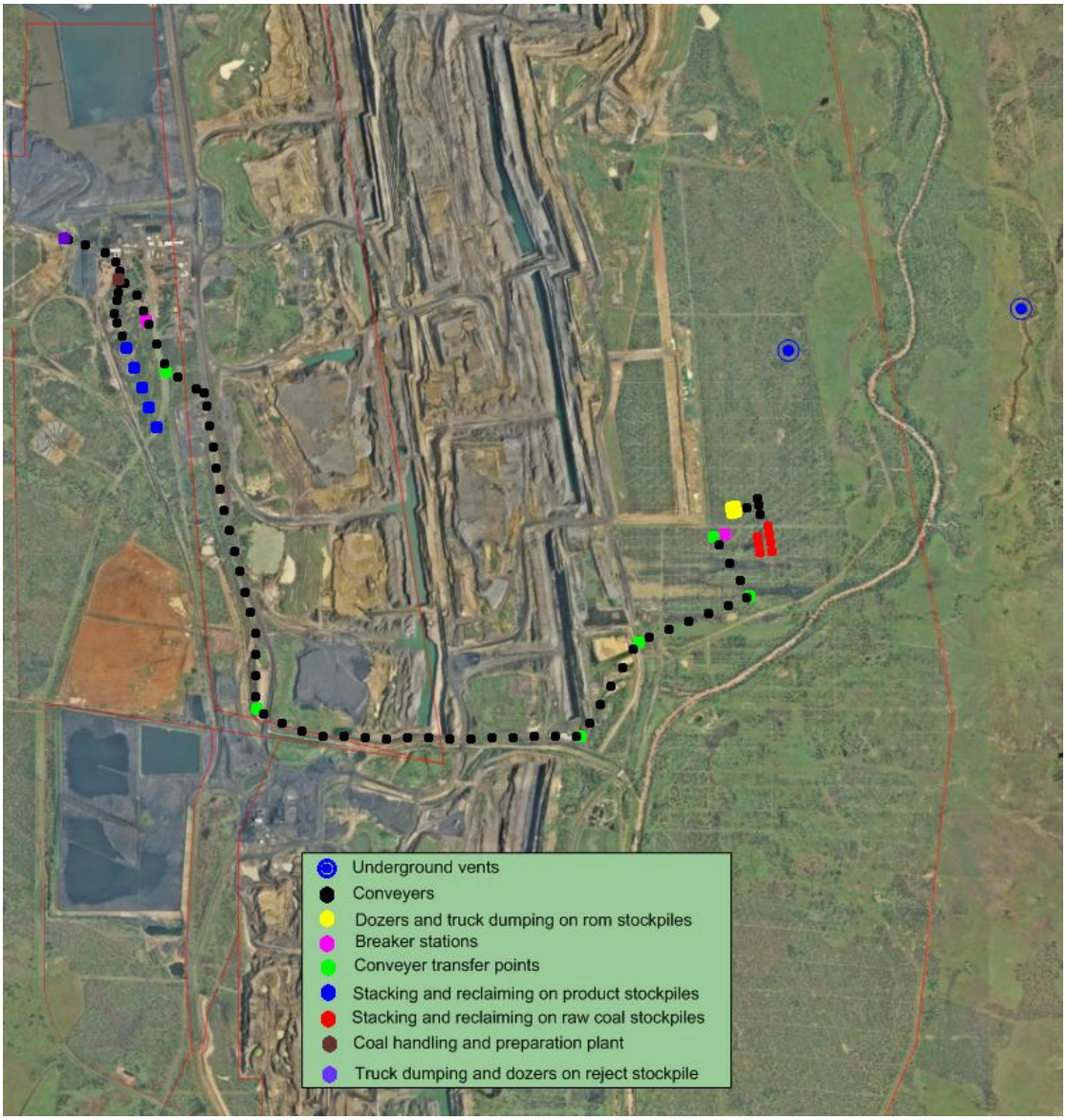
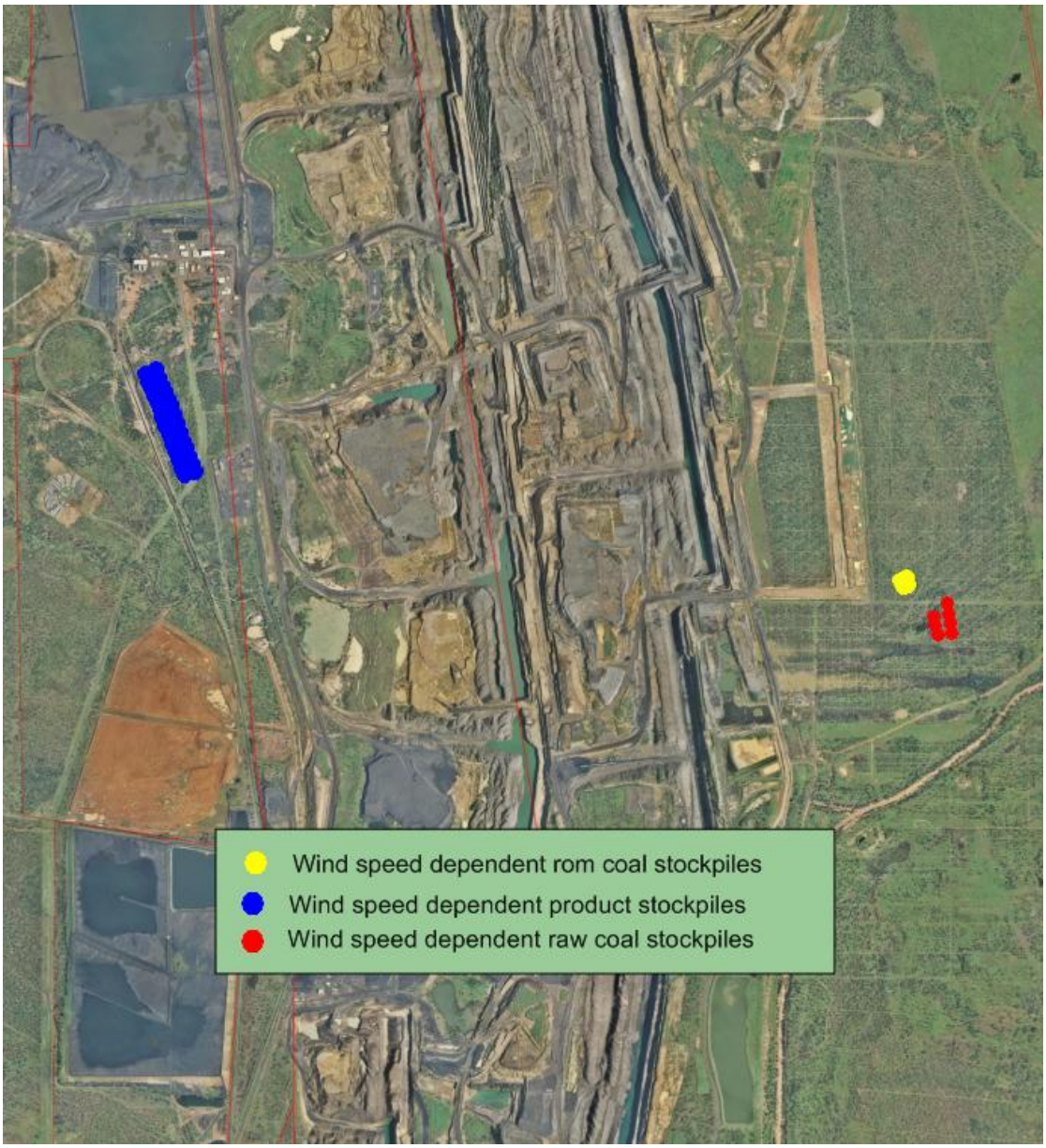


Figure 28: Calpuff Sources Locations – Red Hill CHPP Related Wind Speed Dependent Emission Sources

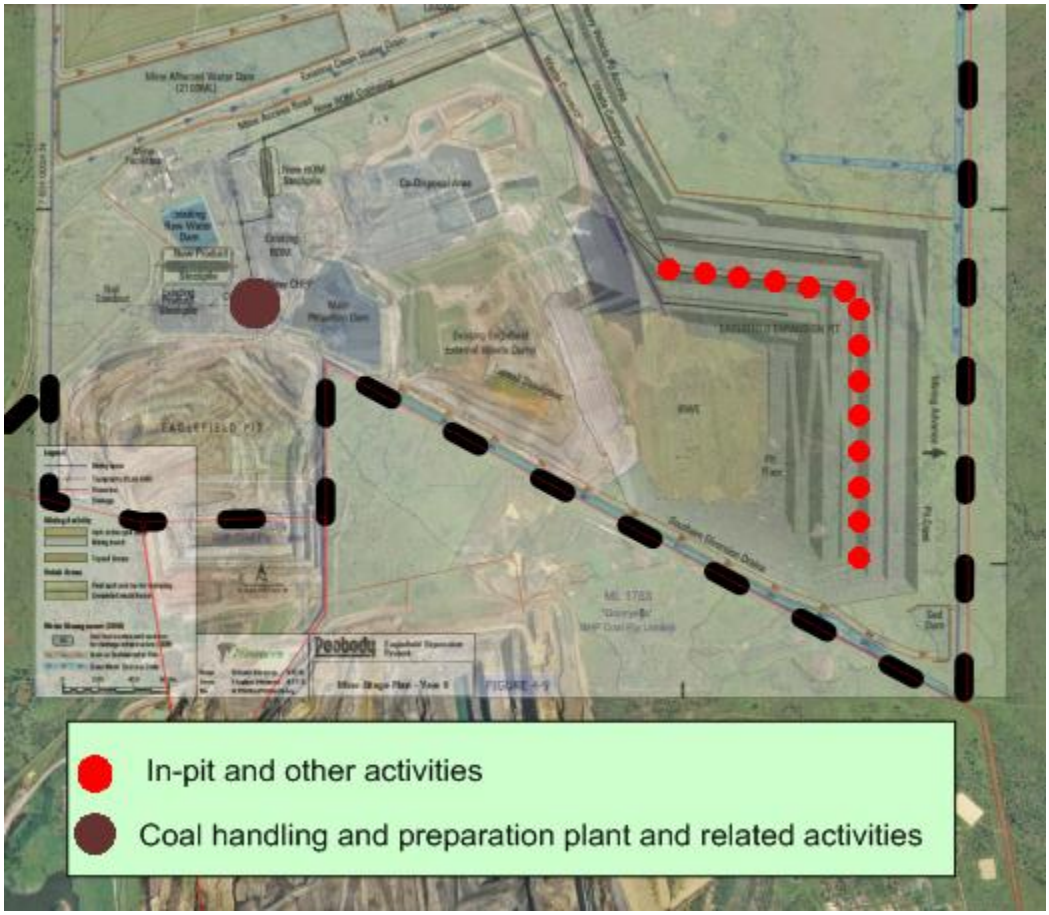


Appendix M Cumulative Future Mining Emission Sources

M.1 Eaglefield Expansion Project

Dust emission sources for Eaglefield mine were sourced from Eaglefield Expansion Project EIS (Eaglefield, 2011). Eaglefield Expansion Project proposed mining of up to 10.2 Mtpa of run-of-mine coal, up from the current average of 5 Mtpa. Details of dust emission rates and source characteristics were sourced from the technical air quality appendix of the EIS.

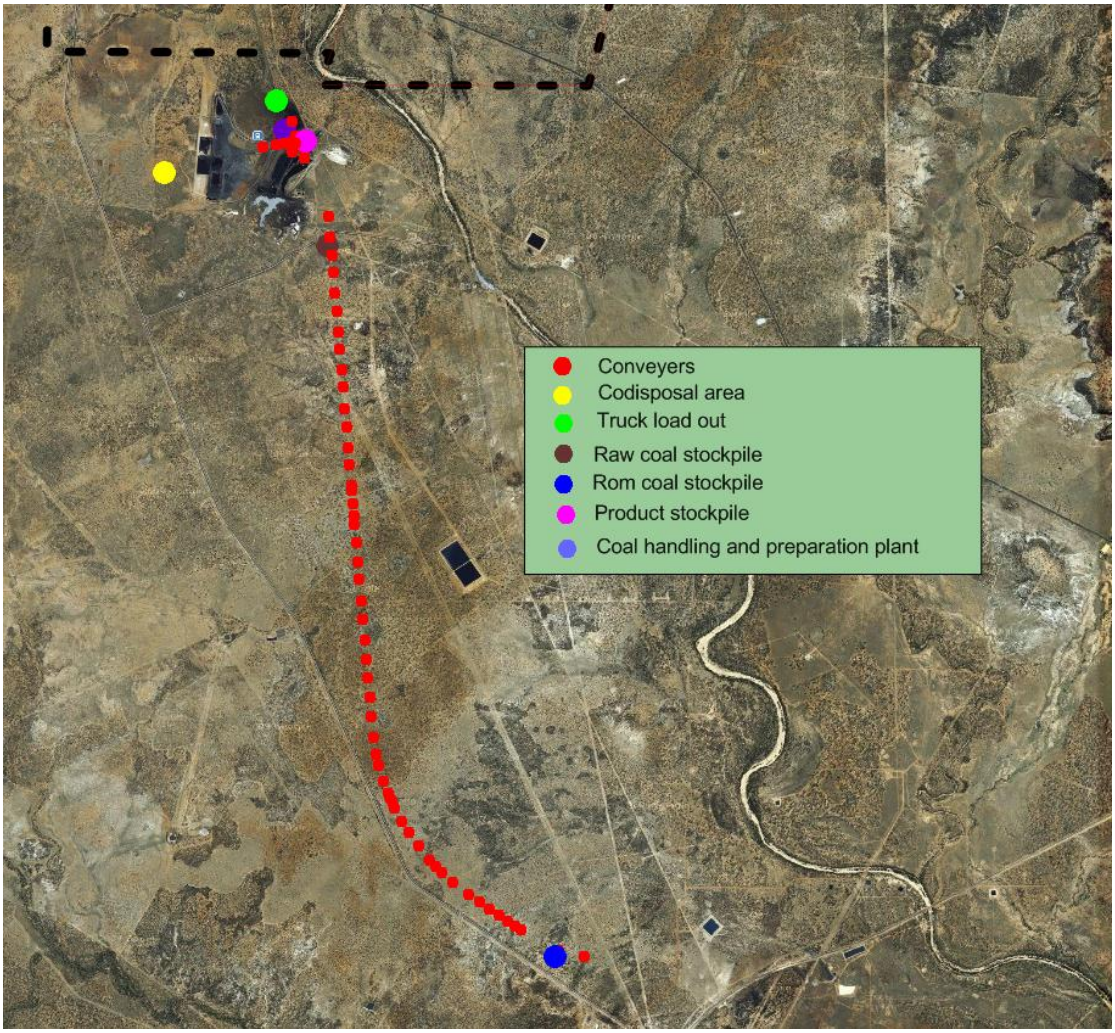
Figure 29: Representative location of Eaglefield Expansion Project Dust emission Sources



M.2 Grosvenor and Moranbah North Mine

Dust emission sources for Grosvenor Project were sourced from Grosvenor Project EIS (Grosvenor, 2010). The proposed Grosvenor Project is a green field underground mine that would produce 7 Mtpa per year of run of mine coal and net 5 Mtpa of coking coal for export. Details of dust emission rates and source characteristics were source from technical air quality appendix of the EIS.

Figure 30: Representative location of Grosvenor Project Dust emission Sources



Appendix N Contour Plots

When interpreting the contour plots presented in this appendix it is important to note that the figures do not represent a snapshot in time but rather a composite of the worst-case conditions at each point within the model domain regardless of when the elevated dust levels occurred. For example, elevated levels to the east of the site will occur at a different date and time than elevated levels to the west of the site.

