Taroborah Coal Project

Appendix 15 – Air Quality Impact Assessment

Air Quality Impact Assessment for the Taroborah Coal Project

Prepared for

AARC

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FINAL

Prepared by

Katestone Environmental Pty Ltd

ABN 92 097 270 276
Ground Floor, 16 Marie Street
PO Box 2217
Milton, Queensland, Australia 4064

www.katestone.com.au
environmental@katestone.com.au
Ph +61 7 3369 3699
Fax +61 7 3369 1966

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Prepared by: Michael Burchill, Ella Castillo and Sarah-Jane Donnelly

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Glossary

Term	Definition
Units of measurement	
%	percentage
g/s	grams per second
m	metre
m^2	square metres
m^3	cubic metres
km	kilometre
kg	kilogram
µm	micrometres
µg/m^3	micrograms per cubic metre
m/s	metres per second
m^3/s	cubic metres per second
ou	odour units
ou/m^3/s	odour units per cubic metre per second
mg/m^2/day	milligrams per square metre per day
K	kelvin
Mtpa	million tonnes per annum
Mt	million tonnes
Air pollutants	
PM	Particulate matter (fine dust)
$PM_{2.5}$ and PM_{10}	Particulate matter with diameter less than 2.5 or 10 microns, respectively
TSP	Total suspended particles
Other abbreviations	
AARC	AustralAsian Resource Consultants
AQMP	Air Quality Management Plan
US EPA	United States Environmental Protection Agency
EPA	Environmental Protection Agency
DERM	Queensland Department of Environment and Resource Management
EHP	Department of Environment and Heritage Protection
EPP	Environmental Protection Policy
TAPM	The Air Pollution Model
CSIRO	Commonwealth Scientific and Industrial Research Organization
NPI	National Pollutant Inventory
OEH	NSW Office of the Environment and Heritage
MCPL	Middlemount Coal Pty Ltd
MDL	Mineral Development License
ROM	Run of mine
DMP	Dust Management Plan
TARP	Trigger Action Response Plan

Term	Definition
CHPP	Coal Handling and Processing Plant
AP-42	Air Pollution Emission Factors Volume 1
HiVol	High Volume sampler – device used to measure dust concentration
TEOM	Tapered Element Oscillating Microbalance – device used to measure dust concentration
AS	Australian Standard
TWN	Abbreviation used in the Wandoan Joint Venture Project for a monitoring station in the Township of Wandoan
WSTN	Abbreviation used in the Wandoan Joint Venture Project for a monitoring station located on the proposed mine site
CALPUFF	An air quality dispersion model
CALMET	A diagnostic 3-dimensional meteorological model
BoM	Bureau of Meteorology

Executive Summary

An air quality impact assessment has been conducted for the proposed Taroborah Coal Project (the Project), located to the west of Emerald in Central Queensland.

The air quality impact assessment investigated the potential for impacts associated with mining operations for two scenarios (Year 2 and Year 5) representing various stages of the life of the open-cut mine. The open-cut mining operation has an anticipated 7 year life, currently projected to commence in 2018 at up to 2.3 Mtpa of ROM coal. The underground longwall mining operation has an anticipated 17 year life, currently projected to commence in 2022 at up to 5.7 Mtpa of ROM coal.

The assessment used meteorological and dispersion models to assess the effect of emissions (TSP, PM_{10}, $PM_{2.5}$ and dust deposition rate) from the Project in isolation and with the inclusion of ambient background levels of dust representative of the region.

The following conclusions may be drawn from the analysis of dispersion meteorology:

- *The site is dominated by light to moderate winds, with an average wind speed of 2.6 m/s and approximately 66 % of winds between 1 and 2 m/s*
- *The prevailing wind direction at the site is from the northeast through the east to the southeast directions.*

The following conclusions may be drawn from the air quality impact assessment:

Year 2 of operations

- *The predicted annual average ground-level concentrations of Total Suspended Particles (TSP) from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for TSP was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.*

- *The predicted 6^{th} highest 24-hour average ground-level concentration of PM_{10} from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including three receptors that lie outside the MDL boundary.*

- *The predicted maximum 24-hour average ground-level concentration of $PM_{2.5}$ from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including two receptors that lie outside the MDL boundary.*

- *The predicted annual average ground-level concentrations of $PM_{2.5}$ from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for $PM_{2.5}$ was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.*

- *The predicted annual average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.*

Year 5 of operations

- *The predicted annual average ground-level concentrations of TSP from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for TSP was predicted to be exceeded at two receptors, Iona Downs and Donnelly House, which are located within the MDL.*

- *The predicted 6th highest 24-hour average ground-level concentration of PM_{10} from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including three receptors that lie outside the MDL boundary.*

- *The predicted maximum 24-hour average ground-level concentration of $PM_{2.5}$ from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including two receptors that lie outside the MDL boundary.*

- *The predicted annual average ground-level concentrations of $PM_{2.5}$ from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for $PM_{2.5}$ was predicted to be exceeded at two receptors, Iona Downs and Donnelly House, which are located within the MDL.*

- *The predicted annual average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at two receptors, Iona Downs and Donnelly House, which are located within the MDL.*

An analysis of the exceedances of the Air EPP objective for PM_{10} shows that:

- *The overburden haul is the most significant contributor to PM_{10} concentrations on most days, in particular during Year 5.*
- *Other important activities include:*
  - *The active pit*
  - *The out of pit dumps in Year 2*
  - *ROM coal haul, train loadout, the CHPP and pit activities may also contribute to PM_{10} concentrations at St Helens – the receptor in closest proximity to these activities*

This analysis indicates that an Air Quality Management Plan (AQMP) with proactive and reactive components including the following actions could be used effectively to ensure exceedances do not occur in practice:

- *Watering and grading haul roads and use of road surface treatments*
- *Continuous monitoring of PM_{10}*
- *Amendment of site activities when monitoring results show that levels are becoming elevated*
- *Limiting, reducing or redirecting potentially significant emission sources at times of elevated risk*

The potential odour impacts associated with the ventilation shaft have been assessed in a screening-level assessment. The results indicate that there is unlikely to be an odour issue from the ventilation shaft. However, when siting ventilation shafts, the location relative to sensitive receptors should be considered.

1. Introduction

Katestone Environmental Pty Ltd (Katestone) has been commissioned by AustralAsian Resource Consultants (AARC), on behalf of Shenhuo International Group Pty Ltd, to conduct an air quality impact assessment of the proposed mining operations at the Taroborah Coal Project (the Project).

The Project consists of a combination of underground and open-cut mining activities. The Project is located west of Emerald in Central Queensland. The Mineral Development License (MDL) tenure encompasses an area of approximately 7,966 hectares. The Exploration Permit for Coal (EPC1011) tenure is approximately 10,667 hectares.

This report has been prepared to address the Terms of Reference (ToR) (Queensland Government) for the Project. The report describes the methods and findings of the assessment of the potential air quality impacts associated with the construction and mining operations of the Project. In particular, this assessment:

- Describes the current climate including meteorology and existing air quality
- Quantifies mining emissions of dust in the following size categories:
    - TSP - Total Suspended Particulates (TSP), particulate matter with an aerodynamic diameter less than 30-50 micrometres (µm)
    - PM_{10} - particulate matter with an aerodynamic diameter less than 10 µm
    - $PM_{2.5}$ - particulate matter with an aerodynamic diameter less than 2.5 µm
- Conducts dispersion modelling using a recognised atmospheric dispersion model
- Evaluates the incremental air quality impacts of mining operations at identified sensitive receptors and the surrounding environment
- Presents the results in relation to relevant air quality objectives as described in the *Environmental Protection (Air) Policy* (Air EPP) and relevant guidelines.
- Evaluates potential odour impacts from ventilation outlets
- Describes possible dust management measures to be implemented to mitigate against dust

2. Project description

The Project is located approximately 22 km west of Emerald in Central Queensland. The Project coal resource is part of the Bowen Basin. The study area and its location are shown in Figure 1.

The Project consists of a combination of underground and open-cut mining activities. The open-cut mining operation has an anticipated 7 year life, currently projected to commence in 2018 at up to 2.3 Mtpa of ROM coal. The underground longwall mining operation has an anticipated 17 year life, currently projected to commence in 2022 at up to 5.7 Mtpa of ROM coal. The open-cut mining activities are located in the southern part of the proposed mining area and the underground mining is located to the north.

The Project will comprise of one open pit, in-pit and out of pit overburden dumps, a ROM stockpile, a coal handling and preparation plant (CHPP), haul roads from the pit to stockpiles and a rail loop and train loading facility. The coal will be transported to the port of Gladstone via the Central West and Blackwater rail systems.

The open-cut mining operations will consist of conventional open-cut mining techniques, which will include topsoil stripping, drill and blast, truck / shovel operations, dozer push waste removal, coal extraction and progressive rehabilitation. The underground operations will be conducted using conventional longwall mining techniques.

3. Overview of assessment methodology

The air quality assessment is based on a dispersion modelling study that incorporates source characteristics and air pollution emission rates, site-specific meteorology, terrain, land use and the geographical location of sensitive receivers. The assessment implements recognised techniques for emissions estimation and dispersion modelling, using the most recent versions of meteorological and dispersion models available.

The existing environment in the region has been described in terms of:

- Regional terrain and land-use
- Location of sensitive receptors
- National Pollutant Inventory database (NPI) for sources in the region
- Monitoring data obtained from other coal mines located in the Bowen Basin

The air quality impact assessment has focussed on the pollutants identified as most critical in terms of impacts to air quality, namely TSP, PM_{10} and $PM_{2.5}$. Dust deposition rates have also been assessed. Emission estimates for pollutants associated with the Project have been sourced from the following information:

- Site layout plans, infrastructure and operating details provided by AARC and IMC Mining, including the Pre-Feasibility Mining Study for the Project – EPC1011 (IMC, 2009)
- Emission factors published in the National Pollutant Inventory Handbooks and USEPA AP-42 Emission Estimation Manuals (USEPA, 1998, 2006a, 2006b & 2006c)

This assessment has considered the potential change in air quality associated with two years of operation, namely:

- Year 2
- Year 5

Years 2 and 5 have been selected as they represent the scenarios that are likely to contribute most to dust levels at the closest sensitive receptors. The later years of operation include predominantly underground mining with only coal handling and preparation contributing to surface based dust generation. The layout of the proposed mine for Year 2 and Year 5 are shown in Figure 2 and Figure 3.

The dispersion modelling was conducted as follows:

- The prognostic model TAPM (developed by CSIRO, version 4.0.4, 2008) and the diagnostic meteorological model CALMET (developed by EarthTec, version 6.327, 2010) were used to generate the three-dimensional meteorological dataset for the region
- The three dimensional wind field dataset produced by TAPM/CALMET was then used to create a meteorological file suitable for use with the CALPUFF (developed by EarthTec, version 6.267, 2010) dispersion model. Source characteristics and emission rates were then used as input to the CALPUFF dispersion model. Ground-level concentrations of TSP, PM_{10} and $PM_{2.5}$ and dust deposition rates were predicted across a network of evenly-spaced gridded receptors and at sensitive receptor locations.

Details of the model configuration are provided in Appendix A.

The incremental air quality impacts due to mining operations of the Project have been assessed by a comparison of the predicted ground-level concentrations of dust and dust deposition rates at identified sensitive receptors with recognised air quality objectives and guidelines. The cumulative ground-level concentration (incremental plus background) at sensitive receptor locations have also been compared with relevant Air EPP objectives for TSP, PM_{10} and $PM_{2.5}$ as well as guidelines for dust deposition from the Department of Environment and Heritage Protection (EHP), formerly known as the Department of Environment and Resource Management (DERM), and the NSW Office of the Environment and Heritage (OEH).

Contour plots indicative of ground-level concentrations or dust deposition rates were used to illustrate the spatial distribution of dust levels. These were created from the predicted impacts due to the Project mining operations and background levels of dust at the network of gridded receptors within the modelling domain.

An odour assessment has been conducted to assess the potential for odour impacts from a ventilation shaft required for the underground mining.

4. Air quality criteria

The *Environmental Protection Act 1994* (EP Act) provides for the management of the air environment in Queensland. The legislation applies to government, industry and individuals and provides a mechanism for the delegation of responsibility to other government departments and local government and provides all government departments with a mechanism to incorporate environmental factors into decision-making.

The EP Act gives the Minister the power to create Environmental Protection Policies that identify, and aim to protect, environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. The *Environmental Protection (Air) Policy* was originally gazetted in 1997 (EPA, 1997). In 2008, following review, it was reissued as the *Environmental Protection (Air) Policy 2008* (Air EPP) (EPA, 2008). The administering authority must consider the requirements of the Air EPP when it decides an application for an environmental authority, amendment of a licence or approval of a draft environmental management plan. Schedule 1 of the Air EPP specifies air quality indicators and objectives for Queensland.

The predicted concentrations of pollutants associated with coal mining operations were compared with Air EPP objectives. Where pollutants are not covered by the Air EPP objectives, other air quality policies, such as the NSW OEH's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005), were used in the assessment. The ambient air quality objectives used in the assessment are presented in Table 1.

Dust nuisance can occur due to the deposition of larger dust particles in residential areas. Elevated dust deposition rates can cause reduced public amenity, e.g. via the soiling of clothes, building surfaces and other surfaces. Table 1 shows the dust deposition guideline commonly used in Queensland as a benchmark for avoiding amenity impacts due to dust. A dust deposition guideline is not defined in the Air EPP and is therefore not enforceable by legislation. The dust deposition guideline was recommended by the EHP as a design objective and has been adopted for this Project.

The impact assessment criteria from the NSW OEH *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005) defined for the annual deposition rate of dust for general land-use, including all areas other than specialised land-use, have also been adopted for this study.

Table 1 Queensland and New South Wales ambient air quality indicators, objectives and guidelines

Indicator	Averaging period	Objective	Source
Particulate matter (as $PM_{2.5}$)[a]	24-hour	25 µg/m^3	Air EPP
	Annual	8 µg/m^3	Air EPP
Particulate matter (as PM_{10})[b,c]	24-hour	50 µg/m^3	Air EPP
Particulate matter (as TSP)	Annual	90 µg/m^3	Air EPP
Dust deposition rate (total insoluble solids)	Monthly	120 mg/m^2/day	EHP recommended guideline
	Annual	130 mg/m^2/day	OEH[d]

Note: [a] $PM_{2.5}$ are particles that have aerodynamic diameters that are less than 2.5 µm
[b] PM_{10} are particles that have aerodynamic diameters that are less than 10 µm
[c] Five exceedences allowed per year
[d] NSW Office of Environmental and Heritage (OEH) Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW DEC, 2005)

4.1 Odour Guideline

EHP's odour guidelines are promulgated in a document titled: *Guideline: Odour Impact Assessment from Developments, July 2004* (EPA, 2004). The guideline defines generic criteria for assessing odour annoyance as follows:

- 0.5 odour units (ou) for a 1-hour average, 99.5th percentile concentration for tall stacks
- 2.5 ou for a 1-hour average, 99.5th percentile concentration for ground-level sources and downwashed plumes from short stacks

The odour sources assessed in the study comprise of releases from a ventilation shaft that is approximately 2 m high. Consequently, an odour performance criterion of 2.5 ou, 99.5th percentile for a 1-hour average is relevant.

5. Existing environment

5.1 Local terrain and land use

The Project is located approximately 22 km west of Emerald in Central Queensland. The Project extends north and south of the Capricorn Highway and Central West rail system.

The land use is predominantly low-intensity cattle grazing and cropping such as wheat and sorghum. There are a number of existing open-cut mines in the wider study region. The topography of the region is undulating to nearly flat.

5.2 Sensitive receptors

There are fourteen sensitive receptor locations that have been identified by AARC within the project area. Several receptors are located within the MDL for the Project and these are; St Helens, Donnelly, Iona Downs and Walther. The locations of the nearest sensitive receptors are provided in Table 2 and Figure 4.

Table 2 Nearest sensitive receptors

Receptor	Location		Distance and direction from centre of MDL	
	Easting (m)	Northing (m)	Distance (km)	Direction
St Helens	594385	7393080	Within MDL	
Iona Downs	596713	7396823	Within MDL	
Walther	599684	7397217	Within MDL	
Donnelly	596452	7396267	Within MDL	
Jabiru	597530	7403116	5	N
Airlie	596837	7387833	11	S
Glendarriwell	584405	7390097	15	SW
Dunloe	588975	7396455	8	W
Selma	605256	7398618	9	E
Kingower	606347	7407271	13	NE
Fork Lagoons	595304	7410467	12	N
Wilga Downs	599200	7390042	9	SE
Fairways	589708	7395100	8	W
Sypher	602748	7400276	6	E

5.3 Existing sources of air pollutants

The Project is located within the Bowen Basin region in central Queensland. The Bowen Basin is the largest coal deposit in Australia and as such there are a large number of existing coal mines and mining communities in the region. Aside from mining activities the land use is also agriculture and sparsely vegetated.

5.3.1 National Pollution Inventory emissions

The existing coal mines located within a 60 km distance of the Project that reported emissions to the NPI for the period 2011-2012 are presented in Table 3. The largest dust emissions are reported from Ensham Coal Mine, which is located approximately 60 km to the east of the Project.

Table 3 NPI reported emissions for the period 2011-2012

Facility	Distance from the Project (km)	Emissions (kg/annum)			
		NO_x	PM_{10}	$PM_{2.5}$	SO_2
Ensham Coal Mine	60	1,579,095	10,601,343	96,792	1,046
Gregory Crinum Mine	60	1,309,322	889,221	69,442	856
Kestral Operations	52	78,409	732,344	5,614	60
Minerva Mine	48	542,752	581,388	70,375	789

5.3.2 Proposed mineral and energy projects

There are a number of proposed mineral and energy projects currently progressing through the approvals process within this region. The development projects located within approximately 60 km of the Project are summarised in Table 4 (BREE, 2013).

Table 4 Coal development projects (BREE, 2013)

Project	Company	Status	Proposed start-up	New capacity
Kestral underground	Rio Tinto Ltd	Expansion, under construction	2013	5.7 Mtpa Hard coking
Togara North underground	Xstrata Coal Ltd	New project, pre-feasibility study underway	2015	6 Mtpa thermal
Springsure Creek underground	Bandanna Energy ltd	New project, EIS underway, feasibility study completed	2015	11 Mtpa thermal (ROM)
Oaky Creek (phase 2)	Xstrata Coal Ltd	Re-development, pre-feasibility study underway	2015	5 Mtpa coking
Teresa (coal project)	Linc Energy ltd	New project, EIS in progress	2016	8 Mtpa PCI

5.4 On-site monitoring data

An on-site monitoring program has been conducted at six homesteads within the study area. The St Helens, Iona Downs and Walther homesteads lie within the MDL. The Jabiru, Airlie and Dunloe homesteads are outside of the MDL, but are within the study area and are generally indicative of dust levels in the region. Dust deposition gauges were used to measure dust deposition rates for a period of 5 months. A summary of the data obtained is detailed in Table 5.

Table 5 Summary of on-site dust deposition data (mg/m²/day)

Monitoring Site	September 2012	October 2012	November 2012	December 2012	January 2013	Maximum	Average
St Helens	26.2	23.0	45.9	39.3	39.3	45.9	34.8
Jabiru	39.3	32.8	39.3	29.5	39.3	39.3	36.1
Iona Downs	39.3	19.7	32.8	36.1	137.7 [1]	39.3	32.0
Airlie	26.2	52.5	26.2	39.3	59.0	59.0	40.7
Walther	26.2	23.0	26.2	180.3 [1]	39.3	39.3	28.7
Dunloe	6.6	19.7	26.2	32.8	36.1	36.1	24.3
Table note: [1] Value considered an outlier and has been removed from the maximum and average statistics presented							

The highest average dust deposition rate measured at any site is 40.7 mg/m^2/day at the Airlie homestead. This dust deposition rate has been chosen to conservatively represent the background level across the entire study area for this assessment. The following analysis of dust deposition data from other studies in Queensland supports this choice.

5.5 Air quality monitoring in the Bowen Basin

There are currently no EHP monitoring stations operating in the locality of the Project. The existing air quality for the pollutants TSP, PM_{10} and $PM_{2.5}$ have been estimated by considering the monitoring data reported in air quality studies for the following projects:

- Stage 2 Middlemount Coal Project
- Foxleigh Plains Project
- Wandoan Joint Venture Project
- Ensham Central Project

Dust deposition rates reported in the above studies have also been reproduced here to provide context for the 5 month monitoring program conducted for the Project.

5.5.1 Middlemount and Foxleigh mines

A dust monitoring network was implemented by Middlemount Coal Pty Ltd (MCPL) for the period 18 March to 16 June 2010 (Table 6).

Table 6 Project area ambient air quality monitoring network operated by MCPL (Katestone Environmental, 2011)

Monitoring site	Northing, Easting (metres)	PM_{10}	Dust Deposition	Wind Speed	Wind Direction	Temperature
Middlemount township	674310, 7475774	Yes	Yes	Yes	Yes	Yes
Kockane Homestead	658029, 7479965	No	Yes	No	No	No
Foxleigh Residence	676340, 7475280	No	Yes	No	No	No

The proponent of Foxleigh Plains Project has also conducted ambient PM_{10} monitoring using a high volume sampler (HiVol) at Tralee on a 1 day in 7 sampling routine for the period April

to August 2010 and the operators of German Creek have provided dust deposition data for the period 1995 to 2009.

The data for PM_{10} are shown in Table 7 and dust deposition in Table 8.

Table 7 Summary of MCPL and Foxleigh ambient PM_{10} data (24-hour average) (Katestone Environmental, 2012)

Location	Units	Average	70th percentile	95th percentile
MAC Middlemount Village	µg/m³	18	20	33
Tralee		17	20	37

Table 8 MCPL ambient dust deposition data (Katestone Environmental, 2011)

Date	Annual average dust deposition rate (mg/m²/day)			
	MAC Village	Kockane Homestead	Foxleigh Residence	EHP guideline
18/03/10 to 18/04/10	72	95	23	120
19/04/10 to 18/05/10	13	98	43	120
19/05/10 to 16/06/10	151	151	33	120

5.5.2 Wandoan Coal Mine

5.5.2.1 Ambient dust levels and monitoring

The Wandoan Joint Venture Project has monitored PM_{10} and $PM_{2.5}$ using a Tapered Element Oscillating Microbalance (TEOM) in the Township of Wandoan (TWN located at Short Street) and on the mine site (WSTN located near the Wandoan Project's weather station) since 2008. Dust deposition rates were also measured at both of these locations. Fifteen months of monitoring results, from March 2008 until July 2009 are presented below (Katestone Environmental, 2009).

24-hour average PM_{10}

The ambient monitoring conducted in the township of Wandoan and on the project site indicates that 24-hour average concentrations of PM_{10} vary between 2 and 110 µg/m³ depending on synoptic circulation patterns and surface interactions. The natural variability of background concentrations (Table 9) exceeded the Air EPP objective of 50 µg/m³ for a 24-hour averaging period on six occasions. These exceedences can be attributed to regional scale dust storms initiated by the passage of fast moving cold fronts (Bureau of Meteorology 2008-2009).

Table 9 Measured exceedances of the 24-hour average PM_{10} air quality objective of 50 µg/m³ at the WSTN and Wandoan monitoring sites during March 2008 to June 2009 (Katestone Environmental, 2009)

Date	24-hour average PM_{10} concentration	
	WSTN	TWN
3 April 08	57.9	60.5
28 April 08	99.7	108.4
16 September 08	101.8	98.2
17 September 08	62.7	63.2
23 November 08	66.0	58.2
5 March 09	84.7	74.6

The mean, maximum, minimum and standard deviation of the 24-hour average concentrations are presented for the WSTN and the TWN monitoring sites in Table 10. The large range in PM_{10} measurements (2 – 108 µg/m³) and relatively low mean (TWN: 14 µg/m³ and WSTN = 12 µg/m³) compared to the range, suggests that the distribution of concentrations are centred on the lower end of the spectrum, punctuated by a few individual high concentration events.

Table 10 Measured PM_{10} (µg/m³) for the TWN and WSTN monitoring station (March 2008 to July 2009) (Katestone Environmental, 2009)

Variable	TWN_PM_{10}	$WSTN\_PM_{10}$
Mean	13.8	12.1
Standard Error	0.5	0.5
Median	11.7	9.8
Mode	13.5	6.9
Standard Deviation	10.3	11.0
Sample Variance	105.8	121.8
Kurtosis	28.9	30.5
Skewness	4.5	4.8
Range	107.0	100.8
Minimum	1.4	0.9
Maximum	108.4	101.8
Count	520.0	478.0
95th percentile	27.1	24.6
70th percentile	14.2	14.0

24-hour average $PM_{2.5}$

Monitoring data for ambient $PM_{2.5}$ concentrations was available for March 19 2009 to July 31 2009 at the WSTN monitoring site. The ratios of the 24-hour average $PM_{2.5}$ and PM_{10} concentrations measured at the WSTN monitoring site (Table 11) ranged from 0.09 to 1.0, with an average ratio of 0.56.

Table 11 Comparison of measured PM_{10} and $PM_{2.5}$ (µg/m³) for WSTN monitoring station (March 19 2009 to July 31 2009) (Katestone Environmental, 2009)

Variable	$WSTN\_PM_{10}$	$WSTN\_PM_{2.5}$	RATIO
Mean	10.56	5.03	0.56
Standard Error	0.73	0.10	0.01
Median	8.88	4.80	0.56
Standard Deviation	9.05	1.31	0.16
Sample Variance	81.94	1.73	0.02
Kurtosis	60.38	30.22	0.16
Skewness	6.92	4.19	-0.10
Range	94.34	12.94	0.91
Minimum	3.60	3.00	0.09
Maximum	97.94	15.94	1.00
Count	154.00	162.00	154.00
95th percentile	17.83	6.77	0.38
70th percentile	11.21	5.08	0.45

5.5.2.2 TSP and dust deposition rate

The Wandoan Joint Venture Project used dust deposition gauges co-located with the TEOMs to provide baseline data from which to estimate background dust deposition levels. The following observations were made in relation to the deposition rates (Katestone Environmental, 2009). The results of total insoluble solids (mg/m^2/day) for 13 months of monitoring are presented in Table 12. The amounts of deposited dust recorded for the month of July 2008 appear quite low; while May 2008 at the WSTN site, and December 2008, January 2009 and March 2009 at both sites are quite high. The elevated dust deposition levels, when recorded at both sites, are likely to be due to regional scale dust storms. No statistical analysis is available on the frequency of dust storms in the region; however, it is recognised that dust storms are commonly associated with the passage of cold frontal systems. The cold front can generate strong surface winds at the leading edge of the front encouraging the entrainment of dust. The leading edge of the front is also a zone of convergence where vertical uplift of wind and particulates can be quite strong, thus giving rise to localised dust storms (McInnes *et. al.* 1994).