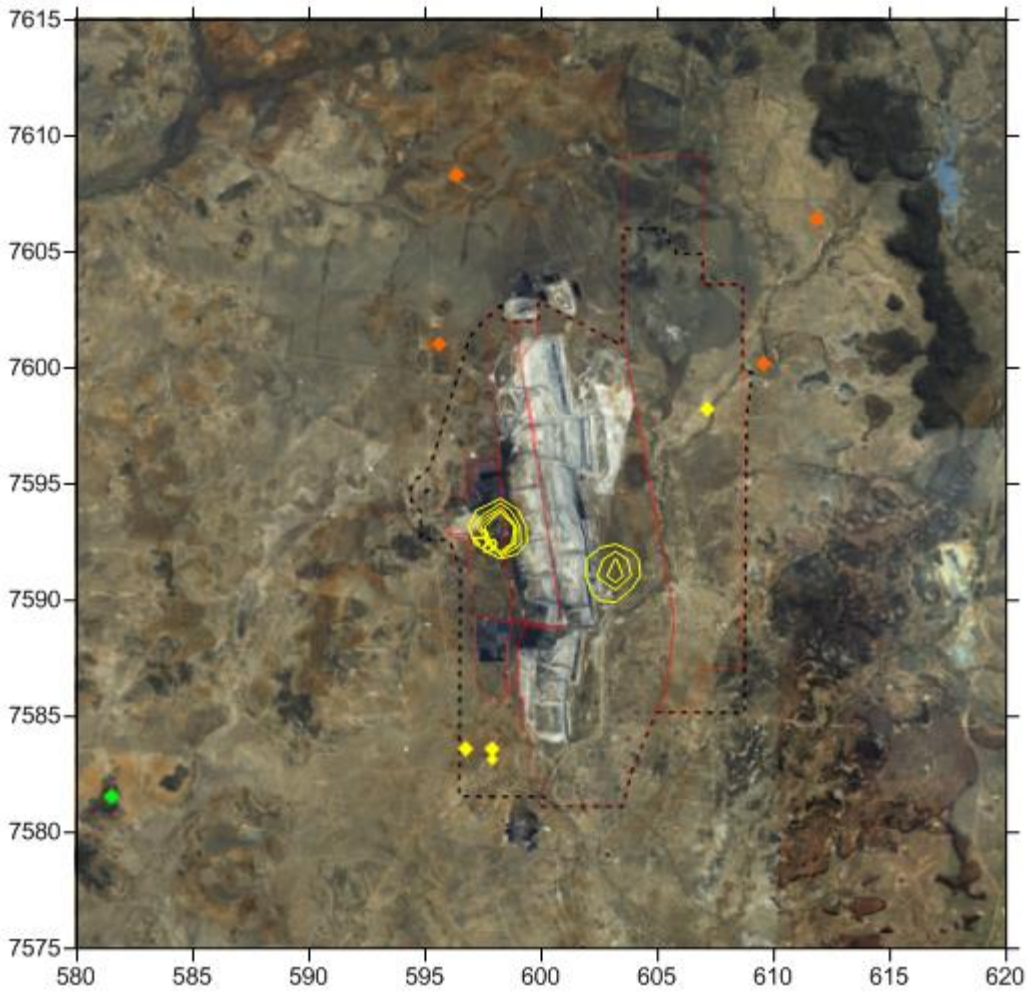
Additionally, it is noted that although the contour plots provided in the following sections provide information pertaining to the distance away from the emission sources that elevated levels are predicted, they do not provide any indication as to the frequency that such elevated levels of dust might occur. The reader is directed to Appendix O for tabulated results highlighting the predicted number of exceedences at the receptor locations.

An interpretation of the results is provided in the RHM EIS Chapter 11: *Air Quality.*

N.1 Total Suspended Particulates

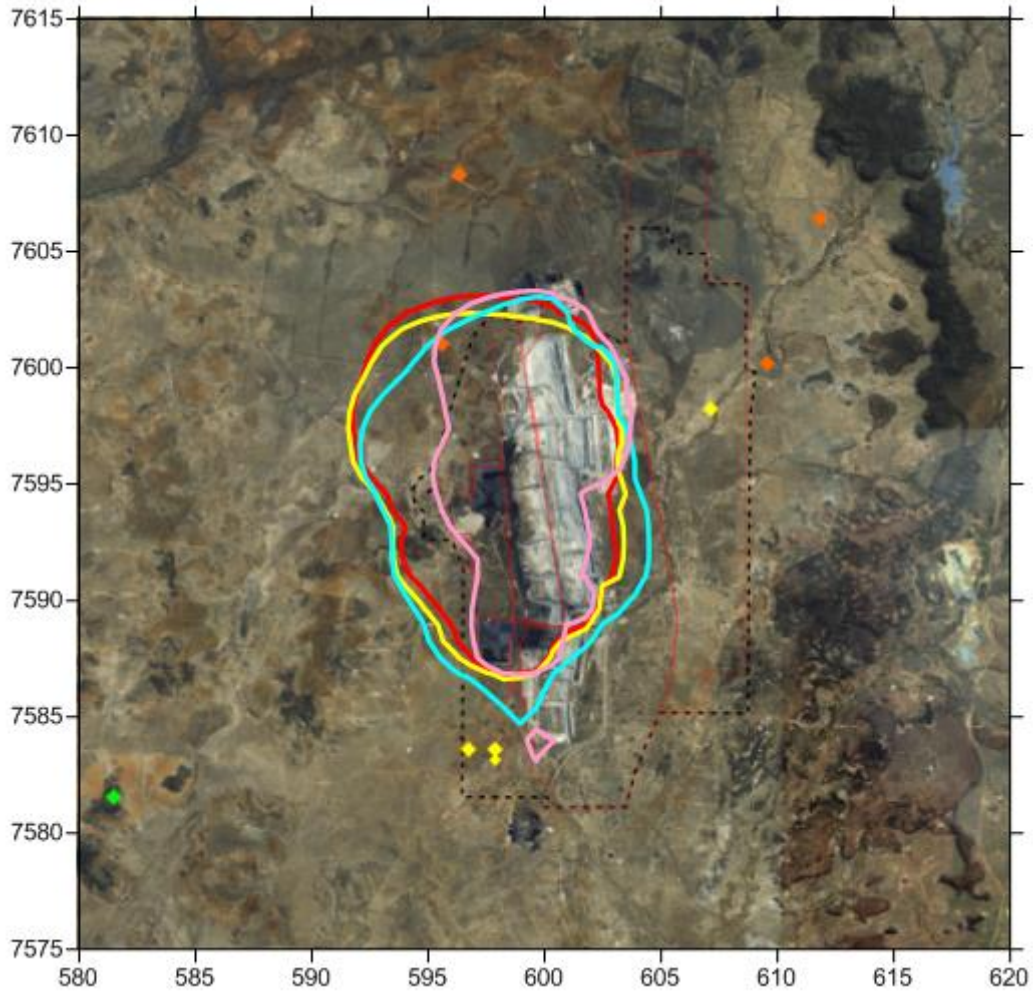
N.1.1 Annual Average

Figure 31: Total Suspended Particulates – Red Hill Mine Only Impacts



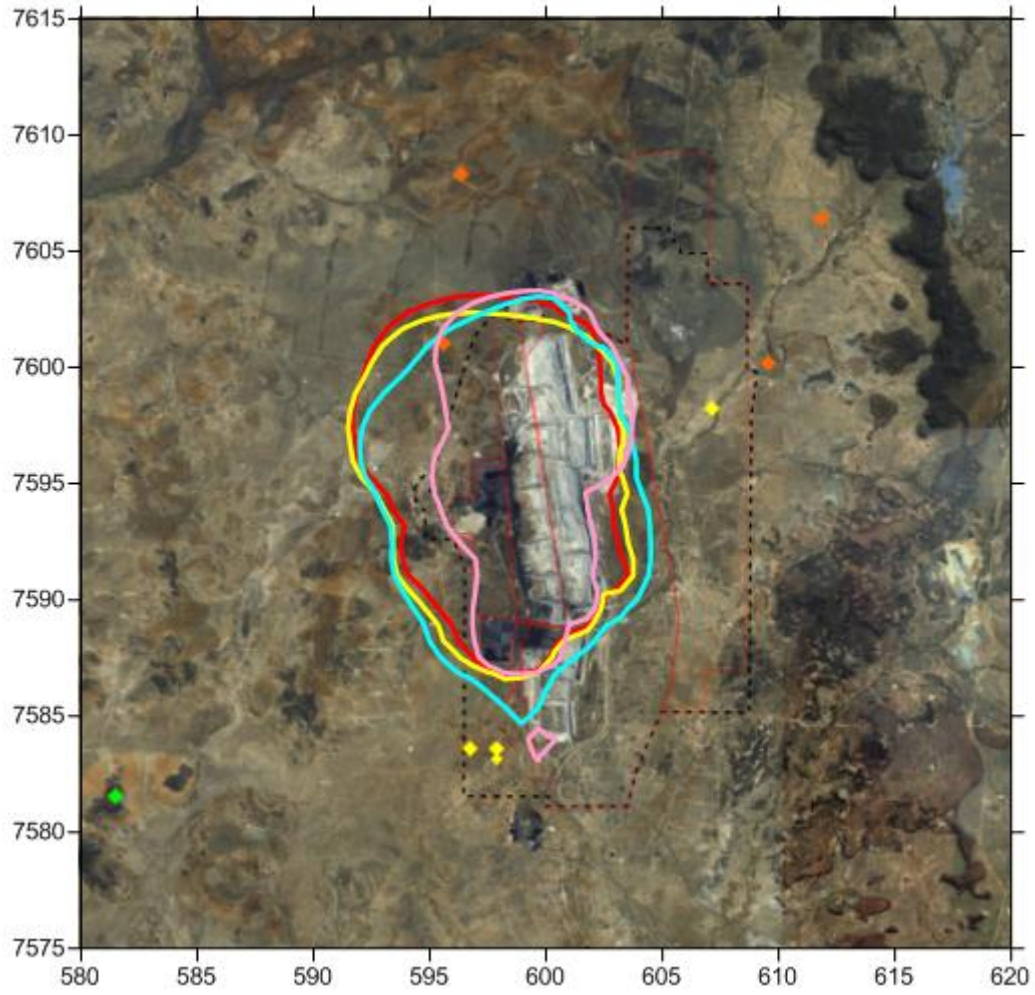
Scenario: Red Hill Mine-only impacts		**Mines included:** RHM	
Pollutant:	TSP	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Maximum
Project Goal:	90 µg/m^3	**Contour level(s):**	10, 20, 30, 40 and 50 µg/m^3
Contour Legend: Red: 90 µg/m^3, Yellow: 10, 20, 30, 40 and 50 µg/m^3			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 32: Total Suspended Particulates - Existing Mining



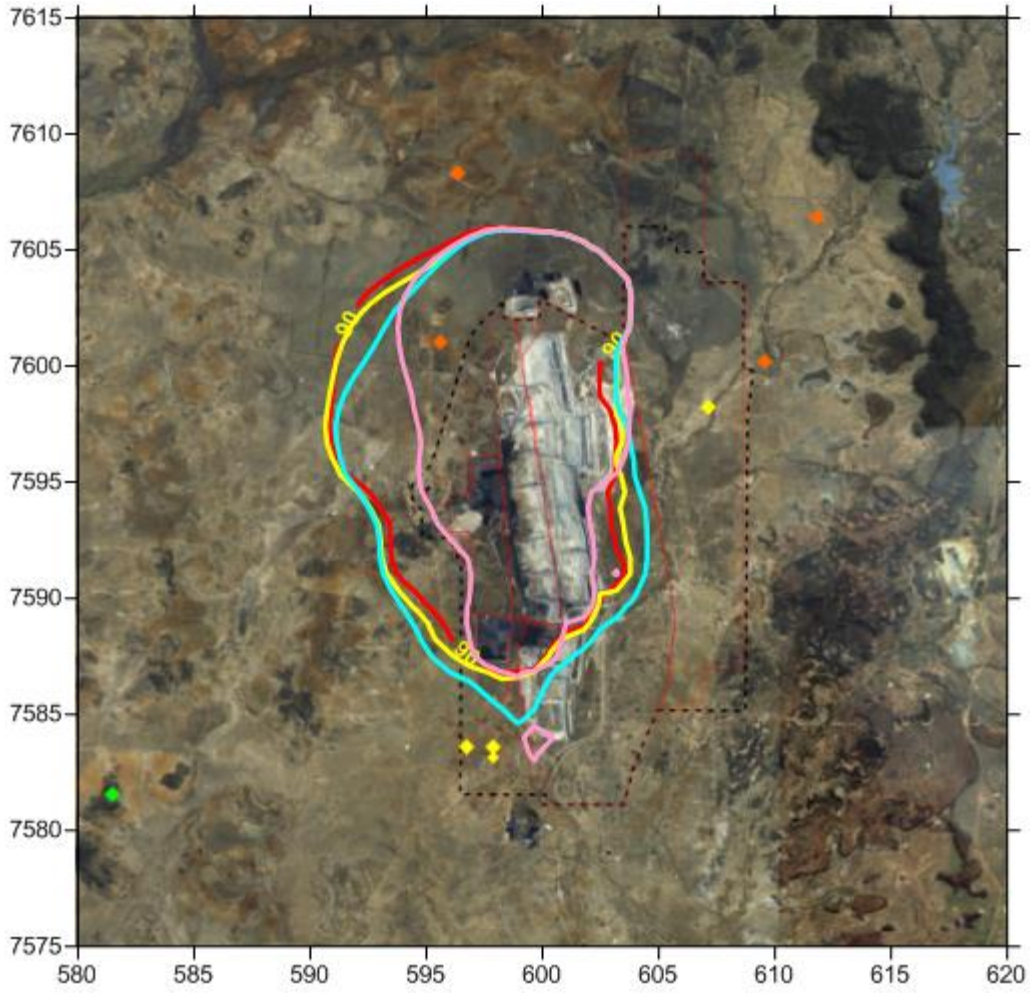
Scenario: Existing Mining		**Mines included:** GRM, BRM	
Pollutant:	TSP	**Averaging Period:**	Annual
Background level:	39.8 µg/m^3	**Rank:**	Maximum
Project Goal:	90 µg/m^3	**Contour level(s):**	90 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 33: Total Suspended Particulates - Future Mining



Scenario: Future Mining		**Mines included:** GRM, BRM, RHM	
Pollutant:	TSP	**Averaging Period:**	Annual
Background level:	39.8 µg/m^3	**Rank:**	Maximum
Project Goal:	90 µg/m^3	**Contour level(s):**	90 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 34: Total Suspended Particulates - Cumulative Future Mining