Table 12 Dust deposition rates for WSTN and TWN monitoring sites between May 2008 and May 2009 (Katestone Environmental, 2009)

Year	Month	Dust deposition rate (mg/m²/day)	
		TWN	WSTN
2008	May	6.7	46.7
	June	16.7	30.0
	July	6.7	3.3
	August	33.3	20.0
	September	20.0	20.0
	October	20.0	20.0
	November	36.7	26.7
	December	50.0	50.0
2009	January	46.7	93.3
	February	23.3	13.3
	March	123.3	63.3
	April	3.3	93.3
	May	30.0	16.7

The statistical breakdown of the monitoring data is shown in Table 13. A maximum monthly average deposition rate of 123 mg/m^2/day was recorded at the TWN site in March 2009. The average dust deposition rate was 32 mg/m^2/day and 38 mg/m^2/day for the TWN and WSTN sites, respectively.

Table 13 Dust deposition statistics for WSTN and the TWN monitoring sites. Units are in mg/m²/day (Katestone Environmental, 2009)

Monitoring Site	Monthly Minimum	Monthly Maximum	Monthly Average	Monthly Standard Deviation	Combined Monthly Average
TWN	3	123	32	31	35
WSTN	3	93	38	29	

5.5.3 Ensham Coal Mine

Dust deposition rates at 19 locations around the Ensham Coal Mine were monitored from January 1998 to December 2003 as part of Ensham Coal Mine's dust monitoring program. PM_{10} and TSP levels were not measured as part of this program.

A short-term monitoring study was conducted from January to March 2005 to provide measurements of PM_{10} to assist in quantifying background dust levels for the Ensham Central Project (Katestone Environmental, 2006). Monitoring was undertaken at two residences, one upwind and one downwind of the mine. Dust deposition rates were measured over the same period and at the same locations as the PM_{10} monitoring. An additional dust deposition monitoring station was installed at a property (the location of Residences 32A, B and C) in response to concerns raised by the property owner.

5.5.3.1 Ensham Coal Mine dust deposition monitoring January 1998 to December 2003

An analysis of historical dust deposition rates measured by Ensham Coal Mine has been undertaken to estimate background dust deposition rates in the absence of coal mining activities. This monitoring data also shows the variability of dust deposition rates and provides a greater context for the very short-term dust deposition monitoring undertaken in early 2005 for the Ensham Central Project. The results of this analysis are presented in Table 14.

The results of dust deposition monitoring that has been undertaken at DG4 provides a good basis to estimate the background dust deposition rate in the absence of the Ensham Coal Mine given that this monitor is well separated from the mining activities and is not likely to be influenced by dust from mining activities under predominant wind conditions.

Table 14 Ensham Coal Mine - Summary of monitoring data for monitoring stations: DG4, DG9, DG10, DG11, DG18 and DG19, 1998-2003 (mg/m²/day) (Katestone Environmental, 2009a)

Ensham dust gauge	Maximum monthly (mg/m²/day)	Maximum rolling annual average (mg/m²/day)	Calendar year annual averages (mg/m²/day)					
			1998	1999	2000	2001	2002	2003
DG4	107.4	54.3	25.6	38.7	21.2	39.6	34.9	51.0
DG9	278.1	96.7	77.4	85.5	71.7	-	-	-
DG10	207.3	96.6	68.5	75.8	61.3	68.4	72.5	96.6
DG11	304.2	106.5	42.0	65.8	55.7	99.4	39.4	59.9
DG18	269.4	90.0	71.8	69.1	50.2	-	-	-
DG19	299.3	76.2	35.3	32.1	17.9	30.4	53.8	53.9
Guideline	-	120						

5.5.3.2 PM_{10} and dust deposition monitoring, January – March 2005

<u>**Monitoring locations and methodology**</u>

A short-term monitoring study was conducted primarily to determine PM_{10} concentrations at residential locations in the vicinity of the Ensham Coal Mine. The monitors were located to the south and southwest of the mine, approximately 6 km away from operations. The results of monitoring for PM_{10} are presented in Table 15. The monitoring results are low compared to the Air EPP objective for 24-hour average PM_{10} concentration. Elevated dust levels were

measured on 3 February 2005 due to a statewide dust storm. Dust levels of a similar magnitude were measured in other areas of Queensland at this time.

Table 15 Ensham Coal Mine - 24-hour average concentrations of PM_{10} at Residence 113 and Residence 68 for January, February and March 2005 (Katestone Environmental, 2009a)

Date	Predominant wind direction	Wind speed (m/s)	PM_{10} (µg/m³)	
			Residence 113	Residence 68
22/01/2005	NNE, NE, ENE	3.4	8.6	12.7
28/01/2005	SSW	2.3	8.0	13.2
3/02/2005	SSW	3.6	100.1	101.4
9/02/2005	W, WNW, WSW, NNE, NE	2.4	26.9	19.1
15/02/2005	NE, ENE, E, ESE, SE	3.7	11.7	13.5
21/02/2005	NNE, NE, ENE	3.2	18.0	24.0
27/02/2005	NNE, NE, ENE	2.8	12.0	22.5
5/03/2005	NNE, NE, ENE	2.3	16.7	26.9
11/03/2005	NE, ENE, E	3.9	14.6	18.7
16/03/2005	NNE, NE, ENE, E, ESE	2.9	16.1	22.4
Average	NNE, NE, ENE, E	3.0	14.7[1]	19.2[1]
Air EPP	-	-	50	
Note [1]Average excludes the dust storm event				

The Ensham Central Project dust impact assessment study determined that the levels measured at Residence 113 represented conditions in the absence of the mine. Measurements made on 3 February 2005 were discounted due to a dust storm event. The average of the available measurements at Residence 113 was used to approximate an annual average, rounded to 14 µg/m³. The annual average was used to estimate the background level of TSP as described in Section 5.5.3.3.

The results of dust deposition monitoring are presented in Table 16.

Table 16 Ensham Coal Mine - Monthly average dust deposition rates for Residence 113, Residence 68 and Residence 32A, B and C for 16 January 2005 to 16 February 2005 and 16 February to 17 March 2005 (mg/m²/day) (Katestone Environmental, 2009a)

Sample	Monitoring period	Dust deposition rate (mg/m²/day)		
		Residence 113	Residence 68	Residence 32 A, B and C
1	16 Jan - 16 Feb 2005	52.8	128.7	NS
2	16 Feb - 17 Mar 2005	62.7	280.5	92.4
NS = No sample.				

5.5.3.3 Total suspended particulates (TSP)

There are no known measurements of TSP in the vicinity of the Ensham Coal Mine. For the Ensham Central Project, the level of TSP was inferred from the PM_{10} monitoring results. The ratio of PM_{10} to TSP that is commonly found in rural areas is 0.5. From this, a background annual average TSP concentration of 28 µg/m³ was inferred.

6. Emissions

The major sources of dust emissions from conventional open-cut mining are the truck and shovels used to remove and transport coal and overburden. The remaining sources of dust from the Project are wind-blown dust from exposed ground and stockpiles and bulldozing activities.

Dust emissions from the mine have been estimated accounting for actual mine activities including:

- Areas disturbed by mining
- Overburden emplacement areas
- ROM coal handling and processing
- Haul roads
- Topsoil and overburden removal, handling, transport and dumping
- Drilling
- Blasting
- ROM coal stockpiles
- Conveyors
- Rail loading

Dust emission rates from the mine have been calculated using emission factors published by the US EPA in their Compilation of Air Pollution Emission Factors Volume 1 (AP-42) and in the National Pollutant Inventory Handbooks. Dust emission rates have been calculated based on detailed activity data determined from the mine plans and other available data.

For the majority of dust producing activities, the dust emission rate is dependent on the wind speed, with little or no dust emissions occurring for some activities (e.g. stockpiling) below a threshold wind speed. For some dust sources (such as coal conveyors), the wind speed, frequency of utilisation and coal throughput are important determinants of the dust emission rate.

Other factors are also important such as coal type, coal moisture content, coal particle size distribution, rainfall and the mitigation measures that may be employed. The key factors that contribute to dust emissions have been accounted for in estimating dust emissions from the Project.

Details of the amount of overburden and coal extracted for the mine pit and the locations where coal and overburden are dumped and where all the equipment will be operating have been provided by AARC. Dust emission rates have been calculated using the detailed information on mining activities for two scenario years and standard coal mining emission factors.

A number of dust controls are proposed to be used throughout the duration of the Project. The level of control selected has been taken from the NPI for Mining (2001). The dust controls included in the calculations for emissions from each of the sources are defined in Table 17.

Table 17 Emission control factors for dust control measures

Source	Control measure	Level of control
Haul roads	Watering	50%
Processing plant	Partially enclosed	40%
Conveyor	Partially enclosed	40%
Wind erosion of stockpiles	Revegetated	99%

A summary of the total dust emission rates from the Project is shown in Table 18. Detailed emission calculations and a detailed breakdown of emissions for each activity are provided in Appendix B.

Table 18 Estimated total dust emission rates for the Project

Activity	Total dust emission rate (g/s)					
	Year 2			Year 5		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
In-Pit Activities including drilling, blasting and truck loading	3.0	1.6	0.3	4.7	2.5	0.4
Haul Roads	77.3	23.9	2.4	79.2	27.9	2.9
Conveyors	0.4	0.1	0.01	1.6	0.4	0.05
CHPP	6.6	1.2	0.1	10.3	1.8	0.2
Wind Erosion of stockpiles	10.3	5.1	0.8	3.4	1.7	0.3
Train loading	1.8	0.3	0.03	2.9	0.5	0.1
Rail line	0.005	0.002	0.000	0.01	0.004	0.001
Total	***99.3***	***32.2***	***3.7***	***102.1***	***34.8***	***3.9***

7. Dispersion modelling methodology

7.1 Development of site-specific meteorology

The site-specific meteorological data for this study was generated by coupling TAPM, a prognostic mesoscale model to CALMET, a diagnostic dispersion model. The coupled TAPM/CALMET modelling system was developed by Katestone to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models, such as CALPUFF.

The period January to December 2009 was modelled. The year 2009 was selected as a representative meteorological dataset that encompasses the full range of meteorological conditions likely to be experienced in the region during a typical year. Emissions representative of Year 2 and Year 5 of mine operations have been modelled in conjunction with the representative meteorological data from 2009.

7.2 Dust dispersion modelling

The dispersion model CALPUFF (Version 6.267) was used to simulate the dispersion characteristics and concentrations of particulate matter generated by the proposed activities at the mine. The CALPUFF dispersion model utilises the three-dimensional wind fields from CALMET to simulate the dispersion of air pollutants to predict ground-level concentrations across a gridded domain.

Dust dispersion modelling was carried out for one representative year of operations. Twelve months of modelled meteorological data was used as input for the dispersion model. This encompasses all weather conditions likely to be experienced in the region during a typical year.

Details of the model configuration are provided in Appendix A.

7.3 Background air quality

In order to undertake a cumulative air quality impact assessment, a suitable background level of each of the dust metrics needs to be established that is representative of the potential levels of dust in the region. This can then be added to the projected concentrations of particulate matter due to the Project to allow a conservative assessment of the expected cumulative levels of particulate matter in the local region.

The background concentrations of TSP, PM_{10} and $PM_{2.5}$ for this assessment have been derived from the monitoring data available for the region as summarised in Section 5.5. The background dust deposition rate has been taken from on-site monitoring data and represents the highest average deposition rate measured at any of the monitoring points, as detailed in Section 5.4.

The background concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition used in this assessment are shown in Table 19.

Table 19 Summary of background concentrations (µg/m³)

Air pollutant	Averaging period	Concentration
TSP	Annual	28[2]
PM_{10}	24-hour	21[1]
$PM_{2.5}$	24-hour	5.4[2]
	Annual	2.8[2]
Dust deposition	Annual	40.7[3]

Table note:
[1] taken from Middlemount Coal Mine (Katestone Environmental, 2011) (70th percentile concentration was 20 µg/m³) and Ensham Coal mine (Katestone Environmental, 2009) (95th percentile concentration was 23.3 µg/m³)
[2] taken from Ensham Coal mine monitoring (Katestone Environmental, 2009)
[3] taken from on-site monitoring data

7.4 Presentation of results

The study presents the results of dispersion modelling of dust emissions from the Project added to a background concentration for each pollutant for Year 2 and Year 5 of the Project.

The predicted annual average TSP, $PM_{2.5}$ and dust deposition rate and the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations are added to their relevant background concentration (detailed in Section 7.3) and compared to their relevant air quality objectives and guidelines (detailed in Section 4). The PM_{10} air quality objective allows five exceedances of the 24-hour objective in a year. Therefore, the 6th highest predicted 24-hour average PM_{10} concentration has been added to the PM_{10} background for comparison with the objective.

Predicted ground-level concentrations of PM_{10}, $PM_{2.5}$, TSP and dust deposition rate are presented at each of the nearest sensitive receptors and as contours on a Cartesian grid, see Figure 9 to Figure 20.

8. Analysis of dispersion meteorology

This section presents an analysis of the site-specific meteorological data generated by the coupled TAPM/CALMET modelling system that was used in the dispersion modelling assessment. The meteorological data cover the twelve-month period from 1 January to 31 December 2009 (see Section 7.1).