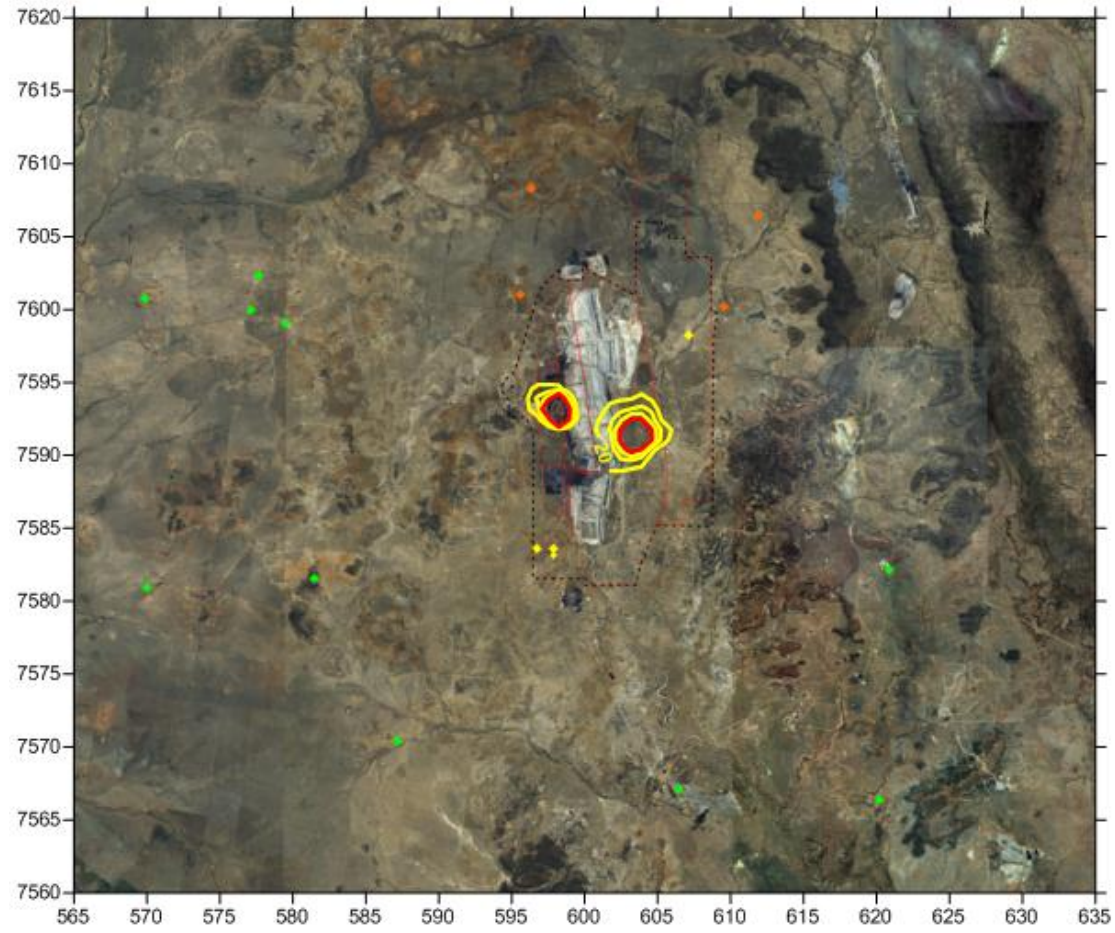


Scenario: Cumulative Future Mining		**Mines included:** GRM, BRM, RHM, Eaglefield, Grosvenor, Moranbah North Mine	
Pollutant:	TSP	**Averaging Period:**	Annual
Background level:	39.8 µg/m^3	**Rank:**	Maximum
Project Goal:	90 µg/m^3	**Contour level(s):**	90 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

N.2 Contour Plots – Particulate Matters as PM_{10}

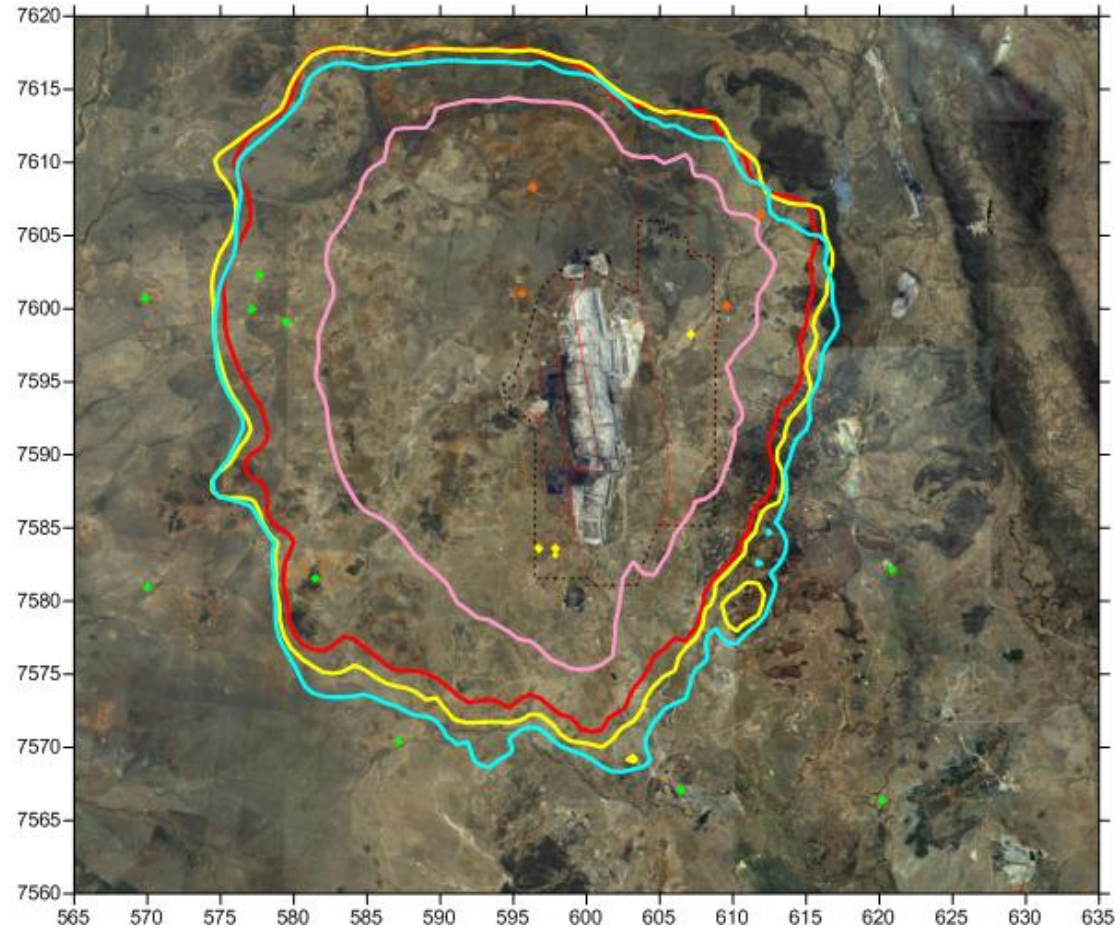
N.2.1 Maximum 24-Hour Average

Figure 35: Particulate Matter as PM_{10} – Red Hill Mine Only Impacts



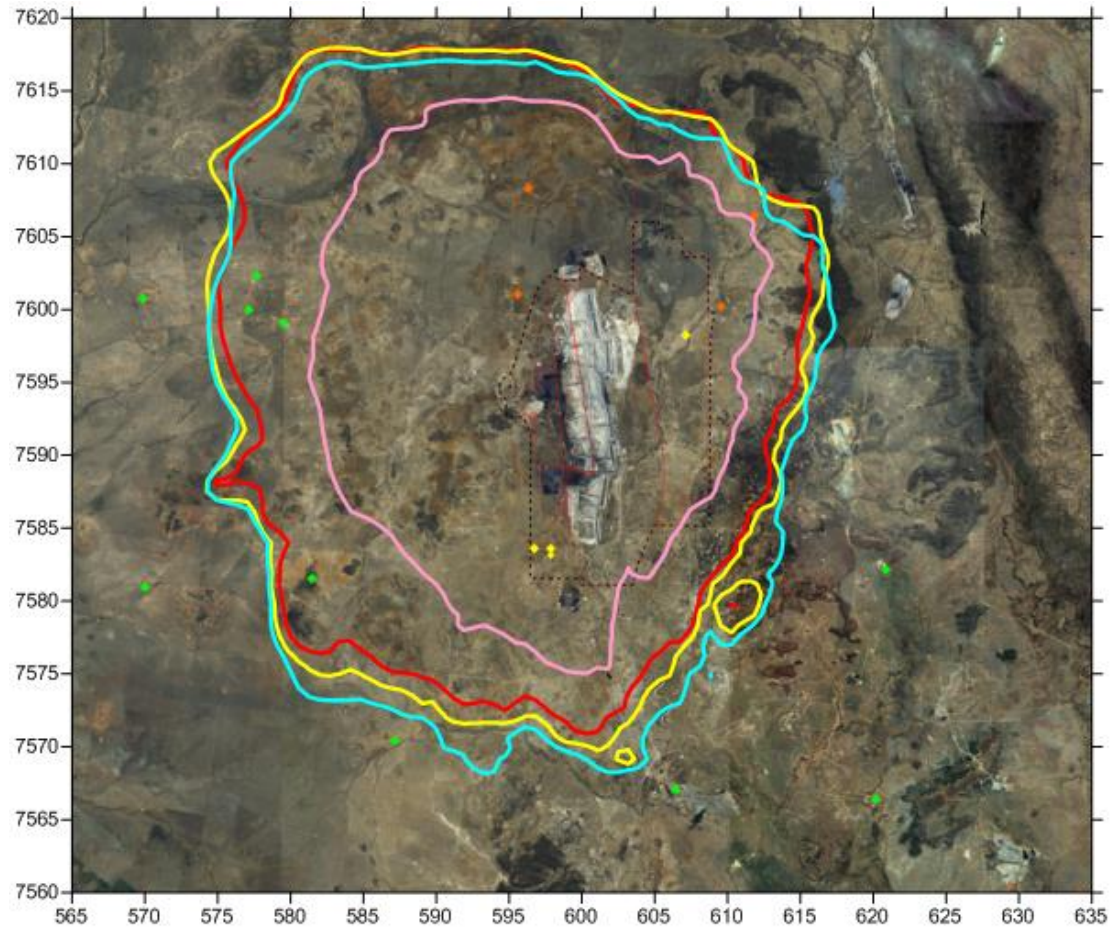
Scenario: Red Hill Mine only impacts		**Mines included:** RHM	
Pollutant:	PM_{10}	**Averaging Period:**	24-Hour
Background level:	Not included	**Rank:**	Fifth Highest
Project Goal:	50 µg/m^3	**Contour level(s):**	20, 30, 40 and 50 µg/m^3
Contour Legend: Red: 50 µg/m^3, Yellow: 20, 30 and 40 µg/m^3			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 36: Particulate Matter as PM_{10} - Existing Mining



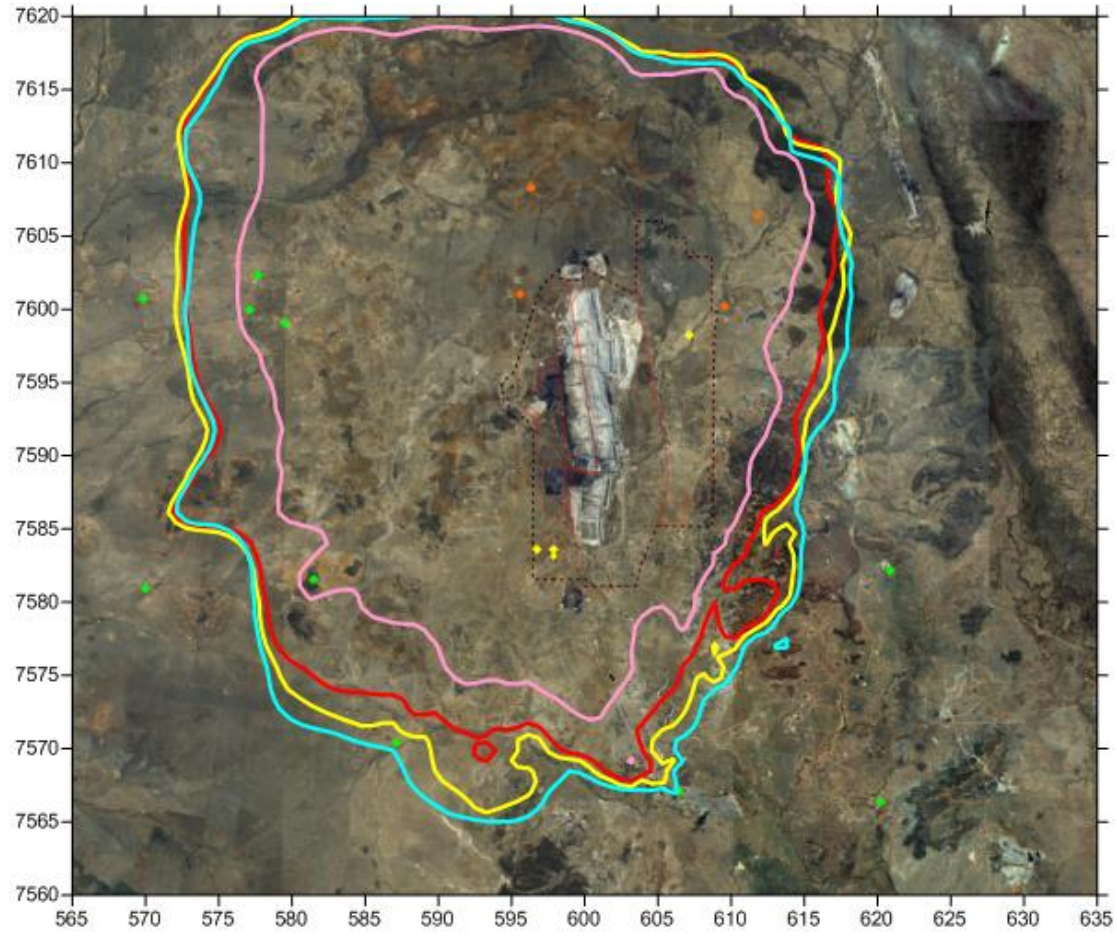
Scenario: Existing Mining		**Mines included:** GRM, BRM	
Pollutant:	PM_{10}	**Averaging Period:**	24-Hour
Background level:	29.6 µg/m^3	**Rank:**	Fifth Highest
Project Goal:	50 µg/m^3	**Contour level(s):**	50 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 37: Particulate Matter as PM_{10} - Future Mining



Scenario: Future Mining		**Mines included:** GRM, BRM, RHM	
Pollutant:	PM_{10}	**Averaging Period:**	24-Hour
Background level:	29.6 µg/m^3	**Rank:**	Fifth Highest
Project Goal:	50 µg/m^3	**Contour level(s):**	50 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 38: Particulate Matter as PM_{10} - Cumulative Future Mining

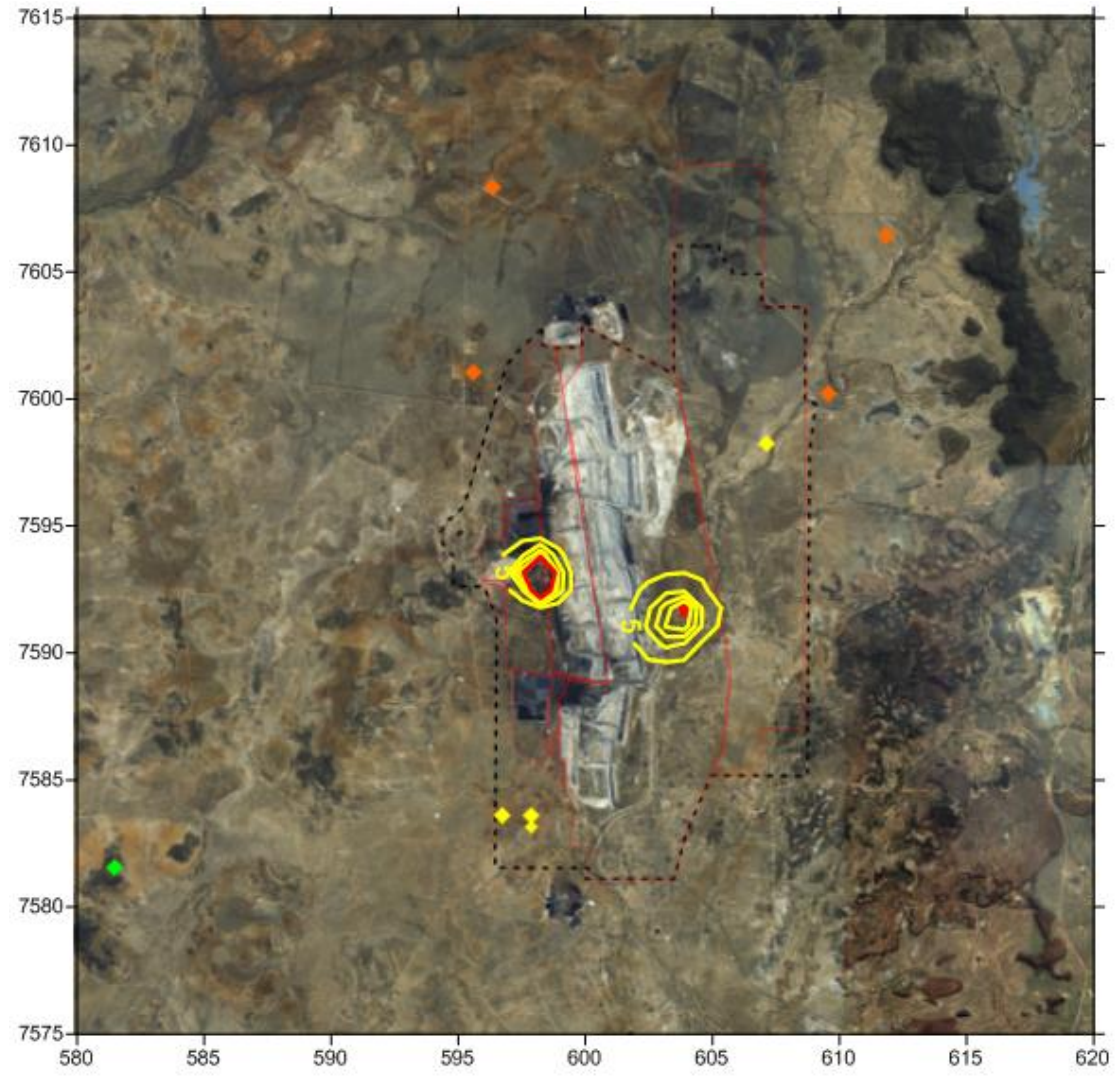


Scenario: Cumulative Future Mining		**Mines included:** GRM, BRM, RHM, Eaglefield, Grosvenor, Moranbah North Mine	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	24-Hour
Background level:	29.6 µg/m^3	**Rank:**	Fifth Highest
Project Goal:	50 µg/m^3	**Contour level(s):**	50 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

N.3 Contour Plots – Particulate Matters as $PM_{2.5}$

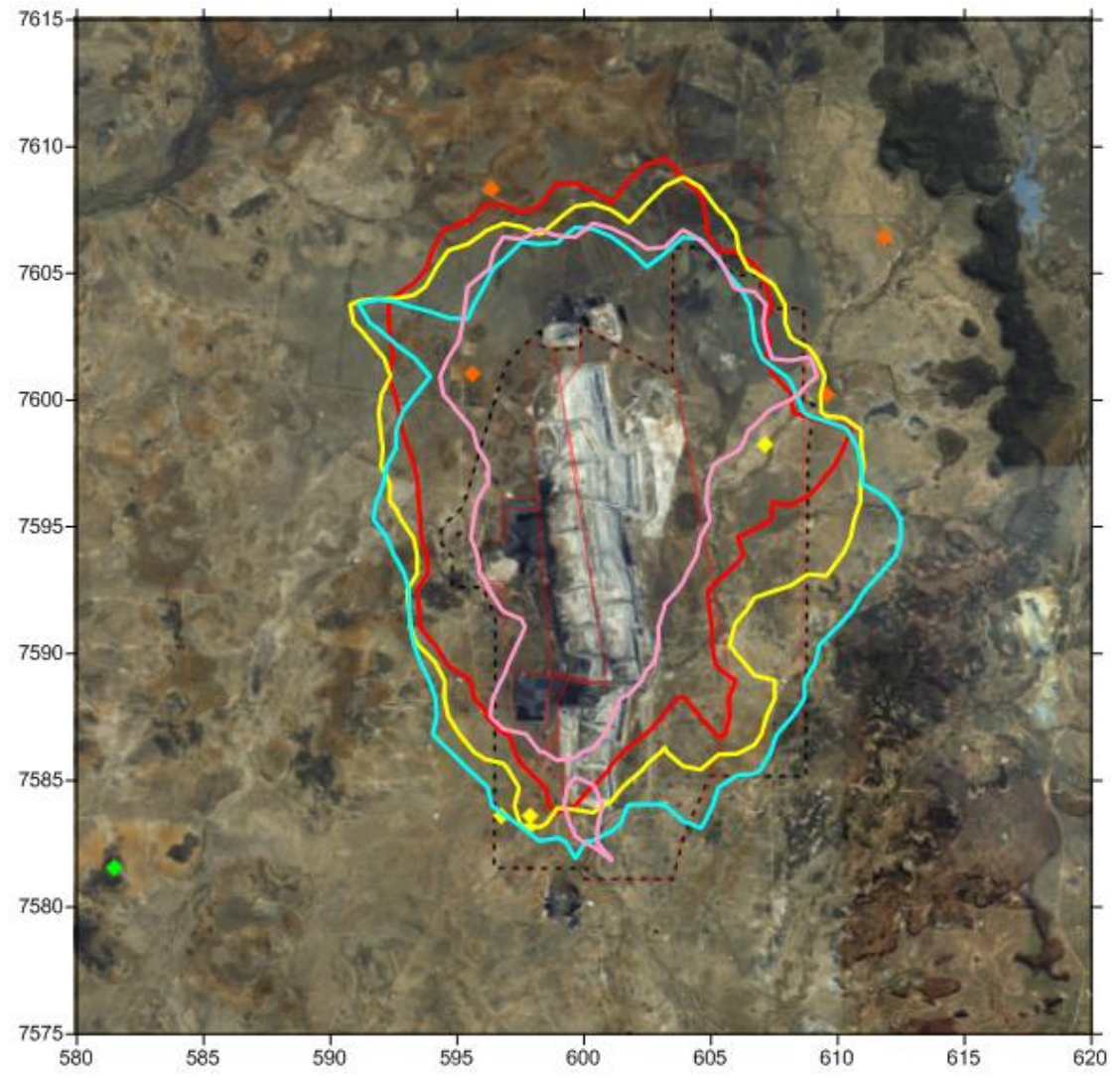
N.3.1 Maximum 24-Hour Average

Figure 39: Particulate Matter as $PM_{2.5}$ – Red Hill Mine Only Impacts



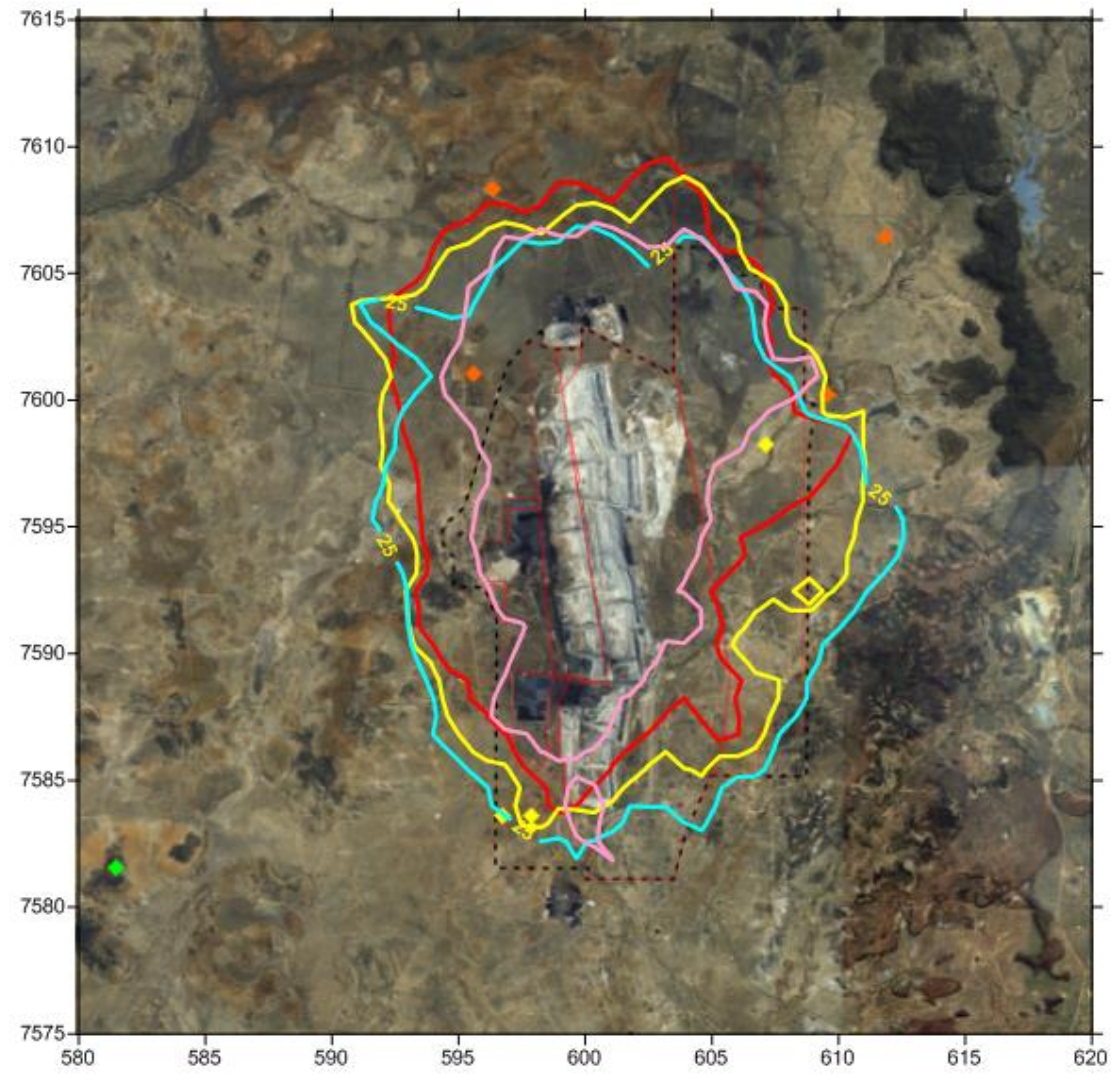
Scenario: Red Hill Mine only impacts		**Mines included:** RHM	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	24-Hour
Background level:	Not included	**Rank:**	Maximum
Project Goal:	25 µg/m^3	**Contour level(s):**	5, 10, 15, 20 and 25 µg/m^3
Contour Legend: Red: 25 µg/m^3, Yellow: 5, 10, 15, and 20 µg/m^3			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 40: Particulate Matter as $PM_{2.5}$ - Existing Mining



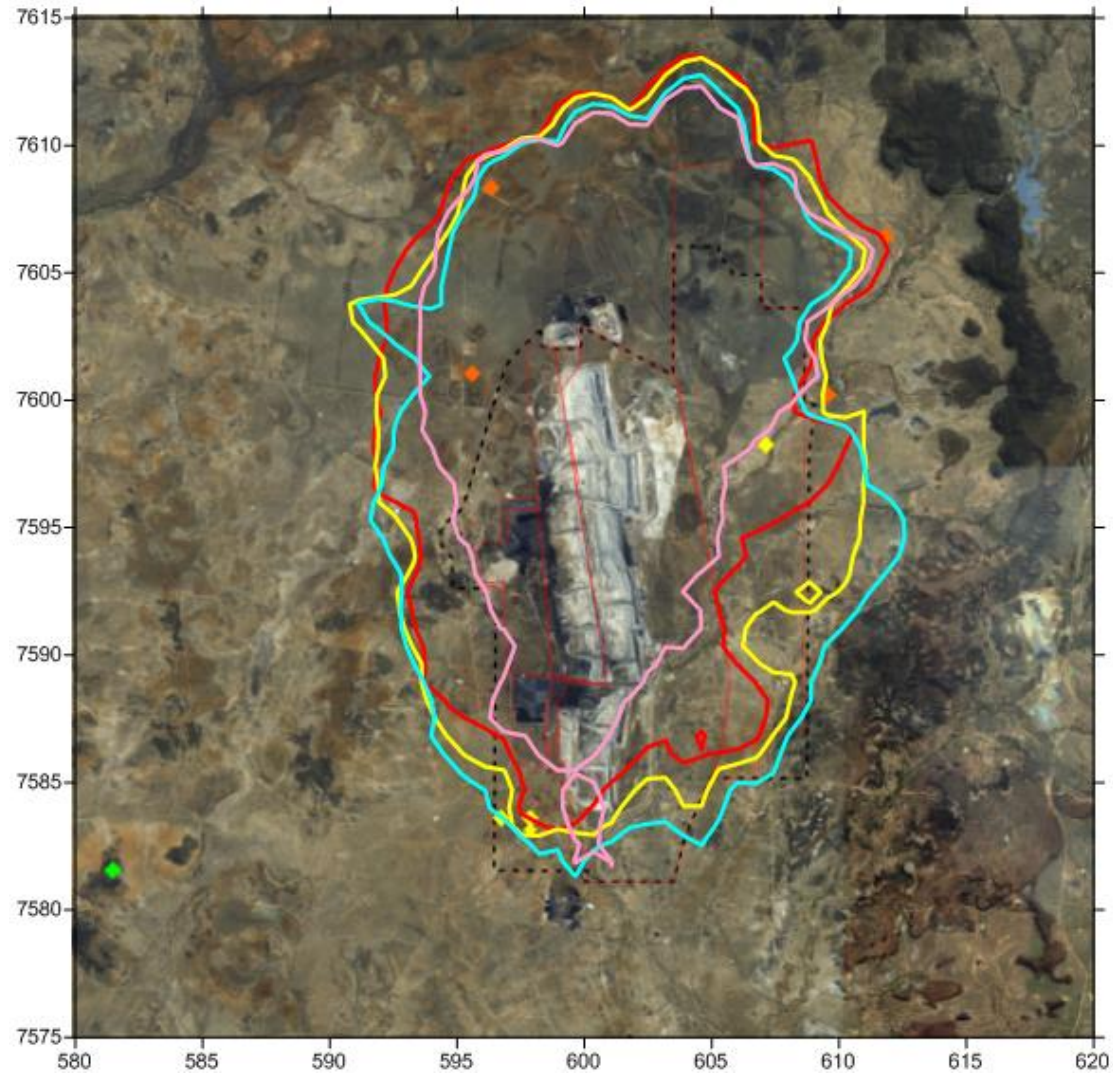
Scenario: Existing Mining		**Mines included:** GRM, BRM	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	24-Hour
Background level:	7.0 µg/m^3	**Rank:**	Maximum
Project Goal:	25 µg/m^3	**Contour level(s):**	25 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 41: Particulate Matter as $PM_{2.5}$ - Future Mining



Scenario: Future Mining		**Mines included:** GRM, BRM, RHM	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	24-Hour
Background level:	7.0 µg/m^3	**Rank:**	Maximum
Project Goal:	25 µg/m^3	**Contour level(s):**	25 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

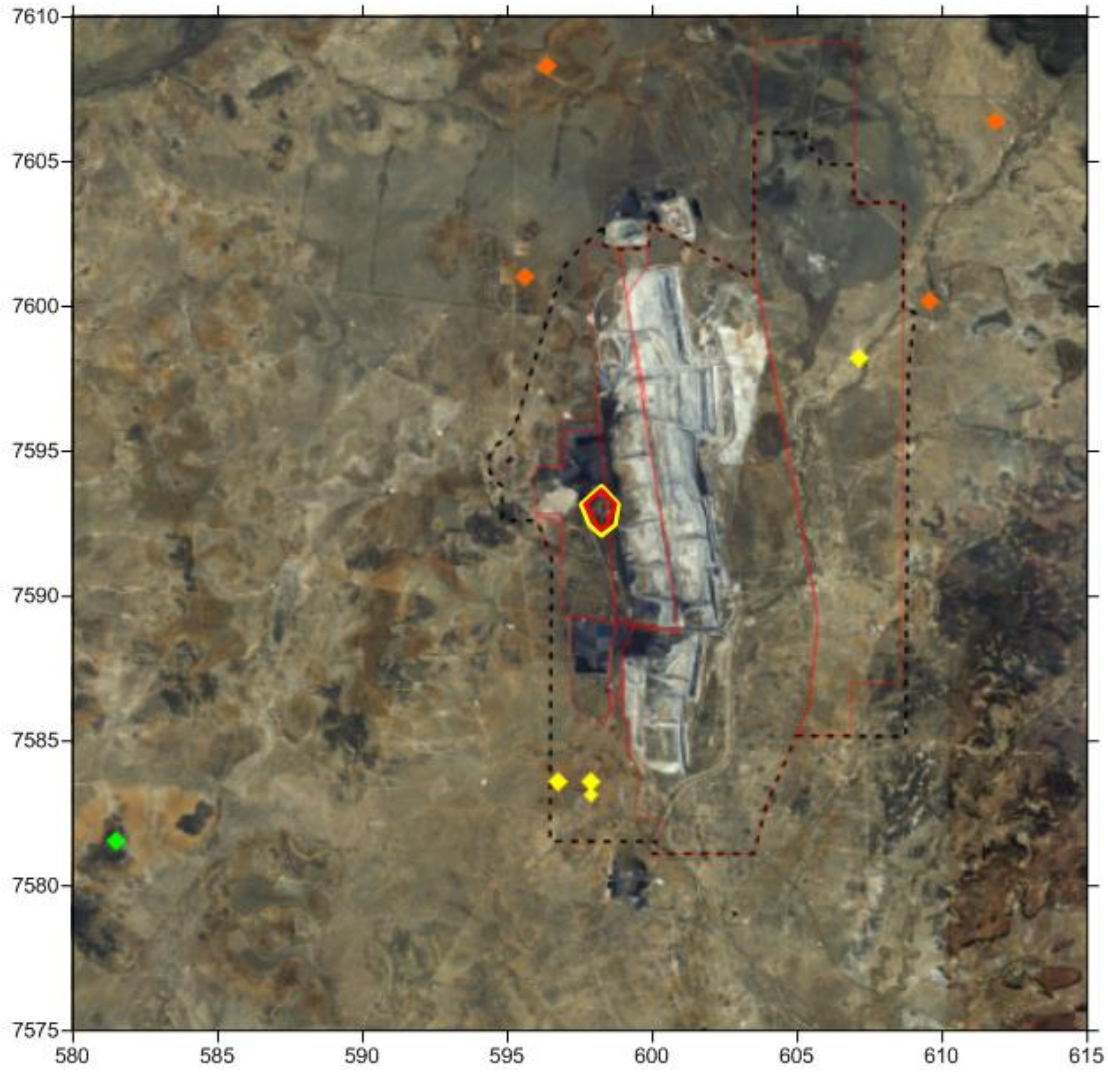
Figure 42: Particulate Matter as $PM_{2.5}$ - Cumulative Future Mining