8.1 Wind speed and wind direction

Wind flows in the area are important for understanding the capacity of the air to disperse air pollutants. For the generation of dust emissions, worst-case meteorological conditions are generally moderate to strong winds. Activities that have emission rates dependent on wind speed will have higher emission rates during strong winds and during these strong winds, dust particles are more likely to be lifted up by the wind and carried further off-site than during light winds. Light winds, however, will result in the worst-case dispersion conditions if dust is generated independent of wind speed, for example wheel generated dust. Under these conditions the light winds will inhibit the dispersion of dust resulting in elevated concentrations.

The annual, diurnal and seasonal distributions of winds at the Project site are presented as wind roses in Figure 5, Figure 6 and Figure 7, respectively. The predominant winds are from the north-northeast through the east to the southeast, as shown in the annual wind rose in Figure 5.

The diurnal wind roses (Figure 6) show a predominance of strong winds from the northeast to east in the afternoon, between midday and 6 pm, with wind speeds decreasing after 6 pm. Winds during the early morning period (midnight to 6 am) are generally light.

The seasonal wind roses (Figure 7) show that winds from the northeast to east quadrant are most frequent during spring and summer. In winter there is no predominant direction in the distribution of winds; however, in autumn winds from the southwest are predicted to be the most frequent.

8.2 Atmospheric stability

Stability classification is a measure of the stability of the atmosphere and can be determined from wind measurements and other atmospheric observations. The Pasquill-Gifford stability classes range from A Class, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to F Class stability which represents very stable atmospheric conditions that typically occur during light wind conditions at night. Unstable conditions (Classes A to C) are characterised by strong solar heating of the ground that induces turbulent mixing in the atmosphere close to the ground. This turbulent mixing is the main driver of dispersion during unstable conditions. Dispersion processes for Class D conditions are dominated by mechanical turbulence generated as the wind passes over irregularities in the local surface. During the night, the atmospheric conditions are generally stable (often Classes E and F).

Table 20 shows the percentage of stability classes at the Project site for the January to December 2009 meteorological data used in the dispersion modelling, where Class A represents the most unstable conditions.

Table 20 Frequency of occurrence (%) of surface atmospheric stability at the Project site under Pasquil-Gifford stability classification scheme

Pasquil-Gifford stability class	Classification	Frequency (%)
A	Extremely unstable	1.5
B	Unstable	11.6
C	Slightly unstable	14.5
D	Neutral	29.6
E	Slightly stable	10.4
F	Stable	32.4

8.3 Mixing height

The mixing height refers to the height above ground within which particulates or other pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer. During the day, solar radiation heats the air at the ground level and causes the mixing height to rise. The air above the mixing height during the day is generally cooler. The growth of the mixing height is dependent on how well the air can mix with the cooler upper level air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed. During strong wind speed conditions the air will be well mixed, resulting in a high mixing height.

Mixing height information has been extracted from the CALMET simulation at the Project site and is presented in Figure 8. The data shows that the mixing height develops around 7am, increases to a peak around 2 pm before descending rapidly.

9. Impact assessment

This section presents the results of the air quality impact assessment for predicted ground-level concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition for operational Years 2 and 5 of the Project.

Contour plots indicative of ground-level concentrations or dust deposition rates are presented in the following sections. These are created from the predicted dust levels at the network of gridded receptors within the modelling domain and an ambient background concentration, which are converted to contours using a standard interpolation technique. Contour plots are presented to illustrate the spatial distribution of dust levels. However, the process of interpolation causes smoothing of the base data that can lead to minor differences between the contours and discrete model predictions.

Dust levels at specific points of interests, such as identified residences, were represented as discrete receptors in the model. Predicted cumulative ground-level concentrations of dust (TSP, PM_{10}, and $PM_{2.5}$) and dust deposition rates due to the Project mining operations at the 14 sensitive receptors identified in Section 5.2 are summarised in the following sections.

9.1 Year 2

Predicted ground-level concentrations of PM_{10}, $PM_{2.5}$, TSP and dust deposition rates at the location of each sensitive receptor are presented in Table 21. Predicted ground-level concentrations, including background levels, are presented in Table 22.

Figure 9 to Figure 14 show domain wide contour plots of predicted ground-level concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rate respectively, including background levels.

Table 21 Predicted ground-level concentrations and deposition rates at sensitive receptor locations during Year 2 in isolation

Receptor	Concentration (µg/m³)					Deposition rate (mg/m²/day)	
	TSP	PM_{10}		$PM_{2.5}$			
	Annual average	Maximum 24 hour average	6th Highest 24 hour average	Maximum 24 hour average	Annual average	Maximum monthly average	Annual average
St Helens	52.2	228.4	**164.7**	**30.7**	4.3	92.7	61.1
Jabiru	1.6	24.6	18.4	4.1	0.2	2.5	1.1
Iona Downs	41.3	294.3	**179.4**	**37.7**	3.1	111.3	50.5
Walther	6.2	112.2	**72.8**	15.9	0.7	17.1	5.4
Airlie	3.9	67.1	41.4	11.4	0.6	6.6	2.5
Glendarriwell	2.6	25.5	16.4	6.3	0.5	4.1	1.6
Dunloe	12.4	114.0	**92.2**	21.9	2.0	17.6	8.0
Selma	0.7	48.3	9.8	8.9	0.1	1.8	0.4
Kingower	0.5	14.8	7.8	2.3	0.1	0.8	0.3
Fork Lagoons	0.5	18.5	9.3	3.7	0.1	0.5	0.3
Donnelly	85.9	330.6	**270.4**	**49.1**	5.3	**258.5**	**122.5**
Wilga Downs	1.3	32.2	15.8	5.9	0.1	6.0	1.6
Fairways	17.1	138.5	**79.0**	24.8	2.3	21.8	12.8
Sypher	1.1	28.5	21.5	4.5	0.2	2.1	0.8
Air EPP objective	***90***	***-***	***50***	***25***	***8***	***120[1]***	***130[2]***

[1] NSW OEH – amenity dust guideline
[2] EHP recommended guideline

Table 22 Predicted ground-level concentrations and deposition rates at sensitive receptor locations during Year 2 including background

Receptor	Concentration (µg/m³)					Deposition rate (mg/m²/day)	
	TSP	PM_{10}		$PM_{2.5}$			
	Annual average	Maximum 24 hour average	6th Highest 24 hour average	Maximum 24 hour average	Annual average	Maximum monthly average	Annual average
St Helens	80.2	249.4	**185.7**	**36.1**	7.1	**133.4**	101.8
Jabiru	29.6	45.6	39.4	9.5	3.0	43.2	41.8
Iona Downs	69.3	315.3	**200.4**	**43.1**	5.9	**152.0**	91.2
Walther	34.2	133.2	**93.8**	21.3	3.5	57.8	46.1
Airlie	31.9	88.1	**62.4**	16.8	3.4	47.3	43.2
Glendarriwell	30.6	46.5	37.4	11.7	3.3	44.8	42.3
Dunloe	40.4	135.0	**113.2**	**27.3**	4.8	58.3	48.7
Selma	28.7	69.3	30.8	14.3	2.9	42.5	41.1
Kingower	28.5	35.8	28.8	7.7	2.9	41.5	41.0
Fork Lagoons	28.5	39.5	30.3	9.1	2.9	41.2	41.0
Donnelly	**113.9**	351.6	**291.4**	**54.5**	**8.1**	**299.2**	**163.2**
Wilga Downs	29.3	53.2	36.8	11.3	2.9	46.7	42.3
Fairways	45.1	159.5	**100.0**	**30.2**	5.1	62.5	53.5
Sypher	29.1	49.5	42.5	9.9	3.0	42.8	41.5
Background	**28.0**	**21.0**	**21.0**	**5.4**	**2.8**	**40.7**	**40.7**
Air EPP objective	***90***	***-***	***50***	***25***	***8***	***120[1]***	***130[2]***

[1] NSW OEH – amenity dust guideline
[2] EHP recommended guideline

The results show that:

- The predicted annual average ground-level concentrations of TSP from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for TSP was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.

- The predicted 6th highest 24-hour average ground-level concentration of PM_{10} from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including three receptors that lie outside the MDL boundary.

- The predicted maximum 24-hour average ground-level concentration of $PM_{2.5}$ from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including two receptors that lie outside the MDL boundary.

- The predicted annual average ground-level concentrations of $PM_{2.5}$ from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for $PM_{2.5}$ was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.

- The predicted annual average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.

- The predicted maximum monthly average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at three receptors located within the MDL.

9.2 Year 5

Predicted ground-level concentrations of PM_{10}, $PM_{2.5}$, TSP and dust deposition rates at the location of each sensitive receptor are presented in Table 23. Predicted ground-level concentrations, including background levels, are presented in Table 24.

Figure 15 to Figure 20 show domain wide contour plots of predicted ground-level concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition rate respectively, including a background.

Table 23 Predicted ground-level concentrations and deposition rates at sensitive receptor locations during Year 5 in isolation

Receptor	Concentration (µg/m³)					Deposition rate (mg/m²/day)	
	TSP	PM10		PM2.5			
	Annual average	Maximum 24 hour average	6th Highest 24 hour average	Maximum 24 hour average	Annual average	Maximum monthly average	Annual average
St Helens	39.0	224.2	**167.9**	**31.5**	3.8	60.9	37.9
Jabiru	1.8	41.9	20.3	6.9	0.3	2.3	1.1
Iona Downs	71.1	689.0	**377.0**	**86.9**	5.4	**199.6**	82.6
Walther	7.5	138.9	**94.0**	19.5	0.9	18.7	5.8
Airlie	3.7	56.7	42.3	12.1	0.6	4.8	2.0
Glendarriwell	2.5	27.2	16.9	6.7	0.5	3.9	1.5
Dunloe	11.8	111.6	**78.1**	21.6	1.9	15.6	7.6
Selma	0.8	52.2	11.1	9.9	0.1	1.8	0.5
Kingower	0.6	18.9	8.6	2.9	0.1	0.8	0.3
Fork Lagoons	0.6	16.7	7.5	3.4	0.1	0.6	0.3
Donnelly	**249.0**	909.9	**750.5**	**117.1**	**14.4**	**776.0**	**359.1**
Wilga Downs	1.7	45.7	17.9	6.9	0.2	6.7	1.6
Fairways	16.2	149.9	**87.8**	**27.1**	2.3	22.2	11.8
Sypher	1.3	33.8	24.9	5.3	0.2	2.3	0.8
Air EPP objective	***90***	***-***	***50***	***25***	***8***	***120[1]***	***130[2]***

[1] NSW OEH – amenity dust guideline
[2] EHP recommended guideline

Table 24 Predicted ground-level concentrations and deposition rates at sensitive receptor locations during Year 5 including background

Receptor	Concentration (µg/m³)					Deposition rate (mg/m²/day)	
	TSP	PM10		PM2.5			
	Annual average	Maximum 24 hour average	6th Highest 24 hour average	Maximum 24 hour average	Annual average	Maximum monthly average	Annual average
St Helens	67.0	245.2	**188.9**	**36.9**	6.6	101.6	78.6
Jabiru	29.8	62.9	41.3	12.3	3.1	43.0	41.8
Iona Downs	**99.1**	710.0	**398.0**	**92.3**	**8.2**	**240.3**	123.3
Walther	35.5	159.9	**115.0**	24.9	3.7	59.4	46.5
Airlie	31.7	77.7	**63.3**	17.5	3.4	45.5	42.7
Glendarriwell	30.5	48.2	37.9	12.1	3.3	44.6	42.2
Dunloe	39.8	132.6	**99.1**	**27.0**	4.7	56.3	48.3
Selma	28.8	73.2	32.1	15.3	2.9	42.5	41.2
Kingower	28.6	39.9	29.6	8.3	2.9	41.5	41.0
Fork Lagoons	28.6	37.7	28.5	8.8	2.9	41.3	41.0
Donnelly	**277.0**	930.9	**771.5**	**122.5**	**17.2**	**816.7**	**399.8**
Wilga Downs	29.7	66.7	38.9	12.3	3.0	47.4	42.3
Fairways	44.2	170.9	**108.8**	**32.5**	5.1	62.9	52.5
Sypher	29.3	54.8	45.9	10.7	3.0	43.0	41.5
Background	**28.0**	**21.0**	**21.0**	**5.4**	**2.8**	**40.7**	**40.7**
Air EPP objective	***90***		***50***	***25***	***8***	***120[1]***	***130[2]***

[1] NSW OEH – amenity dust guideline
[2] EHP recommended guideline

The results show that:

- The predicted annual average ground-level concentrations of TSP from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for TSP was predicted to be exceeded at two receptors; Iona Downs and Donnelly House, which are located within the MDL.

- The predicted 6th highest 24-hour average ground-level concentration of PM_{10} from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including three receptors that lie outside the MDL boundary.

- The predicted maximum 24-hour average ground-level concentration of $PM_{2.5}$ from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including two receptors that lie outside the MDL boundary.

- The predicted annual average ground-level concentrations of $PM_{2.5}$ from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for $PM_{2.5}$ was predicted to be exceeded at two receptors; Iona Downs and Donnelly House, which are located within the MDL.

- The predicted annual average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at two receptors, Iona Downs and Donnelly House, which are located within the MDL.

- The predicted maximum monthly average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at two receptors, Iona Downs and Donnelly House, which are located within the MDL.