Scenario: Cumulative Future Mining		**Mines included:** GRM, BRM, RHM, Eaglefield, Grosvenor, Moranbah North Mine	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	24-Hour
Background level:	7.0 µg/m^3	**Rank:**	Maximum
Project Goal:	25 µg/m^3	**Contour level(s):**	25 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

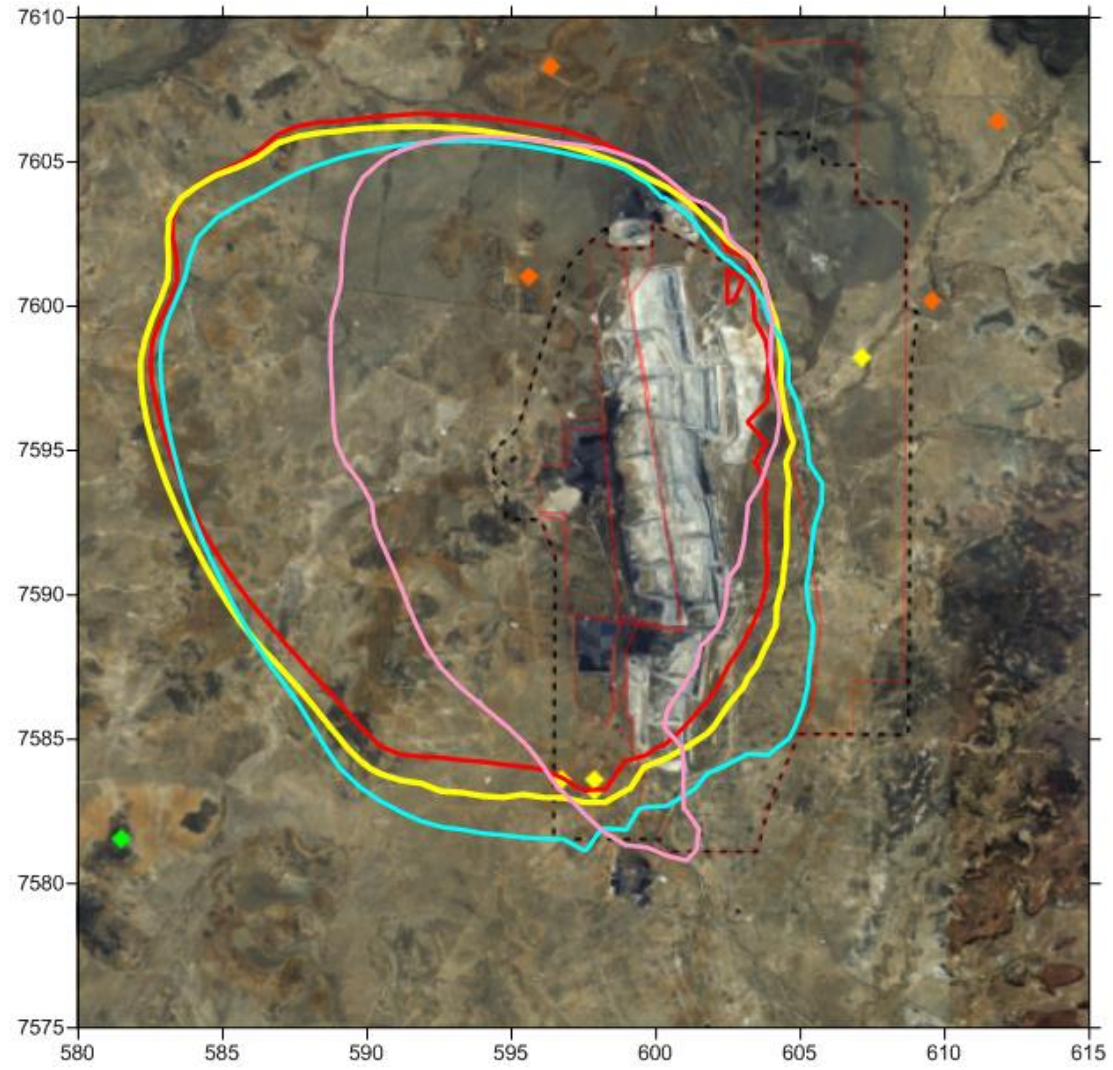
N.3.2 Annual Average

Figure 43: Particulate Matter as $PM_{2.5}$ – Red Hill Mine Only Impacts



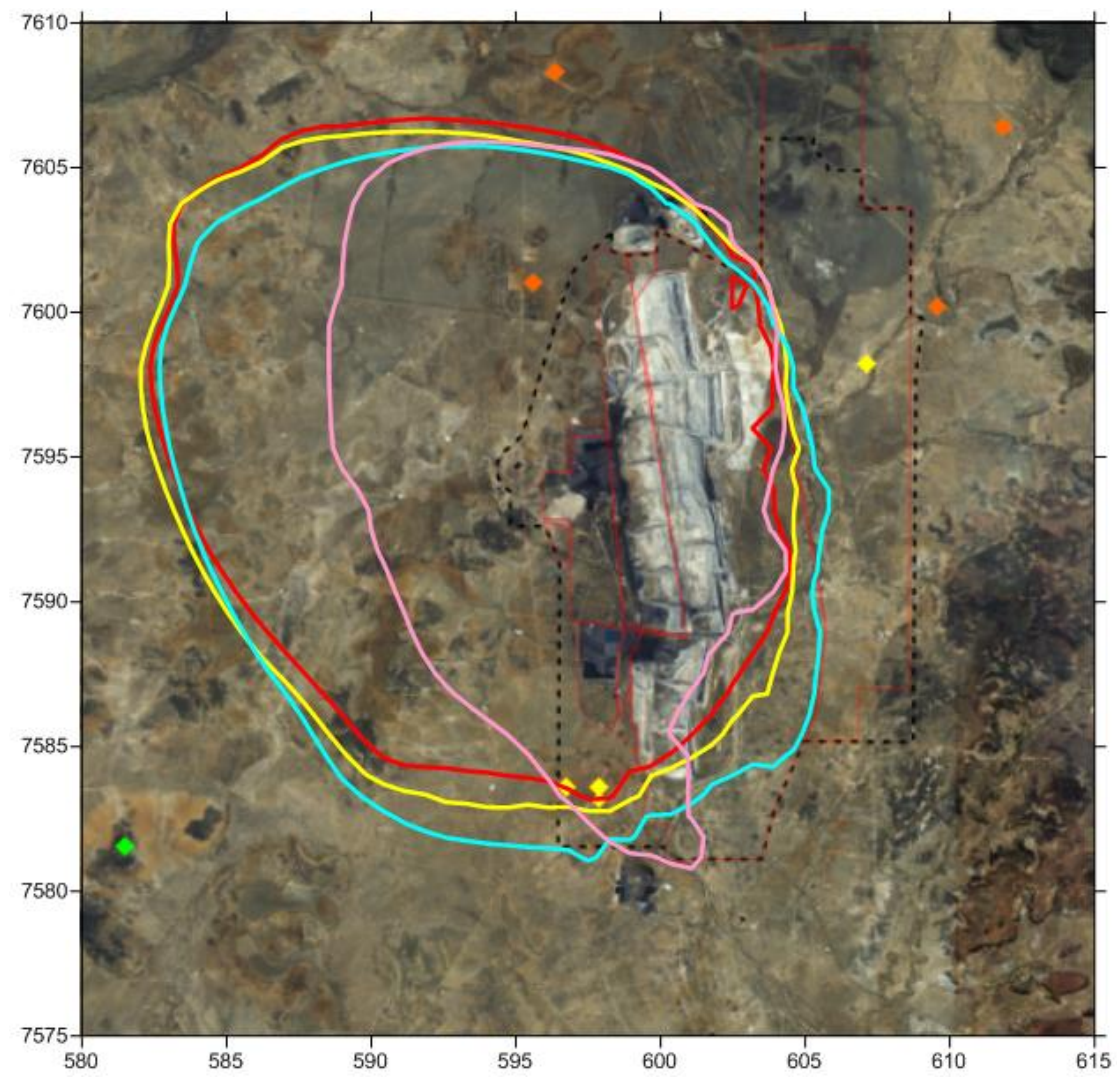
Scenario: Red Hill Mine only		**Mines included:** RHM	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	Annual
Background level:	Not included	**Rank:**	Maximum
Project Goal:	8 µg/m^3	**Contour level(s):**	5 µg/m^3 and 8 µg/m^3
Contour Legend: Red: 8 µg/m^3, Yellow: 5 µg/m^3			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 44: Particulate Matter as $PM_{2.5}$ - Existing Mining



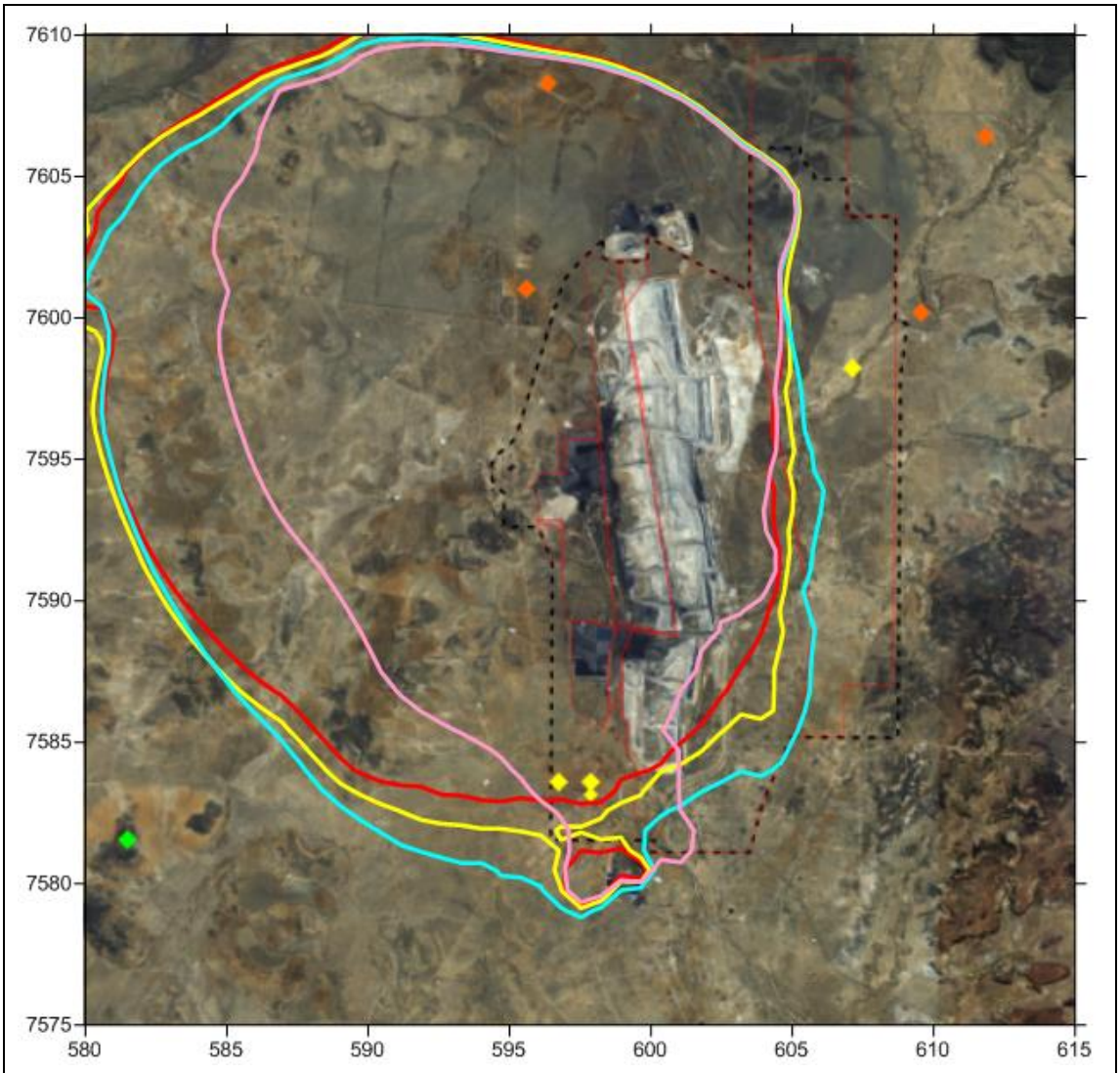
Scenario: Existing Mining		**Mines included:** GRM, BRM	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	Annual
Background level:	6.6 µg/m^3	**Rank:**	Maximum
Project Goal:	8 µg/m^3	**Contour level(s):**	8 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 45: Particulate Matter as $PM_{2.5}$ - Future Mining



Scenario: Future Mining		**Mines included:** GRM, BRM, RHM	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	Annual
Background level:	6.6 µg/m^3	**Rank:**	Maximum
Project Goal:	8 µg/m^3	**Contour level(s):**	8 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 46: Particulate Matter as $PM_{2.5}$ - Cumulative Future Mining

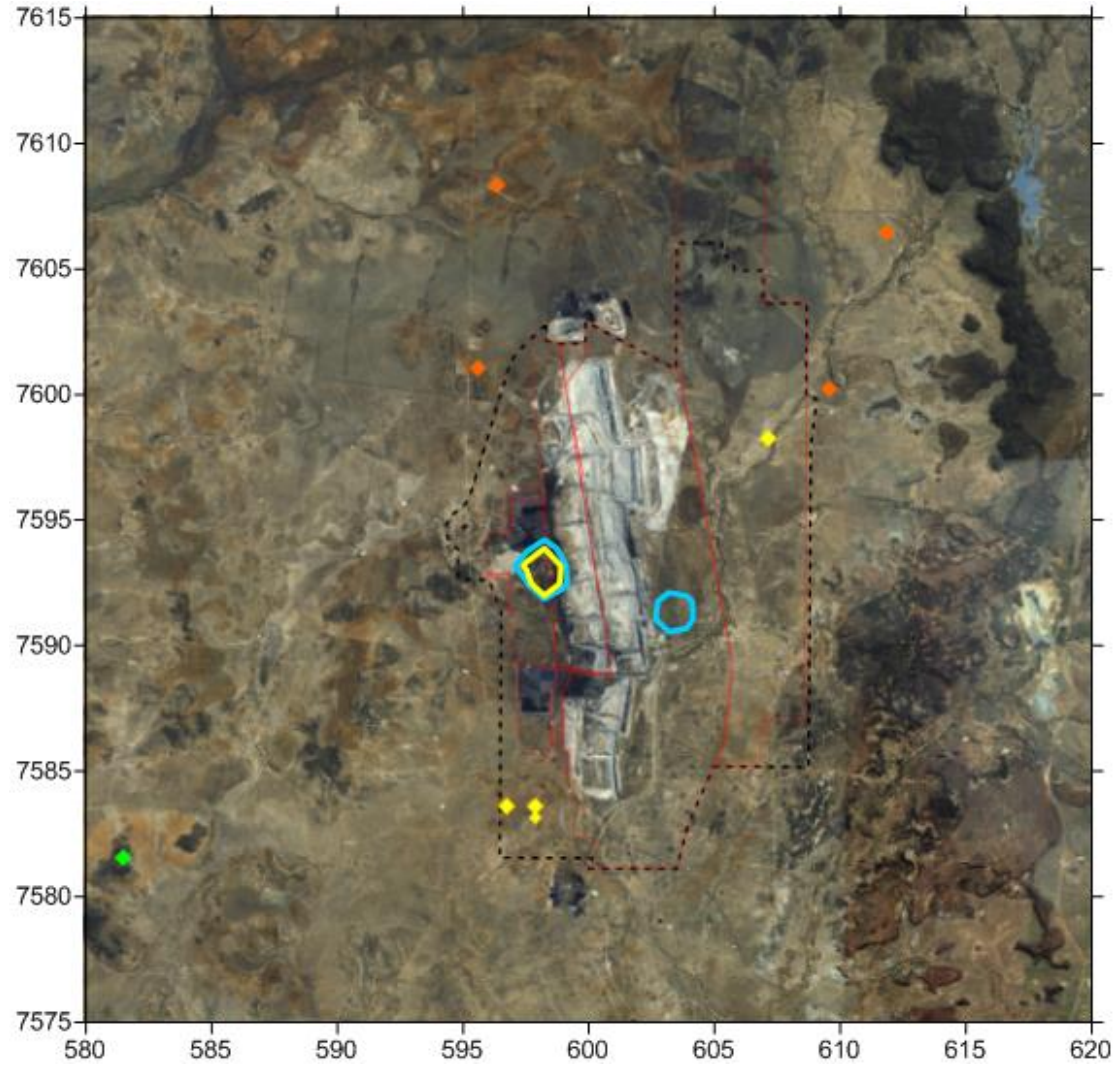


Scenario: Cumulative Future Mining		**Mines included:** GRM, BRM, RHM, Eaglefield, Grosvenor, Moranbah North Mine	
Pollutant:	$PM_{2.5}$	**Averaging Period:**	Annual
Background level:	6.6 µg/m^3	**Rank:**	Maximum
Project Goal:	8 µg/m^3	**Contour level(s):**	8 µg/m^3
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

N.4 Dust Deposition

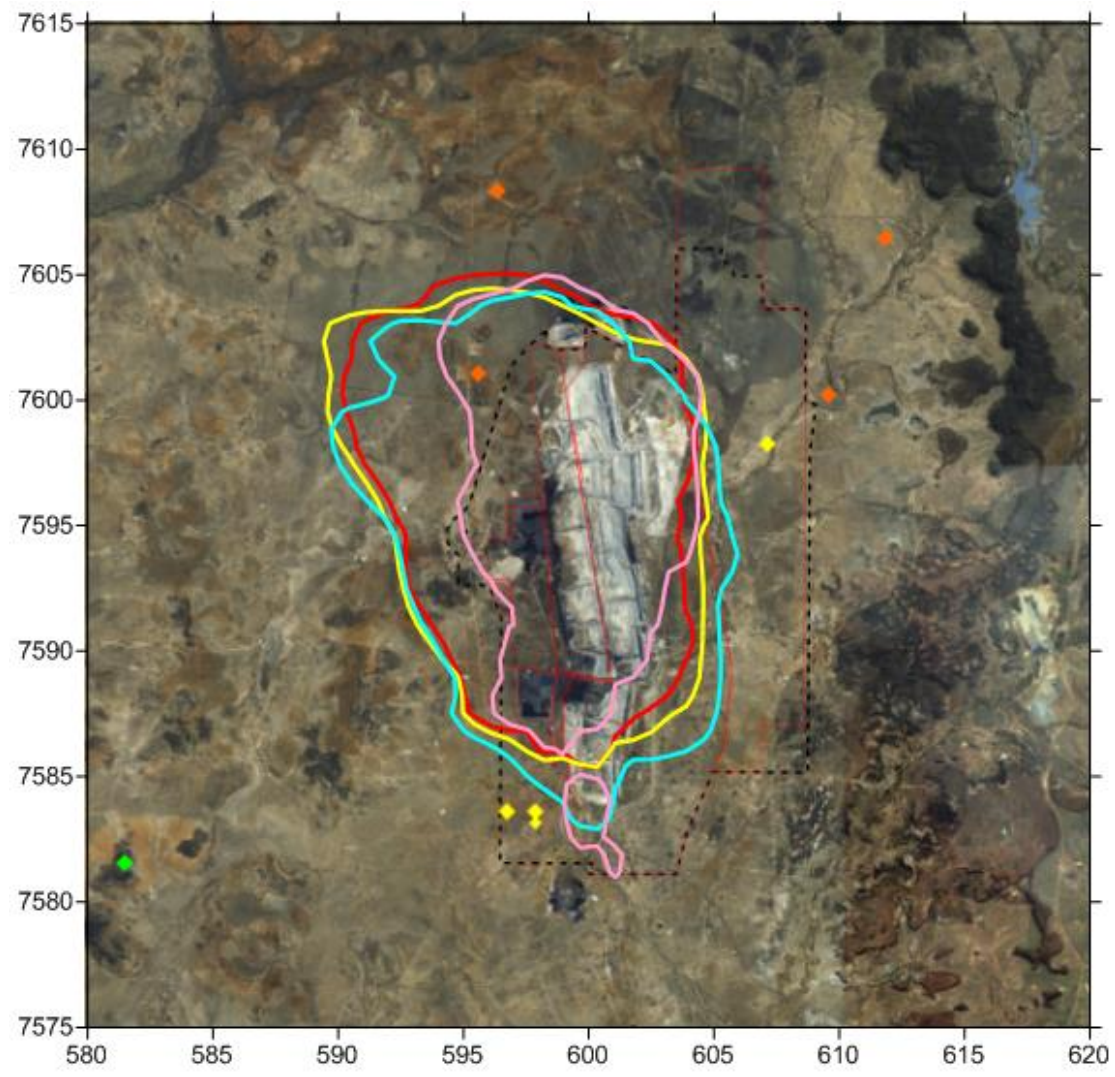
N.4.1 Monthly Average

Figure 47: Dust Deposition – Red Hill Mine Only Impacts



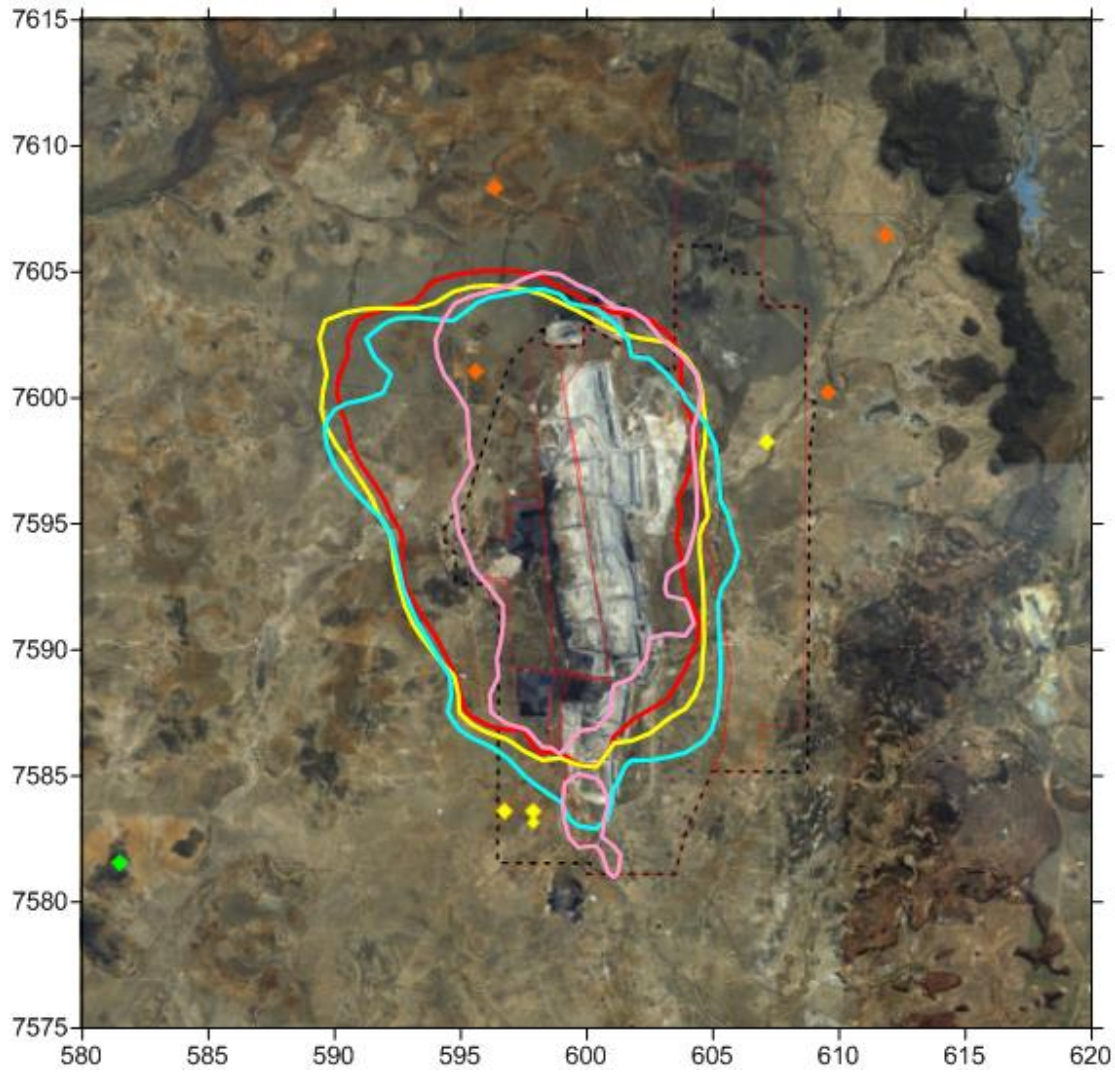
Scenario: Red Hill Mine only		**Mines included:** RHM	
Pollutant:	Dust Deposition	**Averaging Period:**	Monthly
Background level:	Not included	**Rank:**	Maximum
Project Goal:	120 mg/m^2/day	**Contour level(s):**	0.5, 1, 120 mg/m^2/day
Contour Legend: Red: 120 mg/m^2/day , Cyan: 0.5 mg/m^2/day, Yellow: 1 mg/m^2/day			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 48: Dust Deposition - Existing Mining



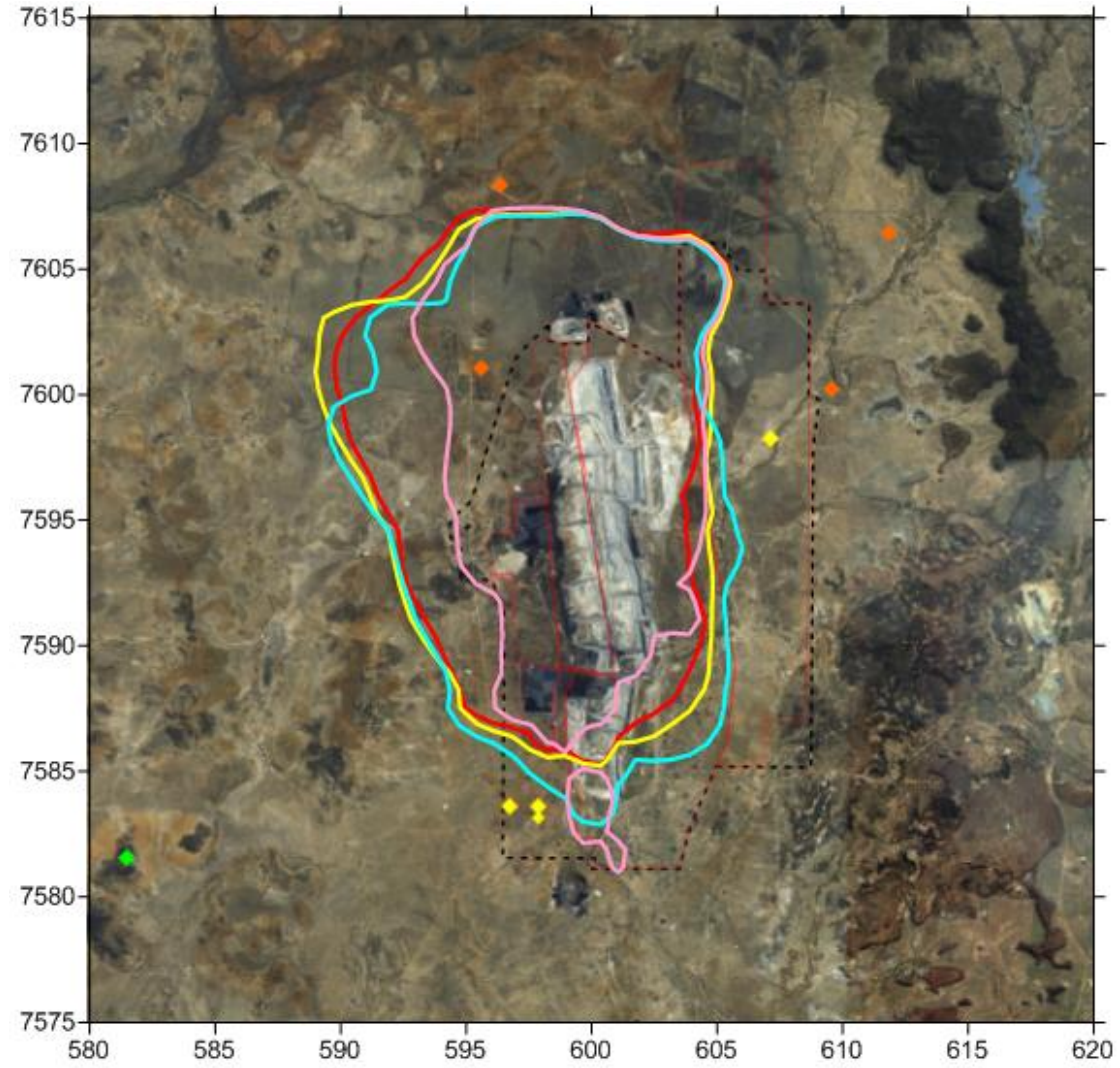
Scenario: Existing Mining		**Mines included:** GRM, BRM	
Pollutant:	Dust Deposition	**Averaging Period:**	Monthly
Background level:	50 mg/m^2/day	**Rank:**	Maximum
Project Goal:	120 mg/m^2/day	**Contour level(s):**	120 mg/m^2/day
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 49: Dust Deposition - Future Mining



Scenario: Future Mining		**Mines included:** GRM, BRM, RHM	
Pollutant:	Dust Deposition	**Averaging Period:**	Monthly
Background level:	50 mg/m^2/day	**Rank:**	Maximum
Project Goal:	120 mg/m^2/day	**Contour level(s):**	120 mg/m^2/day
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Figure 50: Dust Deposition - Cumulative Future Mining