10. Source contributions

The predicted number of exceedances of the PM_{10} and $PM_{2.5}$ objectives at each of the receptor locations is shown in Table 25. The receptor of St Helens has the highest number of predicted PM_{10} exceedances in Year 2 and the second highest in Year 5 and has been selected for further analysis. The relative source contributions at St Helens will be similar to those at the other receptors.

Table 25 Predicted number of exceedances at sensitive receptors

Receptor	Number of exceedances			
	Year 2		Year 5	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
St Helens	145	9	127	9
Jabiru	0	0	3	0
Iona Downs	82	15	89	41
Walther	23	0	27	0
Airlie	15	0	14	0
Glendarriwell	0	0	0	0
Dunloe	43	3	46	2
Selma	2	0	2	0
Kingower	0	0	0	0
Fork Lagoons	0	0	0	0
Donnelly	114	32	164	95
Wilga Downs	1	0	3	0
Fairways	67	3	68	3
Sypher	0	0	4	0
Background	**21.0 µg/m³**	**5.4 µg/m³**	**21.0 µg/m³**	**5.4 µg/m³**
Air EPP objective	***5 or less***	***0***	***5 or less***	***0***

The estimated contribution from each dust-generating activity to the predicted 24-hour average ground-level PM_{10} concentration at St Helens is shown in Table 26 for Year 2 and Table 27 for Year 5.

The contribution from each source is expressed as a percentage of the total predicted ground-level concentration for the 25 highest predicted 24-hour averages. The source contributions for Year 2 and Year 5 are shown in Figure 21 and Figure 22.

Table 26 Year 2 source contribution at St Helens for the 25 highest 24-hour average concentrations

Concentration (µg/m³)	Active pit	Blasting	Inactive pit	Ex-pit dumps	Stockpiles	Overburden haul	Rejects haul	ROM haul	CHPP	Rail	Background
249.4	23.7%	0.1%	1.1%	11.6%	0.0%	53.2%	0.1%	1.9%	0.0%	0.0%	8.4%
214.3	24.9%	0.0%	1.1%	10.6%	0.0%	50.9%	0.0%	2.7%	0.0%	0.0%	9.8%
204.3	25.1%	0.1%	1.1%	10.0%	0.0%	51.5%	0.2%	1.7%	0.0%	0.0%	10.3%
196.5	22.9%	0.0%	1.0%	10.6%	0.0%	52.9%	0.0%	1.9%	0.0%	0.0%	10.7%
192.6	22.9%	0.0%	1.0%	10.9%	0.1%	49.7%	0.5%	3.0%	1.0%	0.0%	10.9%
185.7	25.1%	0.0%	1.2%	11.7%	0.0%	48.2%	0.2%	2.2%	0.1%	0.0%	11.3%
184.7	27.7%	0.1%	1.2%	11.0%	0.0%	44.3%	0.4%	3.9%	0.0%	0.0%	11.4%
170.8	13.1%	0.0%	0.6%	17.9%	0.1%	44.5%	2.9%	7.5%	1.2%	0.0%	12.3%
166.2	21.9%	0.0%	1.1%	11.2%	0.0%	51.6%	0.0%	1.6%	0.0%	0.0%	12.6%
163.9	24.2%	0.1%	1.1%	10.1%	0.1%	48.2%	0.2%	2.5%	0.7%	0.0%	12.8%
163.1	26.8%	0.0%	1.2%	10.8%	0.0%	45.3%	0.0%	2.9%	0.0%	0.0%	12.9%
156.7	20.2%	0.0%	0.9%	9.9%	0.0%	55.5%	0.0%	0.2%	0.0%	0.0%	13.4%
155.5	20.2%	0.0%	0.9%	15.0%	0.0%	42.2%	2.1%	6.0%	0.0%	0.0%	13.5%
154.9	21.6%	0.0%	1.0%	13.1%	0.0%	43.9%	1.5%	5.1%	0.2%	0.0%	13.6%
152.8	19.2%	0.0%	0.9%	10.3%	0.0%	54.8%	0.0%	1.1%	0.0%	0.0%	13.7%
142.5	19.1%	0.0%	0.9%	11.2%	0.0%	53.3%	0.0%	0.7%	0.0%	0.0%	14.7%
139.7	22.5%	0.0%	0.9%	12.3%	0.5%	30.4%	2.4%	10.2%	5.7%	0.0%	15.0%
129.5	23.7%	0.0%	1.1%	9.9%	0.0%	46.5%	0.0%	2.5%	0.0%	0.0%	16.2%
128.8	17.2%	0.0%	0.7%	9.0%	1.6%	29.1%	1.8%	7.2%	17.0%	0.0%	16.3%
128.7	31.1%	0.0%	1.4%	9.3%	0.0%	37.4%	0.1%	4.5%	0.0%	0.0%	16.3%
126.5	20.2%	0.0%	0.9%	13.5%	0.2%	35.5%	2.1%	8.3%	2.6%	0.0%	16.6%
125.7	20.9%	0.0%	1.0%	9.8%	0.0%	50.8%	0.0%	0.8%	0.0%	0.0%	16.7%
125.2	39.9%	0.0%	1.5%	9.0%	0.0%	22.5%	1.1%	9.1%	0.1%	0.0%	16.8%
122.8	20.5%	0.0%	0.9%	9.3%	0.0%	50.2%	0.0%	1.9%	0.0%	0.0%	17.1%
122.4	29.6%	0.0%	1.2%	8.6%	0.0%	39.6%	0.0%	3.9%	0.0%	0.0%	17.2%

Table 27 Year 5 Source contribution at St Helens for the 25 highest 24-hour average concentrations

Concentration (µg/m³)	Active pit including overburden haul	Blasting	Inactive pit	Ex-pit dumps	Stockpiles	Rejects haul	ROM haul	CHPP	Rail	Background
245.2	83.9%	0.2%	1.6%	0.0%	0.0%	0.0%	5.7%	0.1%	0.0%	8.6%
219.5	84.9%	0.1%	1.5%	0.0%	0.1%	0.0%	3.8%	0.1%	0.0%	9.6%
195.9	79.5%	0.0%	1.8%	0.0%	0.0%	0.0%	8.0%	0.0%	0.0%	10.7%
191.3	81.9%	0.0%	1.6%	0.0%	0.1%	0.0%	5.1%	0.3%	0.0%	11.0%
191.2	82.0%	0.0%	1.5%	0.0%	0.0%	0.0%	5.5%	0.0%	0.0%	11.0%
188.9	78.0%	0.0%	1.4%	0.0%	0.2%	0.3%	7.1%	1.8%	0.0%	11.1%
174.9	86.2%	0.0%	0.9%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	12.0%
166.1	80.8%	0.0%	1.4%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	12.6%
163.1	77.6%	0.1%	1.6%	0.0%	0.1%	0.2%	6.2%	1.3%	0.0%	12.9%
155.3	71.6%	0.1%	2.5%	0.0%	0.2%	0.0%	11.7%	0.3%	0.0%	13.5%
153.1	81.5%	0.0%	1.1%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	13.7%
151.0	75.5%	0.0%	2.1%	0.0%	0.0%	0.0%	8.4%	0.0%	0.0%	13.9%
148.3	65.0%	0.0%	0.9%	0.0%	1.0%	0.4%	15.7%	2.9%	0.0%	14.2%
145.8	81.7%	0.1%	1.1%	0.0%	0.0%	0.0%	2.7%	0.0%	0.0%	14.4%
137.3	81.4%	0.0%	1.2%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	15.3%
127.4	67.2%	0.0%	1.9%	0.0%	0.7%	0.1%	12.6%	1.0%	0.0%	16.5%
125.1	77.6%	0.0%	1.3%	0.0%	0.0%	0.1%	3.8%	0.4%	0.0%	16.8%
123.2	31.2%	0.0%	1.2%	0.0%	2.0%	4.1%	15.0%	29.3%	0.0%	17.1%
123.0	80.7%	0.0%	1.1%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	17.1%
117.8	72.7%	0.0%	2.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	17.8%
117.6	80.7%	0.1%	1.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	17.9%
115.7	74.9%	0.0%	1.4%	0.0%	0.0%	0.0%	5.4%	0.0%	0.0%	18.2%
114.8	79.4%	0.0%	0.9%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	18.3%
109.6	36.6%	0.0%	2.3%	0.1%	1.4%	1.7%	26.3%	12.6%	0.0%	19.2%
109.1	59.6%	0.0%	2.2%	0.1%	1.4%	0.0%	16.6%	0.9%	0.0%	19.2%

The source contribution analysis shows that:

- The overburden haul is the most significant contributor to PM_{10} concentrations on most days, in particular during Year 5.
- Other important activities include:
    - The active pit
    - The out of pit dumps in Year 2
    - ROM haul, train loadout, the CHPP and pit activities may also contribute to PM_{10} concentrations at St Helens

This analysis indicates that a proactive and reactive management strategy that includes the following could be used effectively to ensure exceedances do not occur in practice:

- Continuous monitoring of PM_{10}
- Amendment of site activities when monitoring results show that levels are becoming elevated
- Limiting, reducing, redirecting or stopping potential significant emission sources at times of elevated risk

11. Odour Impact assessment

Underground coal mines are ventilated to control dust and to ensure that coal seam gases, when present, do not build up and become hazardous. At some coal mines in the Hunter Valley in New South Wales, the ventilation air from underground coal mines has been investigated as a possible source of odour annoyance at residential areas nearby. Sampling and analysis has been undertaken at these mines to quantify odour emission rates and odour concentrations. Detailed odour impact assessment studies (Holmes Air Sciences 2003) have concluded that mine ventilation emissions are not likely to cause elevated odour levels.

Notwithstanding the above, a detailed odour study has been undertaken for the Project to ensure that there is a low risk of odour impacts associated with the construction and operation of the Project underground mine ventilation system.

Whilst full details of the design and location of the Project ventilation shaft are not available, this assessment has been conducted in a conservative manner to provide a quantitative basis to specify a minimum recommended separation distance that should be maintained between any vent shaft and nearby residences.

Table 28 summarises the available information for the design of the ventilation shaft. The odour concentration has been taken from the EIS prepared for the Wambo Coal Mine (Holmes Air Sciences 2003), which contained data from odour concentration measurements at an underground mine in the Hunter Valley.

Table 28 Underground mine ventilation shaft discharge preliminary design

Parameter	Preliminary design
Volumetric flowrate	300 m^3/s (at discharge conditions) [a]
Diameter	6 metres [b]
Height	Low angle with consideration of prevailing winds, estimate – 2 metres
Odour concentration	170 ou [c]
Odour emission rate	51,000 ou.m^3/s
Temperature	Estimate – 298 Kelvin
Discharge velocity	10.6 m/s

Table note:
[a] Pre-feasibility study for Taroborah Coal Project
[b] Estimate
[c] Wambo Coal Mine (Holmes Air Sciences 2003)

The CALPUFF dispersion model has been used to model odour emissions from the ventilation shaft and to predict ground-level concentrations of odour for comparison with the EHP's odour guideline of 2.5 ou (99.5th percentile, 1-hour average). The CALPUFF model has been configured in the same method as for the air quality assessment and is detailed in Appendix A.

The modelling results from CALPUFF predict odour concentrations to be below the EHP's odour guideline across the entire study area. The maximum predicted 99.5th percentile 1-hour average ground-level concentration is 1.7 ou, which is 68% of EHP's odour guideline and occurs approximately 100 m to the southwest of the stack.

The odour assessment indicates that there is unlikely to be an odour issue from the ventilation shaft. However, when siting ventilation shafts, the location relative to sensitive receptors should be considered.

12. Mitigation measures

12.1 Construction dust

Dust management should include regular watering of roads and exposed areas to reduce wheel-generated dust and restricting vehicle speeds. During high wind conditions, dust-generating activities such as earthworks that could potentially affect residents should be restricted or cease. The loads of haul vehicles should be covered when moving outside of the construction site and any spillages should be cleaned up. Stockpiled material should be vegetated or kept in appropriate enclosures to prevent wind.

Before construction commences, a dust management plan (DMP) should be developed in conjunction with the construction management plan to assist in minimising nuisance dust. Dust measures that should be included are:

- So far as practical, erect physical barriers such as bunds and or wind breaks around stockpiles or areas where earth moving is required
- Where possible, earth moving activities should be avoided during unfavorable meteorological conditions
- Minimise speed of on-site traffic, where applicable, to minimise wheel generated dust
- Ensure all vehicles are suitably fitted with exhaust systems that minimise gaseous and particle emissions to meet vehicle design standards
- Water bunds and stockpiles to minimise dust lift-off
- Water high use unsealed roads to minimise dust lift-off from the road surface
- Limit vegetation and soil clearing to approved areas, so as to minimise the area of exposed soil that may generate dust
- Compact construction site and stabilise vegetation to minimise dust lift-off due to wind erosion

12.2 Operational dust

12.2.1 Dust generating activities

The extraction of coal from an open-cut mine is a dust generating activity with the potential to impact on human health and amenity. Key operational activities that contribute to dust generation include:

- Vehicle traffic on haul roads
- Overburden removal truck and shovel
- Drilling and blasting
- Extraction activities within the pit itself
- Wind erosion from stockpiles
- Conveyors
- Wind erosion of exposed surfaces, such as the pit floor and other cleared areas
- Product preparation and washing
- Train loading

12.2.2 Measures to minimise dust emissions

The Air EPP includes a hierarchy for air emissions, in which an order of preference for the management of air emissions is defined:

- Firstly - avoid
- Secondly - recycle
- Thirdly - minimise
- Fourthly - manage

The Project has been designed as far as practicable to eliminate unnecessary emissions of dust and the modelling study has accounted for these as far as this is practicable. There are no opportunities to use recycling to minimise emissions in the context of a coal mine. Further reductions in emissions can be achieved through actions aimed at minimising and managing dust emissions. An air quality management plan (AQMP) should be developed to assist with the implementation of minimisation and management strategies.

Measures to minimise the potential impact of fugitive dust emissions must recognise all potential sources of dust emissions and have strategies in place to mitigate any unnecessary emissions and adverse impacts that the proposed activities may have on the health and amenity of the surrounding community. The AQMP should be developed considering the Air EPP objectives and emissions management hierarchy. The AQMP should have both proactive and reactive measures.

The proactive management plan should include, where necessary:

- Watering and grading haul roads and use of road surface treatments
- Water sprays, covers and chutes used in all coal handling and preparation operations as applicable (crushing, screening, conveying, stockpiling and train loading)
- Progressive revegetation of disturbed areas as mining operations develop
- Provision of windbreaks (such as tree planting) around stockpiles
- Continuous real time monitoring of dust concentrations at sensitive receptors
- Continuous real time monitoring of meteorological conditions
- Improve load profiles and loading techniques of trains to avoid spillage
- Adaptive management strategies such as reduction in extraction rates of operations when meteorological monitoring suggests adverse wind conditions or dust monitoring at sensitive receptors indicates levels are near to exceeding air quality criteria
- Consultation with potentially impacted landowners and negotiation of relevant mitigation measures. The implementation of simple mitigation measures at residences if appropriate, for example installing first flush systems on rainwater tanks.
- The surface of coal in wagons will be profiled to a flat “garden bed” shape and a surface treatment will be applied to minimise coal dust emissions during transit to the port. This is a requirement of all trains using the port at Gladstone.

These control measures are considered leading industry practice for this Project.

The AQMP should include the following routine elements:

- Watering of haul routes as necessary
- Continuous monitoring of PM_{10} dust deposition and meteorological variables at an appropriate location will be implemented at the first instance and continued for the life of the mine
- Specify auditing requirements, if appropriate
- A procedure for dealing with received complaints

The AQMP should include a reactive component (such as a Trigger Action Response Plan) that includes:

- Implementation of additional mitigation measures when wind conditions become adverse, reducing activity rates, covering equipment or temporarily casing operations if absolutely necessary
- Trigger points for management decisions based on measurements of wind conditions and/or dust monitoring at sensitive receptors when levels are near to exceeding air quality criteria

12.2.3 Dust and meteorological monitoring

The following monitoring is recommended to be implemented:

- Establish continuous real time monitoring of PM_{10} at representative sites of potential high dust occurrences
- Establish real time meteorological monitoring at a location that is representative of meteorological conditions in the area surrounding the mine

The real time monitoring system will provide the mine management team with real time information on PM_{10} concentrations. The monitoring should occur in the vicinity of the most affected receptors. Monitoring devices located upwind and downwind of the Project site should be considered. The system will be linked to a trigger action response plan (TARP) that will be activated once the rolling 24-hour average concentrations exceed 80% (40 $\mu g/m^3$) of the Air EPP objective of 50 $\mu g/m^3$.

The site selection process for the dust and meteorological monitors will depend on the availability of suitable land. The following site factors will need to be considered:

- Suitability as a dust and meteorological monitoring location
- Local terrain features
- Road accessibility
- Proximity to a power supply
- The amount of tree coverage, which will require additional maintenance
- The amount of earthworks required as the site will need to be flat for the monitor
- The ease of maintenance to the site
- Compliance with the Australian Standard for the siting of monitors

The siting of air monitoring equipment must comply with Australian Standards as specified in Table 29.

Table 29 Australian Standards that are relevant to the Project's ambient air monitoring programme

Air Quality Determination	Monitoring method to be used
Concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (PM_{10}) suspended in the atmosphere over a 24 hour averaging time	Real-time monitoring of the 24 hour average. Australian Standard AS3580.9.8 : 2008 *Determination of suspended PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser* (or the most recent version), or any alternative method of monitoring PM_{10} that may be permitted by the Air Quality Sampling Manual as published from time to time by the administering authority.
Concentration of particulate matter suspended in the atmosphere in micrograms per cubic metre over a 24 hr averaging time	AS/NZS 3580.9.3:2003 *Determination of suspended particulate matter - Total suspended particulate matter (TSP) - High volume sampler gravimetric method* (or the most recent version)
Deposited Dust	Australian Standard AS 3580.10.1:2003 (or the most recent version);
Meteorological data (including but not limited to wind speed and direction, humidity, temperature and precipitation)	AS 3580.14-2011: *Meteorological monitoring for ambient air quality monitoring applications*
Siting of monitoring equipment	AS/NZS 3580.1.1:2007 Guide to siting air monitoring equipment

13. Conclusions

An air quality impact assessment has been conducted for the proposed Taroborah Coal Project in the Bowen Basin region of Queensland, located to the west of Emerald.

The air quality impact assessment investigated the potential for impacts associated with mining operations for two scenarios (Year 2 and Year 5) representing various stages of the life of the mine. The open-cut mining operation has an anticipated 7 year life, currently projected to commence in 2018 at up to 2.3 Mtpa of ROM coal. The underground longwall mining operation has an anticipated 17 year life, currently projected to commence in 2022 at up to 5.7 Mtpa of ROM coal.

The assessment used meteorological and dispersion models to assess the effect of emissions (TSP, PM_{10}, $PM_{2.5}$ and dust deposition rate) from the Project in isolation and with the inclusion of ambient background levels of dust representative of the region.

The following conclusions may be drawn from the air quality impact assessment in relation to dispersion meteorology:

- The site is dominated by light to moderate winds, with an average wind speed of 2.6 m/s and approximately 66 % of winds between 1 and 2 m/s
- The prevailing wind direction at the site is from the northeast through the east to the southeast directions

The following conclusions may be drawn from the air quality impact assessment:

Year 2 of operations

- The predicted annual average ground-level concentrations of Total Suspended Particles (TSP) from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for TSP was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.

- The predicted 6th highest 24-hour average ground-level concentration of PM_{10} from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including three receptors that lie outside the MDL boundary.

- The predicted maximum 24-hour average ground-level concentration of $PM_{2.5}$ from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including two receptors that lie outside the MDL boundary.

- The predicted annual average ground-level concentrations of $PM_{2.5}$ from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for $PM_{2.5}$ was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.

- The predicted annual average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at one receptor, Donnelly House, which is located within the MDL.

Year 5 of operations

- The predicted annual average ground-level concentrations of TSP from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for TSP was predicted to be exceeded at two receptors; Iona Downs and Donnelly House, which are located within the MDL.

- The predicted 6th highest 24-hour average ground-level concentration of PM_{10} from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including three receptors that lie outside the MDL boundary.

- The predicted maximum 24-hour average ground-level concentration of $PM_{2.5}$ from the Project, including background levels, show predicted exceedances of the Air EPP objective at a number of receptors, including two receptors that lie outside the MDL boundary.

- The predicted annual average ground-level concentrations of $PM_{2.5}$ from the Project, including background levels, show compliance with the Air EPP objective at all receptors outside of the MDL. The objective for $PM_{2.5}$ was predicted to be exceeded at two receptors; Iona Downs and Donnelly House, which are located within the MDL.

- The predicted annual average dust deposition rate from the Project, including background levels, show compliance with the guidelines at all receptors outside of the MDL. The guideline for dust deposition rate was predicted to be exceeded at two receptors, Iona Downs and Donnelly House, which are located within the MDL.

An analysis of the exceedances of the Air EPP objective for PM_{10} shows that:

- The overburden haul is the most significant contributor to PM_{10} concentrations on most days, in particular during Year 5.
- Other important activities include:
  - The active pit
  - The out of pit dumps in Year 2
  - ROM haul, train loadout, the CHPP and pit activities may also contribute to PM_{10} concentrations at St Helens

This analysis indicates that an Air Quality Management Plan with proactive and reactive components including the following actions could be used effectively to ensure exceedances do not occur in practice:

- Continuous monitoring of PM_{10}
- Amendment of site activities when monitoring results show that levels are becoming elevated
- Limiting, reducing, redirecting or stopping potential significant emission sources at times of elevated risk

The potential odour impacts associated with the ventilation shaft have been assessed in a screening-level assessment. The results indicate that there is unlikely to be an odour issue from the ventilation shaft. However, when siting ventilation shafts, the location relative to sensitive receptors should be considered.

14. References

Bureau of Meteorology (BoM), 2008-2009. Significant Weather – April 2008, September 2008, November 2008 and March 2009. http://www.bom.gov.au/inside/services_policy/public/sigwxsum/sigwmenu.shtml accessed 24/04/2009

Bureau of Resources and Energy Economics (BREE), April 2013. Rresources and Energy Major Projects.

CSIRO, 2008, The Air Pollution Model (TAPM) Version 4.0.4, http://www.cmar.csiro.au/research/tapm/

Earth Tech Inc, 2010, CALPUFF - Version 6.267, CALMET - Version 6.327. Concord, MA, USA, http://www.src.com

Environmental Protection Act, 1994 (Queensland Government)

Environmental Protection Agency 2008. Environmental Protection (Air) Policy, Subordinate Legislation 2008 No. 441. *Office of the Queensland Parliamentary Counsel, Queensland.*

Environmental Protection Agency 1997. Environmental Protection (Air) Policy, Subordinate Legislation 1997 No. 468 and amendments. *Office of the Queensland Parliamentary Counsel, Queensland.*

Environmental Protection Agency (EPA), 2004, Guideline: Odour Impact Assessment from Developments, Queensland Government, Environmental Protection Agency.

Holmes Air Sciences 2003, Air quality impact assessment: Wambo Development Project, a report prepared for Wambo Coal Pty. Limited.

IMC Mining Solutions, 2009. Pre-feasibility Mining Study for the Taroborah Project - EPC1011

Katestone Environmental 2006. Air Quality Impact Assessment Study of the Proposed Ensham Central Project.

Katestone Environmental 2009. Supplementary Air Quality Assessment for the Wandoan Joint Venture Project.

Katestone Environmental 2009a. Air Quality Assessment – Ensham Central Project – revised Central Area mining Methodology.

Katestone Environmental 2011. Air Quality and Greenhouse Gas Assessment of the Stage 2 Middlemount Coal Project.

Katestone Environmental 2012. Air Quality Assessment of the Foxleigh Plains Project.

McInnnes K.L, McBride, J.L., & Leslie, L.M. 1994, Cold fronts over Southern Australia: Their representation in an operational numerical weather prediction model. *Weather and Forecasting*, Vol. 9, 384-409.

National Pollutant Inventory (NPI), 2001, Emission Estimation Technique Manual for Mining, National Environment Protection Council.

National Pollutant Inventory, 2012, "Search NPI data", http://www.npi.gov.au/data/search.html , accessed 26 June 2012.

NSW Department of Environment and Conservation, 2005, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

Standards Australia and Standards New Zealand, 2003a. Australian/New Zealand Standard AS/NZS 3580.10.1- 2003. Methods for sampling and analysis of ambient air. Method 10.1: Determination of particulate matter-Deposited matter-Gravimetric method

Standards Australia and Standards New Zealand, 2003b. Australian/New Zealand Standard AS/NZS 3580.9.3- 2003. Methods for sampling and analysis of ambient air. Method 9.3: Determination of suspended particulate matter-Total suspended particulate matter (TSP)-High volume sampler gravimetric method

Standards Australia and Standards New Zealand, 2007. Australian/New Zealand Standard AS/NZS 3580.1.1- 2007. Methods for sampling and analysis of ambient air. Part 1.1: Guide to siting air monitoring equipment

Standards Australia, 2008. Australian Standard AS 3580.9.8- 2008. Methods for sampling and analysis of ambient air. Method 9.8: Determination of suspended particulate matter-PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser

Standards Australia, 2011. Australian Standard AS 3580.14-2011. Methods for sampling and analysis of ambient air. Meteorological monitoring for ambient air quality monitoring applications

United States Environmental Protection Agency (USEPA), 1998, Western surface coal mining, AP-42 Chapter 11.9, USEPA Office of Air Quality Planning and Standards.

United States Environmental Protection Agency (USEPA), 2006a, Aggregate handling and storage piles, AP-42 Chapter 13.2.4, USEPA Office of Air Quality Planning and Standards.

United States Environmental Protection Agency (USEPA), 2006b, Industrial wind erosion, AP-42 Chapter 13.2.5, USEPA Office of Air Quality Planning and Standards.