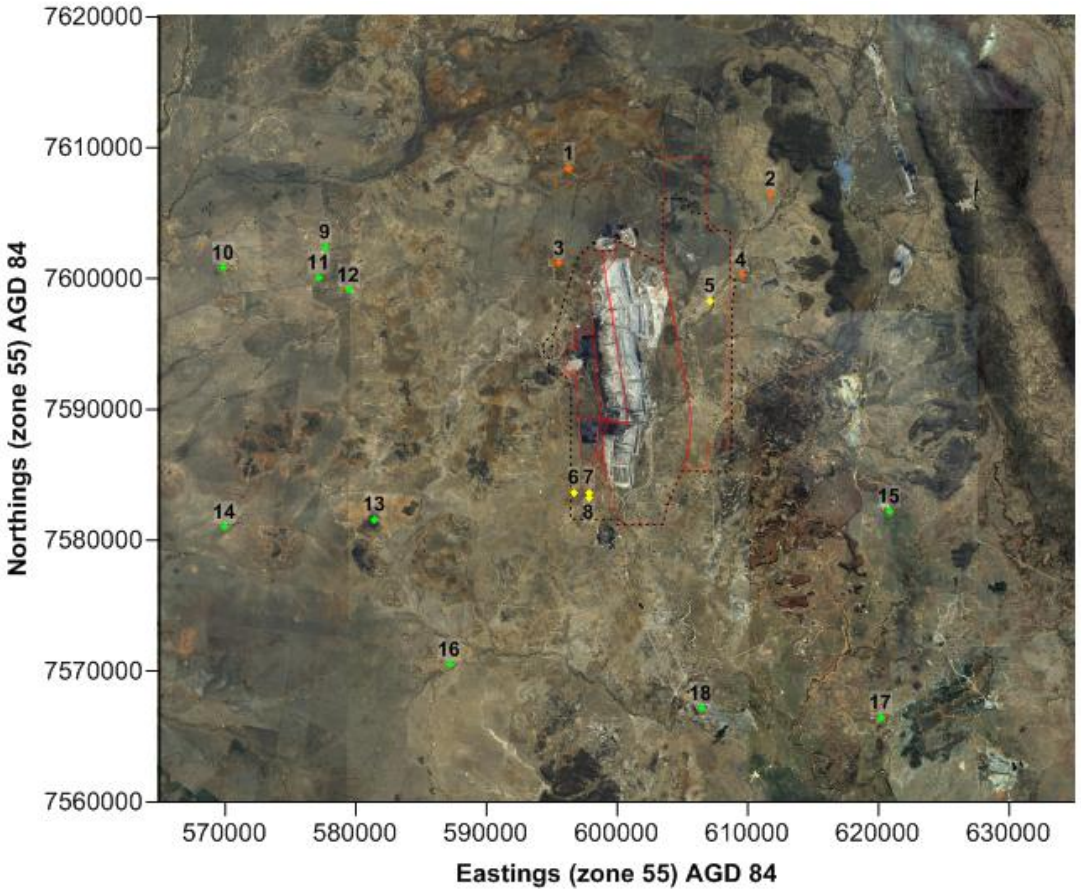


Scenario: Cumulative Future Mining		**Mines included:** GRM, BRM, RHM, Eaglefield, Grosvenor, Moranbah North Mine	
Pollutant:	Dust Deposition	**Averaging Period:**	Monthly
Background level:	50 mg/m^2/day	**Rank:**	Maximum
Project Goal:	120 mg/m^2/day	**Contour level(s):**	120 mg/m^2/day
Contour Legend: Red: FY2015, Yellow: FY2030, Cyan: FY2040, Pink: FY2050			
Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner			

Appendix O Results at Receptor Locations

Presented in this Appendix are the results of the dispersion modelling at the location of the receptors (Figure 51, see also Appendix E).

Figure 51: Receptor Locations



Receptor Legend: Orange:- BMA/BMC controlled, Green:- Privately owned homesteads, Yellow:- Privately owned homesteads – subject to negotiation with landowner

Results are presented for the Red Hill Mine only, Existing Mining (FY2015, FY2030, FY2040, FY2050), Future Mining (FY2015, FY2030, FY2040, FY2050) and Cumulative Future Mining (FY2015, FY2030, FY2040, FY2050) for the following:

- A summary of the receptors for which exceedences are predicted
- Annual average ground-level concentration of TSP (maximum and number of exceedences)
- 24-hour average ground-level concentration of PM_{10} (maximum, 5th highest per annum, background creep, and number of exceedences)

- 24-hour average ground-level concentration of $PM_{2.5}$ (maximum, 5th highest per annum, background creep, and number of exceedences per year)
- Annual average ground-level concentration of $PM_{2.5}$ (maximum and number of exceedences per year)
- Monthly average dust deposition (maximum and number of exceedences per year)

Note that background creep is defined here as the incremental contribution to the 70th percentile 24-hour average concentration of PM_{10} and/or $PM_{2.5}$.

Note that contour plots for the incremental contribution to the 70th percentile 24-hour average concentration of PM_{10} (i.e. background creep) for the Existing Mining Scenario and Cumulative Future Mining Scenario are presented in the Red Hill Mining Lease Project EIS Chapter 11*: Air Quality*.

Table 21: Receptor Numbers Exceeding Pollutant Criteria

Scenario	RHM Only	Existing Mining				Future Mining				Cumulative Future Mining			
Pollutant	**Worst Case**	**2015**	**2030**	**2040**	**2050**	**2015**	**2030**	**2040**	**2050**	**2015**	**2030**	**2040**	**2050**
TSP Annual average	None	3	3	3	3	3	3	3	3	3	3	3	3
PM_{10} 24-hour average	None	1, 2, 3, 4, 5, 6, 7, 8, 9,11, 12,13, 18	1, 2, 3, 4, 5, 6, 7, 8, 9,11, 12,13, 18	1, 2, 3, 4, 5, 6, 7, 8, 9,11, 12,13, 16, 18	1, 2, 3, 4, 5, 6, 7, 8, 12	1, 2, 3, 4, 5, 6, 7, 8, 9,11, 12,13, 18	1, 2, 3, 4, 5, 6, 7, 8, 9,11, 12,13, 18	1, 2, 3, 4, 5, 6, 7, 8, 9,11, 12,13, 16, 18	1, 2, 3, 4, 5, 6, 7, 8, 12	1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11, 12,13, 15, 18	1, 2, 3, 4, 5, 6, 7, 8, 9,10, 11, 12,13, 15, 16, 18	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12,13, 15, 16, 18	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
$PM_{2.5}$ 24-hour average	None	3, 5	3, 5, 7	3, 5, 7, 8	3	3, 5	3, 5, 7	3, 5, 7, 8	3	1, 2, 3, 5	1,3, 5, 7, 8	1, 3, 5, 6, 7, 8	1,3
$PM_{2.5}$ Annual average	None	3, 6, 7	3, 6, 7, 8	3, 6, 7, 8	3, 6, 7, 8	3, 6, 7, 8	3, 6, 7, 8	3, 6, 7, 8	3, 6, 7, 8	1, 3, 6, 7, 8	1, 3, 6, 7, 8, 12	1, 3, 6, 7, 8	1, 3, 6, 7, 8
Dust Deposition Monthly average	None	3	3	3	3	3	3	3	3	3	3	3	3

O.1 Total Suspended Particulates Annual Averaging Period

Table 22: Red Hill Mine

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
RHM Only GLC (max)	µg/m^3	0.1	0.0	0.2	0.0	0.1	0.4	0.4	0.4	0.1	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Total GLC (max)	µg/m^3	39.9	39.8	40.0	39.8	39.9	40.2	40.2	40.2	39.9	39.9	39.9	40.0	39.9	39.8	39.8	39.8	39.8	39.8
Exceedences	#/year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 23: Existing Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	47.2	41.2	**128.8**	42.1	43.7	54.1	55.9	53.6	48.1	43.9	48.0	50.3	45.4	41.6	40.2	41.7	40.2	41.1
FY2030	µg/m^3	46.7	41.3	**111.6**	42.6	44.9	57.3	59.7	57.0	48.5	44.2	48.4	50.8	46.0	41.8	40.3	42.0	40.2	41.3
FY2040	µg/m^3	45.8	41.2	**94.2**	42.8	45.7	64.5	69.9	65.2	48.1	44.1	48.1	50.1	46.3	41.9	40.3	42.4	40.3	41.5
FY2050	µg/m^3	45.7	40.7	**93.8**	41.2	42.2	55.4	63.6	60.8	44.2	42.1	44.2	45.4	42.9	40.8	40.1	41.0	40.0	40.6
Exceedences FY2015	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 24: Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	47.3	41.2	**129.1**	42.1	43.8	54.4	56.3	53.9	48.2	44.0	48.1	50.5	45.6	41.6	40.2	41.8	40.2	41.2
FY2030	µg/m^3	46.7	41.3	**111.9**	42.7	44.9	57.7	60.1	57.4	48.6	44.3	48.5	50.9	46.2	41.8	40.3	42.1	40.2	41.3
FY2040	µg/m^3	45.9	41.2	**94.5**	42.9	45.8	64.9	70.3	65.6	48.2	44.2	48.2	50.3	46.5	41.9	40.3	42.5	40.3	41.5
FY2050	µg/m^3	45.8	40.7	**94.1**	41.3	42.3	55.8	64.0	61.2	44.4	42.2	44.3	45.6	43.1	40.9	40.1	41.1	40.0	40.6
Exceedences FY2015	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 25: Cumulative Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	59.3	41.9	**152.5**	42.8	45.2	56.6	58.3	56.1	50.8	45.2	50.5	53.5	46.9	42.1	40.4	42.4	40.3	41.6
FY2030	µg/m^3	58.8	42.0	**135.3**	43.4	46.4	59.8	62.2	59.5	51.2	45.5	50.9	53.9	47.5	42.3	40.5	42.7	40.3	41.7
FY2040	µg/m^3	57.9	41.9	**117.9**	43.5	47.3	67.0	72.4	67.8	50.7	45.5	50.6	53.3	47.8	42.4	40.5	43.0	40.4	41.9
FY2050	µg/m^3	57.8	41.4	**117.5**	42.0	43.7	57.9	66.1	63.4	46.9	43.4	46.7	48.6	44.4	41.4	40.2	41.6	40.1	41.0
Exceedences FY2015	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

O.2 Particulate Matter as PM_{10} – Twenty Four-Hour Averaging Period

Table 26: Red Hill Mine

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Project Only GLC (max)	µg/m^3	1.1	1.0	2.5	1.7	3.0	2.0	2.5	2.3	0.6	0.3	0.6	0.7	1.2	0.2	0.5	0.4	0.2	0.5
Total GLC (max)	µg/m^3	30.7	30.6	32.1	31.3	32.6	31.6	32.1	31.9	30.2	29.9	30.2	30.3	30.8	29.8	30.1	30.0	29.8	30.1
Project Only GLC (5th)	µg/m^3	0.7	0.4	1.8	0.7	1.1	1.7	2.0	1.8	0.5	0.3	0.5	0.6	0.8	0.2	0.2	0.3	0.1	0.3
Total GLC (5th)	µg/m^3	30.3	30.0	31.4	30.3	30.7	31.3	31.6	31.4	30.1	29.9	30.1	30.2	30.4	29.8	29.8	29.9	29.7	29.9
Background Creep	µg/m^3	0.0	0.0	0.1	0.0	0.0	0.4	0.4	0.3	0.2	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Exceedences	#/year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 27: Existing Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m3	**145**	**104**	**358**	**133**	**159**	**114**	**137**	**126**	**63**	47	**66**	**75**	**65**	44	**50**	48	39	**56**
FY2030	µg/m3	**136**	**106**	**330**	**153**	**193**	**132**	**160**	**143**	**64**	**53**	**68**	**79**	**67**	46	**53**	**51**	40	**56**
FY2040	µg/m3	**121**	**95**	**286**	**158**	**224**	**161**	**189**	**170**	**61**	**51**	**64**	**74**	**70**	45	**55**	**53**	41	**57**
FY2050	µg/m3	**105**	**80**	**177**	**103**	**120**	**82**	**100**	**91**	48	41	48	**52**	47	39	39	40	34	41
Total GLC (5th) FY2015	µg/m3	**103**	**58**	**244**	**76**	**95**	**98**	**115**	**105**	**56**	43	**58**	**67**	**58**	38	37	43	34	43
FY2030	µg/m3	**98**	**55**	**235**	**86**	**112**	**114**	**134**	**122**	**58**	44	**59**	**67**	**62**	39	38	45	34	44
FY2040	µg/m3	**88**	**53**	**175**	**81**	**119**	**140**	**158**	**144**	**55**	44	**57**	**63**	**62**	39	38	46	35	46
FY2050	µg/m3	**78**	**50**	**153**	**57**	**64**	**76**	**86**	**80**	44	37	44	48	44	34	34	37	32	37
Background Creep FY2015	µg/m3	0	0	66	0	0	6	4	3	9	5	9	12	5	2	0	1	0	0
FY2030	µg/m3	0	0	56	0	0	7	5	4	10	5	10	12	6	2	0	1	0	0
FY2040	µg/m3	0	0	42	0	0	17	16	11	10	5	10	12	7	2	0	1	0	0
FY2050	µg/m3	0	0	39	0	0	11	16	14	5	3	5	6	3	1	0	1	0	0
Exceedences FY2015	#/year	36	6	222	9	13	70	69	65	23	0	24	45	29	0	0	0	0	1

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
FY2030	#/year	37	7	192	10	15	74	76	71	29	0	28	52	35	0	0	0	0	1
FY2040	#/year	34	6	182	11	19	99	99	91	26	0	25	44	33	0	0	1	0	1
FY2050	#/year	31	5	193	6	9	63	83	76	0	0	0	1	0	0	0	0	0	0

Table 28: Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m3	**146**	**105**	**359**	**134**	**160**	**116**	**138**	**127**	**64**	47	**66**	**76**	**65**	44	**50**	49	39	**56**
FY2030	µg/m3	**137**	**107**	**331**	**154**	**194**	**134**	**161**	**144**	**64**	**53**	**68**	**79**	**68**	46	**53**	**51**	40	**56**
FY2040	µg/m3	**123**	**96**	**286**	**160**	**226**	**163**	**191**	**172**	**61**	**52**	**65**	**74**	**71**	45	**55**	**54**	41	**57**
FY2050	µg/m3	**106**	**81**	**177**	**103**	**121**	**84**	**101**	**93**	48	42	48	**53**	48	39	39	41	34	42
Total GLC (5th) FY2015	µg/m3	**104**	**58**	**245**	**77**	**96**	**99**	**116**	**106**	**56**	43	**58**	**67**	**59**	38	37	43	34	43
FY2030	µg/m3	**99**	**55**	**236**	**86**	**112**	**115**	**135**	**123**	**58**	45	**59**	**68**	**62**	39	38	45	34	44
FY2040	µg/m3	**89**	**53**	**177**	**81**	**119**	**141**	**160**	**146**	**56**	44	**58**	**64**	**62**	39	39	47	35	46
FY2050	µg/m3	**78**	**50**	**153**	**59**	**66**	**77**	**87**	**81**	44	37	44	48	45	34	34	37	32	37
Background Creep FY2015	µg/m3	0	0	66	0	0	7	5	4	10	5	9	12	5	2	0	1	0	0
FY2030	µg/m3	0	0	56	0	0	8	5	5	10	5	10	13	6	2	0	1	0	0
FY2040	µg/m3	0	0	42	0	0	17	16	11	10	5	10	12	7	2	0	1	0	0
FY2050	µg/m3	0	0	39	0	0	12	16	15	5	3	5	6	3	1	0	1	0	0
Exceedences FY2015	#/year	36	6	222	9	13	72	69	66	24	0	25	46	30	0	0	0	0	1
FY2030	#/year	37	7	192	10	16	77	78	72	31	0	29	53	36	0	0	0	0	1
FY2040	#/year	34	6	183	11	19	100	100	92	27	0	26	46	35	0	0	1	0	2
FY2050	#/year	32	5	194	6	9	66	85	79	0	0	0	2	0	0	0	0	0	0