United States Environmental Protection Agency (USEPA), 2006c, Unpaved Roads, AP-42 Chapter 13.2.2, USEPA Office of Air Quality Planning and Standards

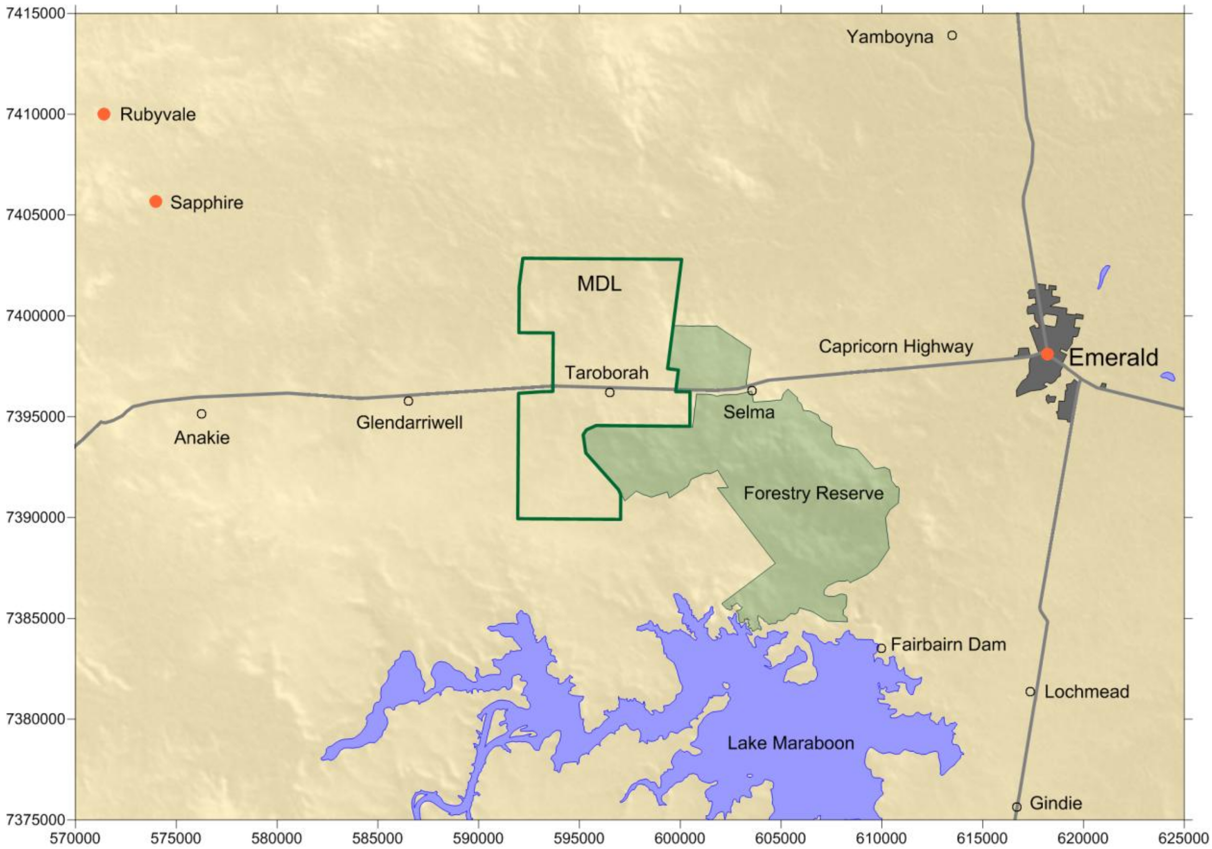

Figure 1	**Location of the Taroborah Coal Project**	
Location: Emerald	**Data source:** AARC	**Units:** Projection MGA94 Zone 55S
Type: Aerial map	**Prepared by:** M. Burchill	**Date:** June 2012

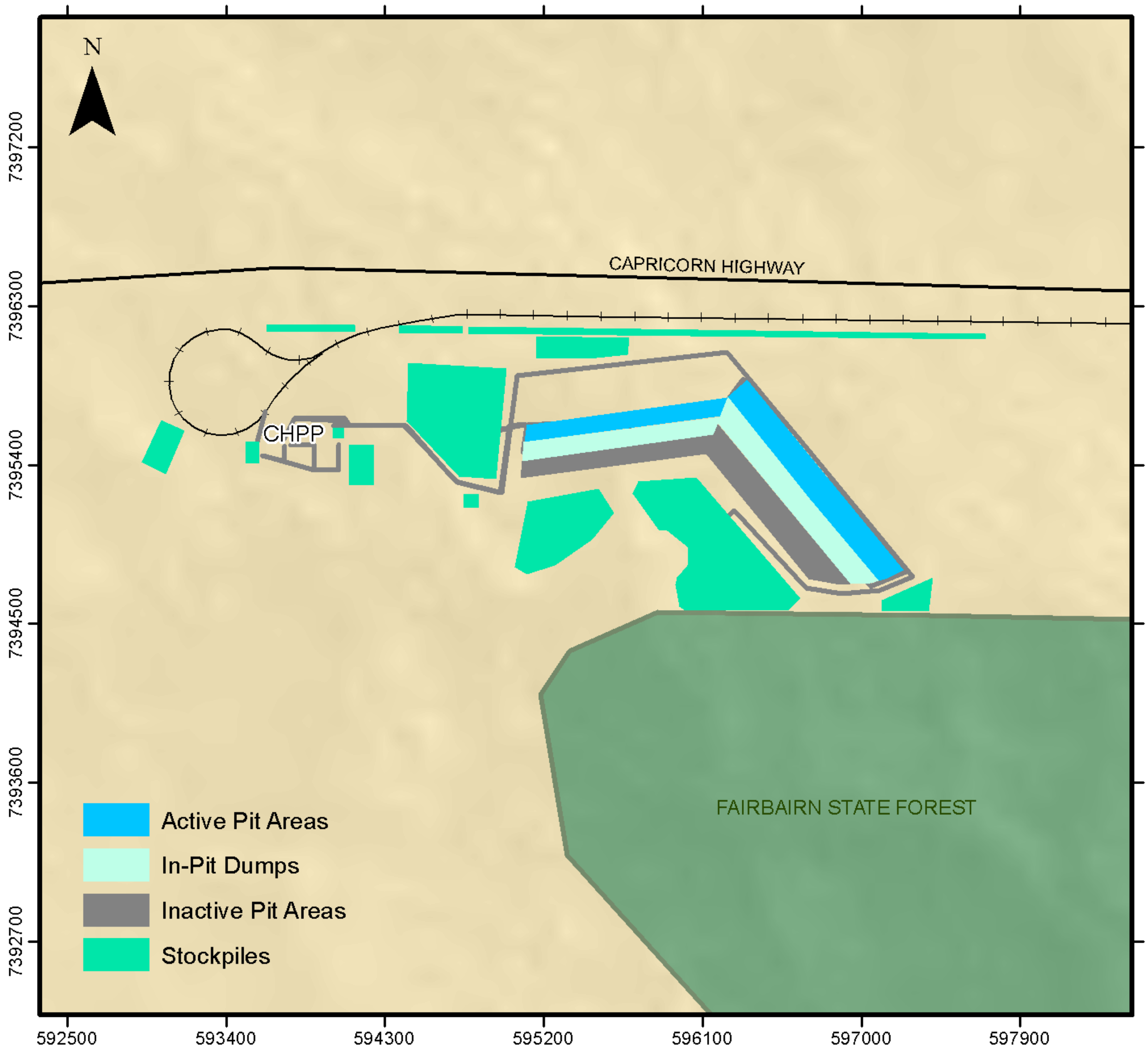

Figure 2 Proposed Taroborah Mine Layout - Year 2

Location: Emerald	**Data source:** AARC and IMC Mining	**Units:** Projection MGA94 Zone 55S
Type: Aerial map	**Prepared by:** A. Thomas	**Date:** September 2013

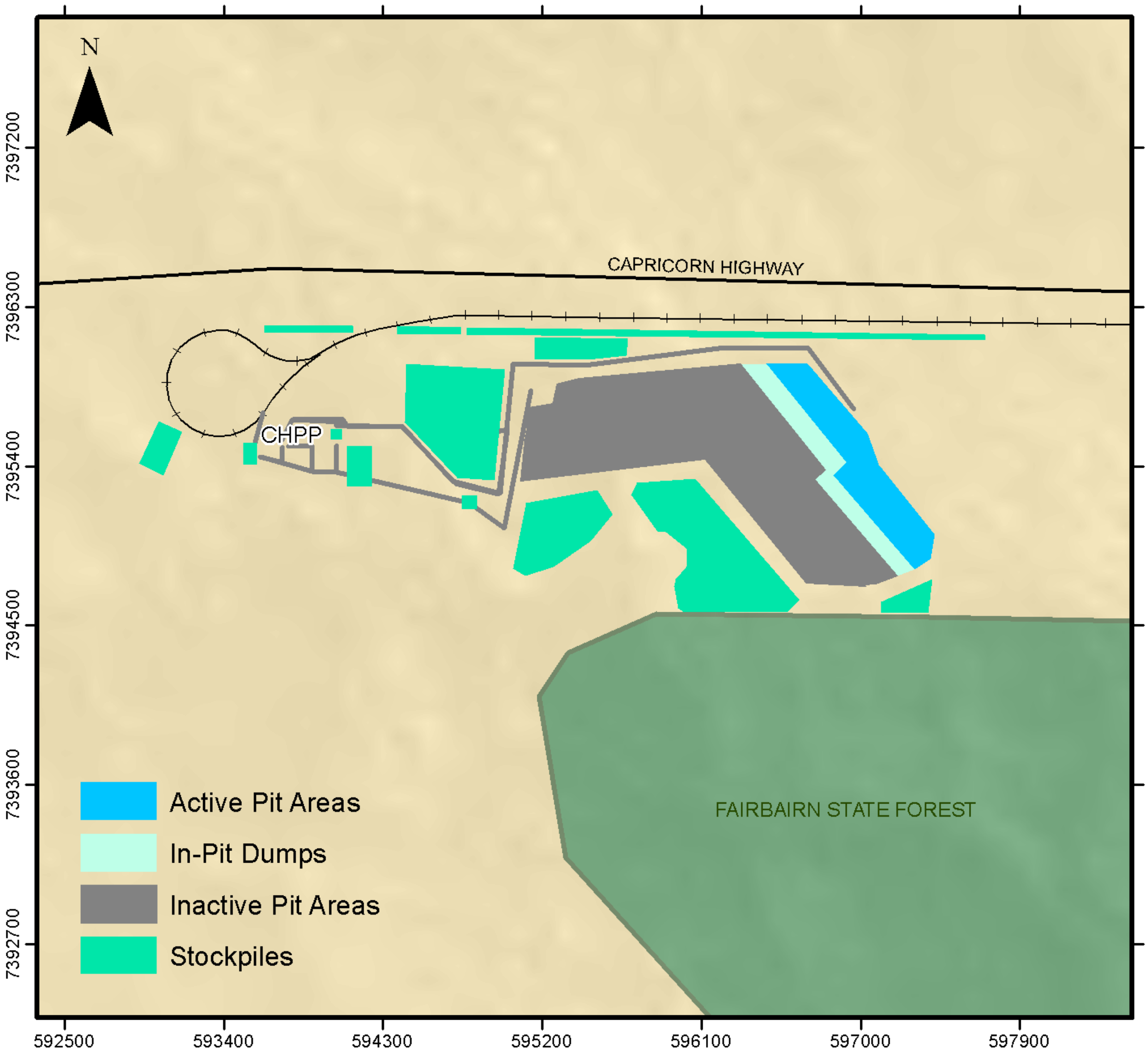

Figure 3 Proposed Taroborah Mine Layout – Year 5

Location: Emerald	**Data source:** AARC and IMC Mining	**Units:** Projection MGA94 Zone 55S
Type: Aerial map	**Prepared by:** A. Thomas	**Date:** September 2013

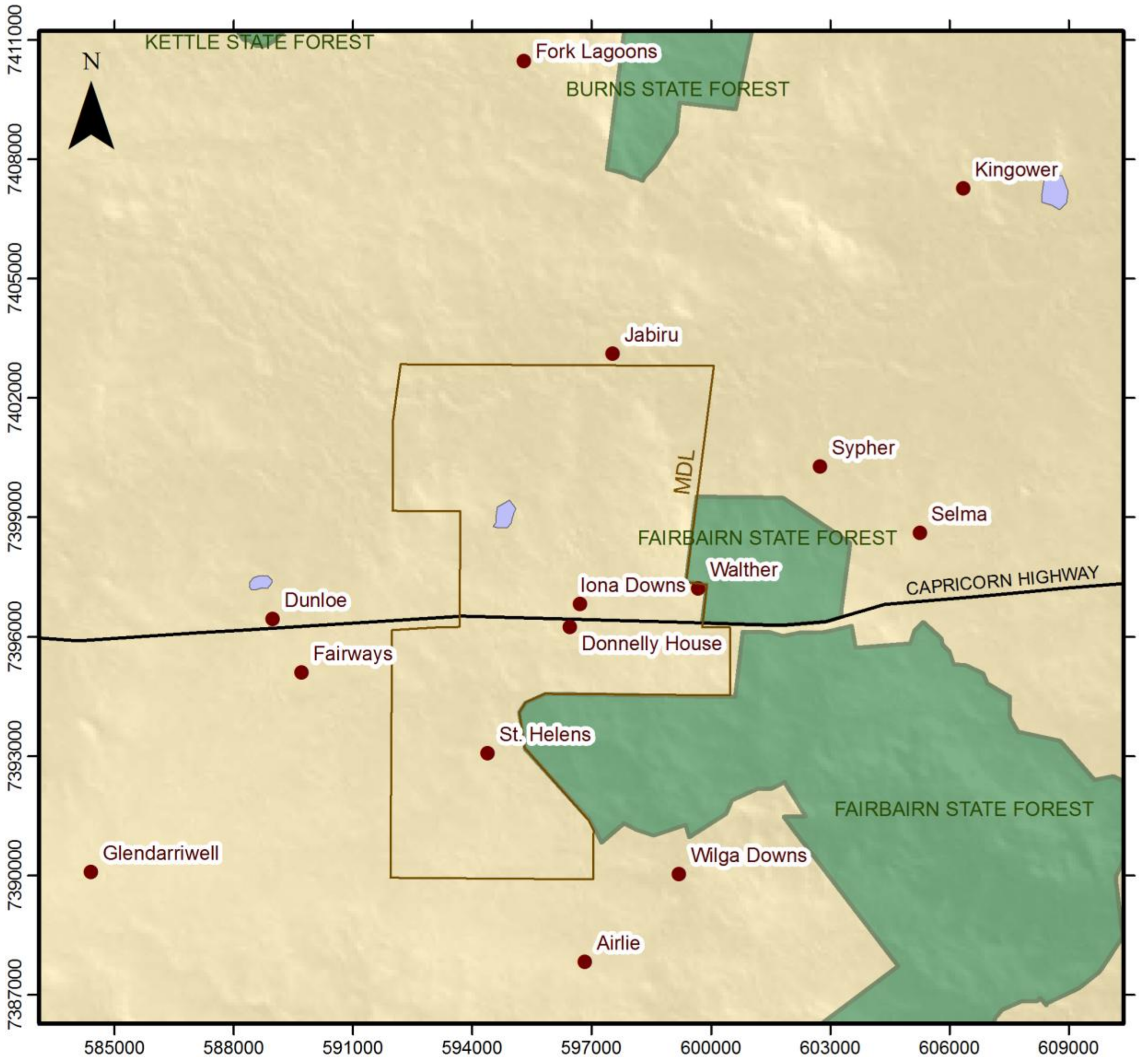

Figure 4 Sensitive receptor locations

Location: Emerald	**Data source:** AARC	**Units:** Projection MGA94 Zone 55S
Type: Aerial map	**Prepared by:** A. Thomas	**Date:** October 2013