Table 29: Cumulative Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	**208**	**174**	**360**	**154**	**177**	**128**	**157**	**144**	**74**	**51**	**73**	**83**	**73**	46	**53**	**53**	41	**57**
FY2030	µg/m^3	**203**	**161**	**332**	**163**	**199**	**144**	**174**	**155**	**75**	**53**	**75**	**85**	**75**	48	**56**	**56**	42	**58**
FY2040	µg/m^3	**194**	**150**	**286**	**160**	**226**	**165**	**201**	**181**	**69**	**52**	**71**	**80**	**73**	46	**58**	**57**	42	**59**
FY2050	µg/m^3	**195**	**164**	**235**	**134**	**137**	**94**	**114**	**105**	**61**	44	**58**	**64**	**58**	41	45	45	36	47
Total GLC (5th) FY2015	µg/m^3	**153**	**80**	**256**	**87**	**104**	**108**	**127**	**117**	**64**	47	**65**	**75**	**66**	40	40	47	35	47
FY2030	µg/m^3	**150**	**82**	**240**	**93**	**121**	**122**	**145**	**131**	**65**	48	**67**	**75**	**68**	41	41	49	36	48
FY2040	µg/m^3	**140**	**77**	**193**	**92**	**127**	**144**	**168**	**151**	**62**	47	**63**	**70**	**66**	41	41	**50**	36	**50**
FY2050	µg/m^3	**143**	**70**	**205**	**67**	**82**	**82**	**97**	**90**	**55**	41	**53**	**60**	**52**	37	37	41	33	41
Background Creep FY2015	µg/m^3	7	0	89	0	0	7	6	6	13	6	12	16	6	2	0	1	0	0
FY2030	µg/m^3	7	0	78	0	0	9	7	7	13	7	13	16	7	2	0	1	0	0
FY2040	µg/m^3	7	0	68	0	0	19	17	13	13	7	13	16	8	3	0	1	0	0
FY2050	µg/m^3	6	0	61	0	0	13	17	16	8	4	8	10	4	1	0	1	0	0
Exceedences FY2015	#/year	75	8	275	12	18	75	72	69	49	1	47	78	41	0	1	0	0	2
FY2030	#/year	75	9	264	13	20	80	79	75	54	2	52	83	46	0	1	2	0	4
FY2040	#/year	74	10	244	14	23	105	102	93	48	0	48	74	48	0	2	5	0	5
FY2050	#/year	73	7	238	9	15	74	91	84	14	0	14	32	9	0	0	0	0	0

O.3 Particulate Matter as $PM_{2.5}$ – Twenty Four-Hour Averaging Period

Table 30: Red Hill Mine

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Project Only GLC (max)	µg/m^3	0.1	0.1	0.3	0.2	0.4	0.2	0.3	0.3	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1
Total GLC (max)	µg/m^3	7.1	7.1	7.3	7.2	7.4	7.2	7.3	7.3	7.1	7.0	7.1	7.1	7.1	7.0	7.1	7.0	7.0	7.1
Project Only GLC (5th)	µg/m^3	0.1	0.0	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Total GLC (5th)	µg/m^3	7.1	7.0	7.2	7.1	7.1	7.2	7.2	7.2	7.1	7.0	7.1	7.1	7.1	7.0	7.0	7.0	7.0	7.0
Background Creep	µg/m^3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exceedences	#/year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 31: Existing Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	22.6	16.2	**49.1**	21.9	**30.2**	19.5	23.7	22.0	10.8	9.7	11.0	12.1	11.0	9.0	9.1	9.3	8.2	10.6
FY2030	µg/m^3	20.6	16.4	**43.3**	24.9	**31.6**	21.0	**27.6**	**25.6**	11.3	10.6	11.7	12.4	11.4	9.2	9.4	9.7	8.3	10.6
FY2040	µg/m^3	19.0	15.9	**49.7**	22.5	**32.2**	**25.2**	**27.8**	**26.5**	11.0	10.3	11.2	11.8	12.0	9.2	9.6	9.8	8.3	10.8
FY2050	µg/m^3	17.8	13.6	**30.4**	20.3	21.5	14.0	17.2	16.3	9.2	8.8	9.2	9.6	8.9	8.3	7.9	8.3	7.5	8.5
Total GLC (5th) FY2015	µg/m^3	16.7	10.6	**40.6**	13.5	17.1	16.6	19.1	17.9	10.1	8.7	10.3	11.1	10.2	8.0	7.9	8.7	7.6	8.8
FY2030	µg/m^3	15.9	10.2	**36.8**	14.8	19.6	18.6	21.4	19.7	10.3	8.8	10.3	11.3	10.5	8.1	7.9	8.8	7.6	9.0
FY2040	µg/m^3	14.6	9.9	**26.4**	14.4	20.0	21.1	24.6	22.8	10.0	8.8	10.2	10.8	10.6	8.2	8.0	9.0	7.7	9.2
FY2050	µg/m^3	14.2	9.6	**26.4**	10.6	12.4	12.9	14.5	13.8	8.7	7.9	8.7	9.1	8.6	7.5	7.5	7.9	7.3	8.0
Background Creep FY2015	µg/m^3	0.0	0.0	12.6	0.0	0.0	0.8	0.6	0.4	1.3	0.6	1.2	1.5	0.6	0.2	0.0	0.1	0.0	0.0
FY2030	µg/m^3	0.0	0.0	10.4	0.0	0.0	1.0	0.8	0.6	1.4	0.6	1.3	1.6	0.7	0.2	0.0	0.1	0.0	0.0
FY2040	µg/m^3	0.0	0.0	7.5	0.0	0.0	2.6	2.7	2.0	1.3	0.6	1.3	1.5	0.8	0.2	0.0	0.1	0.0	0.0
FY2050	µg/m^3	0.0	0.0	7.4	0.0	0.0	1.9	3.1	2.8	0.6	0.3	0.6	0.8	0.4	0.1	0.0	0.1	0.0	0.0
Exceedences FY2015	#/year	0	0	64	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
FY2030	#/year	0	0	40	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	10	0	3	0	4	1	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 32: Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	22.7	16.2	**49.2**	22.0	**30.3**	19.6	23.8	22.0	10.9	9.7	11.0	12.1	11.1	9.0	9.1	9.4	8.2	10.7
FY2030	µg/m^3	20.7	16.5	**43.4**	24.9	**31.7**	21.1	**27.7**	**25.6**	11.3	10.6	11.7	12.5	11.5	9.3	9.4	9.7	8.3	10.6
FY2040	µg/m^3	19.1	16.0	**49.7**	22.5	**32.4**	**25.4**	**28.1**	**26.6**	11.1	10.4	11.3	11.8	12.1	9.3	9.7	9.8	8.4	10.8
FY2050	µg/m^3	17.9	13.6	**30.4**	20.3	21.6	14.2	17.3	16.4	9.2	8.9	9.2	9.6	8.9	8.3	8.0	8.4	7.6	8.5
Total GLC (5th) FY2015	µg/m^3	16.8	10.7	**40.7**	13.6	17.3	16.6	19.2	18.1	10.2	8.7	10.3	11.2	10.3	8.0	7.9	8.7	7.6	8.8
FY2030	µg/m^3	16.0	10.2	**36.9**	14.8	19.7	18.8	21.6	19.8	10.4	8.8	10.4	11.3	10.6	8.2	8.0	8.9	7.6	9.0
FY2040	µg/m^3	14.6	9.9	**26.5**	14.4	20.1	21.3	24.7	22.9	10.0	8.8	10.2	10.9	10.6	8.3	8.0	9.0	7.7	9.2
FY2050	µg/m^3	14.3	9.6	**26.4**	10.6	12.4	13.1	14.7	13.9	8.7	7.9	8.7	9.1	8.7	7.6	7.5	8.0	7.3	8.1
Background Creep FY2015	µg/m^3	0.0	0.0	12.6	0.0	0.0	0.8	0.6	0.5	1.3	0.6	1.2	1.6	0.6	0.2	0.0	0.1	0.0	0.0
FY2030	µg/m^3	0.0	0.0	10.4	0.0	0.0	1.1	0.8	0.7	1.4	0.7	1.3	1.6	0.7	0.2	0.0	0.1	0.0	0.0
FY2040	µg/m^3	0.0	0.0	7.5	0.0	0.0	2.6	2.8	2.0	1.3	0.6	1.3	1.6	0.8	0.2	0.0	0.1	0.0	0.0
FY2050	µg/m^3	0.0	0.0	7.5	0.0	0.0	1.9	3.1	2.8	0.7	0.3	0.7	0.8	0.4	0.1	0.0	0.1	0.0	0.0
Exceedences FY2015	#/year	0	0	64	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	40	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	10	0	3	0	4	1	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 33: Cumulative Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	**28.6**	**25.3**	**49.3**	22.1	**30.3**	21.3	**25.4**	23.6	12.0	9.7	11.9	13.1	11.7	9.3	9.4	9.9	8.3	10.8
FY2030	µg/m^3	**27.8**	23.5	**43.5**	24.9	**31.7**	22.8	**29.3**	**27.2**	12.0	10.6	11.9	13.1	12.0	9.5	9.7	10.2	8.5	10.8
FY2040	µg/m^3	**26.7**	22.1	**49.7**	22.6	**32.5**	**25.6**	**29.4**	**28.1**	11.3	10.4	11.5	12.5	12.1	9.4	9.9	10.4	8.5	10.9
FY2050	µg/m^3	**27.3**	24.0	**34.3**	20.3	23.3	15.1	18.9	18.0	10.6	8.9	10.2	10.7	10.1	8.6	8.6	8.9	7.7	9.1
Total GLC (5th) FY2015	µg/m^3	22.1	13.4	**41.0**	14.9	17.5	17.7	20.4	19.3	11.0	9.1	11.0	12.0	11.0	8.3	8.1	9.1	7.7	9.3
FY2030	µg/m^3	21.7	13.8	**37.3**	16.4	20.3	19.5	22.7	20.8	11.0	9.2	11.1	12.1	11.2	8.4	8.3	9.3	7.7	9.4
FY2040	µg/m^3	20.9	13.0	**28.3**	15.2	22.0	22.0	**25.6**	23.6	10.6	9.0	10.7	11.5	11.1	8.4	8.4	9.4	7.8	9.6
FY2050	µg/m^3	21.2	11.8	**31.5**	12.2	14.9	13.9	15.8	14.9	9.8	8.4	9.7	10.4	9.5	7.8	7.8	8.4	7.4	8.4
Background Creep FY2015	µg/m^3	1.1	0.0	15.5	0.0	0.0	1.0	0.8	0.8	1.6	0.8	1.6	2.0	0.7	0.2	0.0	0.1	0.0	0.0
FY2030	µg/m^3	1.0	0.0	12.7	0.0	0.0	1.2	1.0	0.9	1.7	0.9	1.7	2.1	0.8	0.3	0.0	0.1	0.0	0.0
FY2040	µg/m^3	1.0	0.0	10.8	0.0	0.0	2.8	2.9	2.1	1.7	0.9	1.6	2.0	1.0	0.3	0.0	0.2	0.0	0.0
FY2050	µg/m^3	1.0	0.0	10.8	0.0	0.0	2.0	3.3	2.9	1.0	0.5	1.0	1.3	0.5	0.2	0.0	0.1	0.0	0.0
Exceedences FY2015	#/year	2	0	86	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	1	0	57	0	3	0	2	1	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	1	0	26	0	4	1	7	2	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	1	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

O.4 Particulate Matter as $PM_{2.5}$ – Annual Averaging Period

Table 34: Red Hill Mine

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Project Only GLC (max)	µg/m^3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GLC (max)	µg/m^3	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Exceedences	#/year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 35: Existing Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	7.3	6.7	**15.5**	6.8	7.0	**8.0**	**8.2**	8.0	7.4	7.0	7.4	7.7	7.2	6.8	6.6	6.8	6.6	6.7
FY2030	µg/m^3	7.3	6.7	**13.8**	6.9	7.1	**8.4**	**8.6**	**8.3**	7.5	7.0	7.5	7.7	7.2	6.8	6.6	6.8	6.6	6.8
FY2040	µg/m^3	7.2	6.7	**12.0**	6.9	7.2	**9.1**	**9.6**	**9.1**	7.4	7.0	7.4	7.6	7.3	6.8	6.7	6.9	6.6	6.8
FY2050	µg/m^3	7.2	6.7	**12.0**	6.7	6.8	**8.2**	**9.0**	**8.7**	7.0	6.8	7.0	7.2	6.9	6.7	6.6	6.7	6.6	6.7
Exceedences FY2015	#/year	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0

Table 36: Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	7.4	6.7	15.5	6.8	7.0	8.1	8.2	8.0	7.4	7.0	7.4	7.7	7.2	6.8	6.6	6.8	6.6	6.7
FY2030	µg/m^3	7.3	6.7	13.8	6.9	7.1	8.4	8.6	8.4	7.5	7.0	7.5	7.7	7.2	6.8	6.7	6.8	6.6	6.8
FY2040	µg/m^3	7.2	6.7	12.1	6.9	7.2	9.1	9.7	9.2	7.4	7.0	7.4	7.6	7.3	6.8	6.7	6.9	6.6	6.8
FY2050	µg/m^3	7.2	6.7	12.0	6.7	6.8	8.2	9.0	8.7	7.1	6.8	7.1	7.2	6.9	6.7	6.6	6.7	6.6	6.7
Exceedences FY2015	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0

Table 37: Cumulative Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	µg/m^3	8.6	6.8	17.9	6.9	7.1	8.3	8.5	8.2	7.7	7.1	7.7	8.0	7.3	6.8	6.7	6.9	6.6	6.8
FY2030	µg/m^3	8.5	6.8	16.1	7.0	7.3	8.6	8.8	8.6	7.7	7.2	7.7	**8.0**	7.4	6.8	6.7	6.9	6.7	6.8
FY2040	µg/m^3	8.4	6.8	14.4	7.0	7.3	9.3	9.9	9.4	7.7	7.2	7.7	7.9	7.4	6.9	6.7	6.9	6.7	6.8
FY2050	µg/m^3	8.4	6.8	14.4	6.8	7.0	8.4	9.2	9.0	7.3	7.0	7.3	7.5	7.1	6.8	6.6	6.8	6.6	6.7
Exceedences FY2015	#/year	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	1	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0
FY2040	#/year	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0

O.5 Dust Deposition – Monthly Average

Table 38: Red Hill Mine

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Project Only GLC (max)	$mg/m^2/day$	0.2	0.1	0.5	0.2	0.3	0.5	0.6	0.5	0.3	0.2	0.3	0.4	0.2	0.1	0.0	0.1	0.0	0.1
Total GLC (max)	$mg/m^2/day$	50	50	51	50	50	51	51	51	50	50	50	50	50	50	50	50	50	50
Exceedences	#/year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 39: Existing Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	$mg/m^2/day$	75	56	**243**	60	67	75	79	76	69	63	69	71	60	56	52	54	52	55
FY2030	$mg/m^2/day$	72	57	**227**	62	71	79	85	81	73	65	72	75	61	56	52	55	52	56
FY2040	$mg/m^2/day$	72	56	**214**	62	75	90	97	90	72	65	71	74	62	56	53	55	52	56
FY2050	$mg/m^2/day$	77	54	**140**	56	60	68	74	73	62	58	61	62	55	53	51	53	51	53
Exceedences FY2015	#/year	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 40: Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	mg/m^2/day	75	56	**243**	60	67	76	80	77	69	63	69	72	60	56	52	54	52	55
FY2030	mg/m^2/day	72	57	**227**	62	71	79	85	82	73	66	72	75	61	56	52	55	52	56
FY2040	mg/m^2/day	72	56	**214**	63	75	90	97	90	72	65	72	74	62	56	53	55	52	56
FY2050	mg/m^2/day	77	54	**141**	56	60	69	74	74	62	58	61	62	55	53	51	53	51	53
Exceedences FY2015	#/year	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 41: Cumulative Future Mining

Parameter	Units	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
Total GLC (max) FY2015	mg/m^2/day	93	58	**246**	61	69	78	82	79	70	64	70	73	61	56	53	55	52	56
FY2030	mg/m^2/day	90	59	**231**	62	72	82	88	84	74	66	74	76	62	56	53	56	52	57
FY2040	mg/m^2/day	90	58	**227**	63	75	92	99	93	73	66	73	76	63	57	53	56	53	57
FY2050	mg/m^2/day	95	56	**157**	58	66	70	75	75	63	59	62	65	56	54	52	53	52	54
Exceedences FY2015	#/year	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2030	#/year	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2040	#/year	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FY2050	#/year	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix P Document Limitations

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Appendix Q References

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