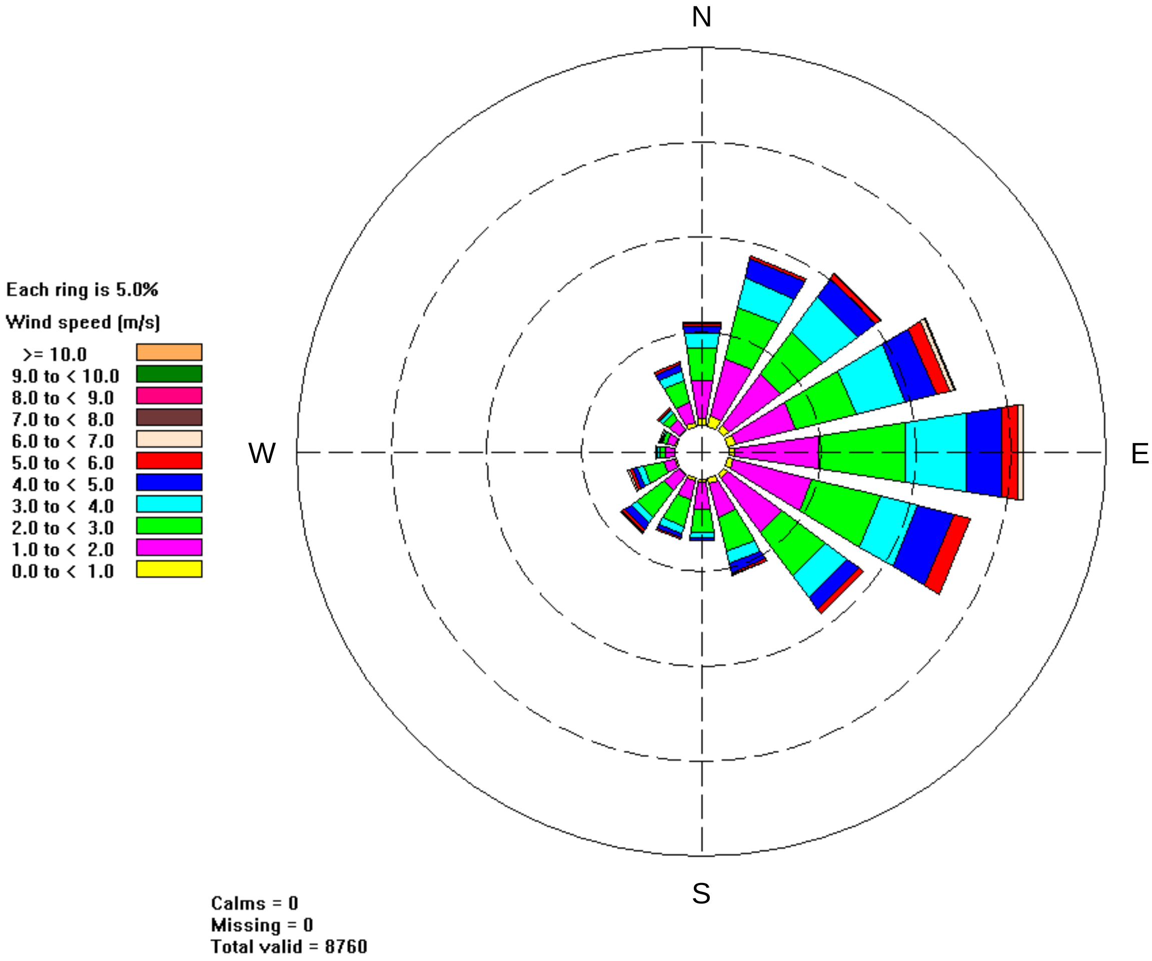

Figure 5 **Annual distributions of modelled winds at the Project site**

Location: Taroborah, Central Queensland	**Period:** 2009	**Data source:** CALMET	**Units:** m/s
Type: Wind rose	8760 hourly average records	**Prepared by:** M. Burchill	**Date:** June 2012

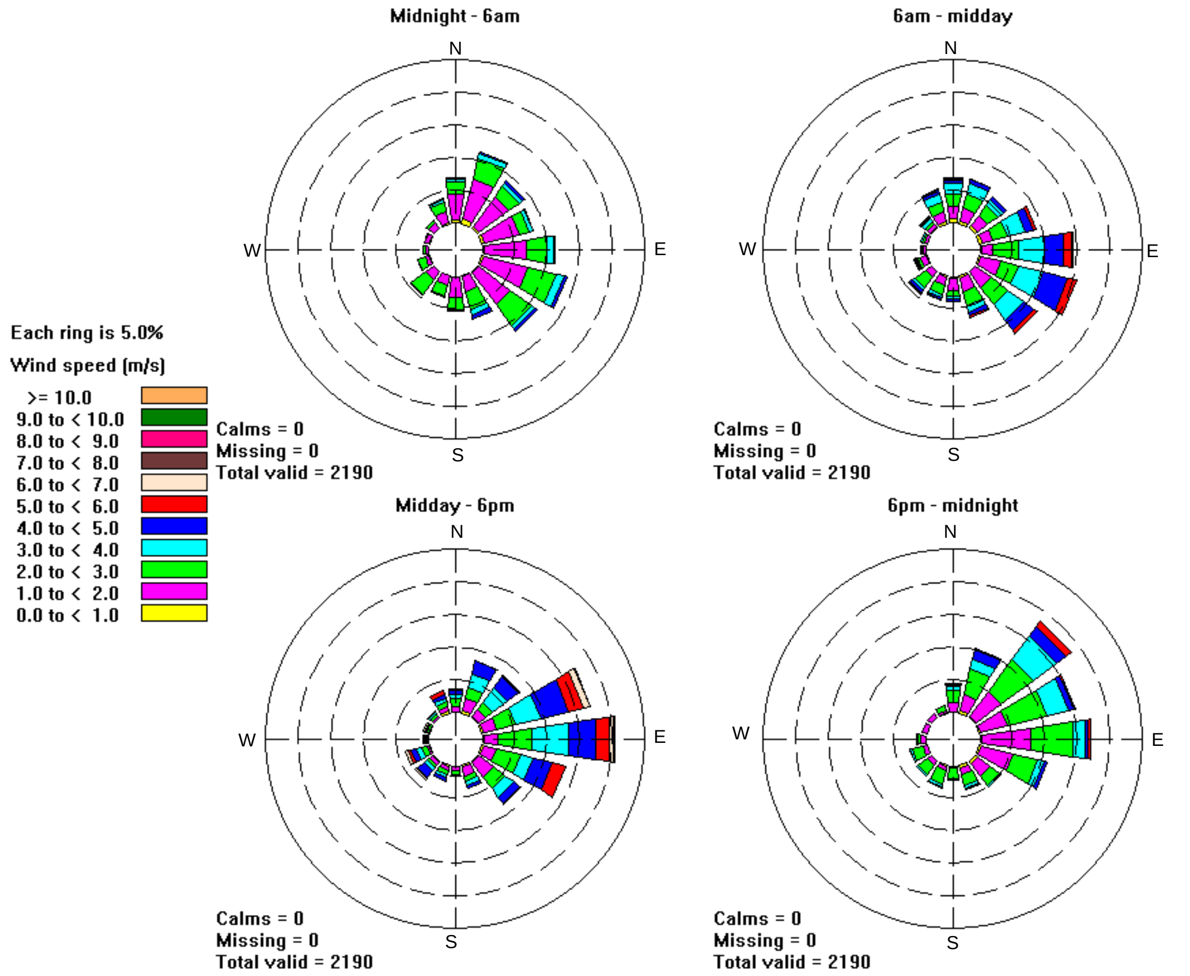

Figure 6	**Diurnal distributions of modelled winds at the Project site**		
Location: Taroborah, Central Queensland	**Period:** 2009	**Data source:** CALMET	**Units:** m/s
Type: Wind rose	8760 hourly average records	**Prepared by:** M. Burchill	**Date:** June 2012

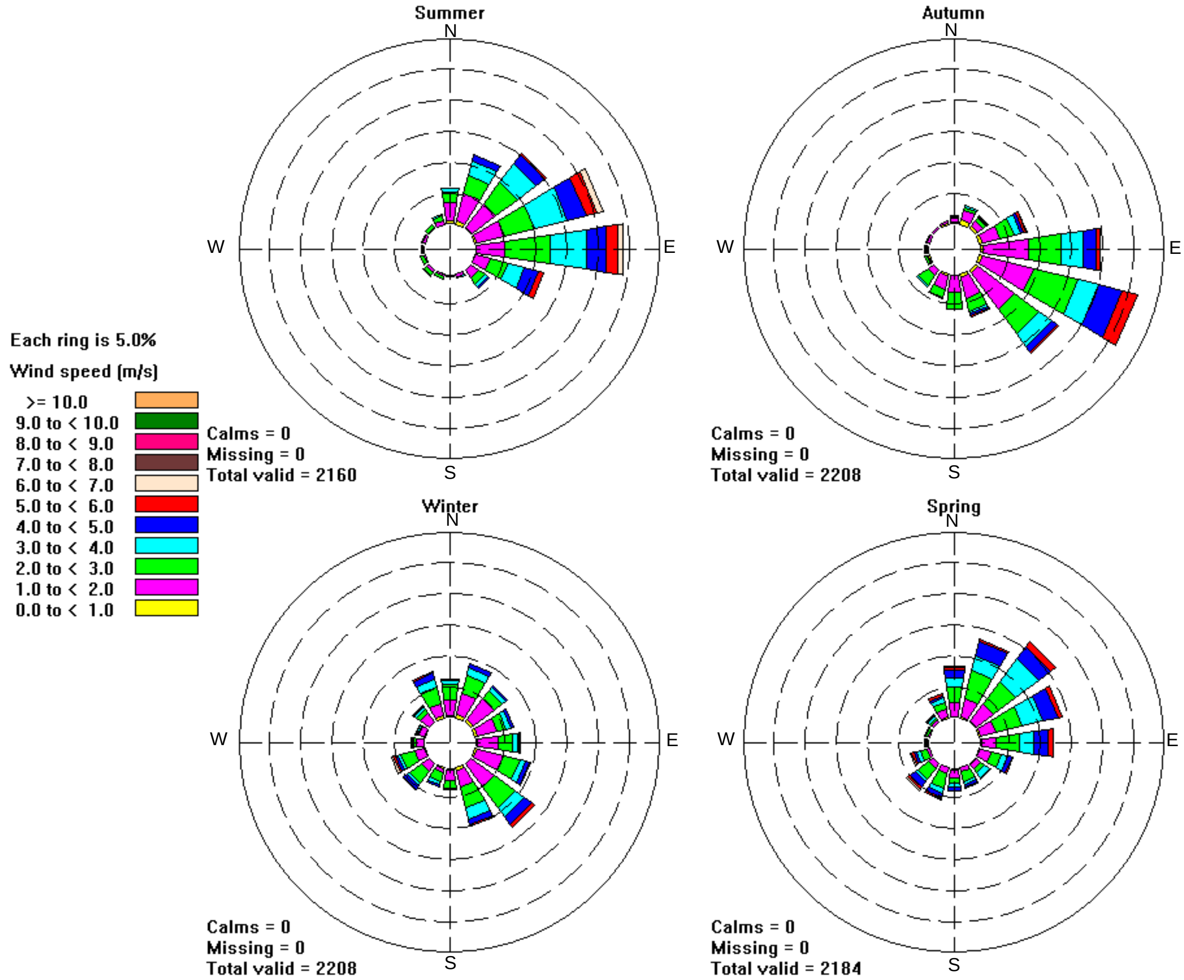

Figure 7 Seasonal distributions of modelled winds at the Project site

Location: Taroborah, Central Queensland	**Period:** 2009	**Data source:** CALMET	**Units:** m/s
Type: Wind rose	8760 hourly average records	**Prepared by:** M. Burchill	**Date:** June 2012

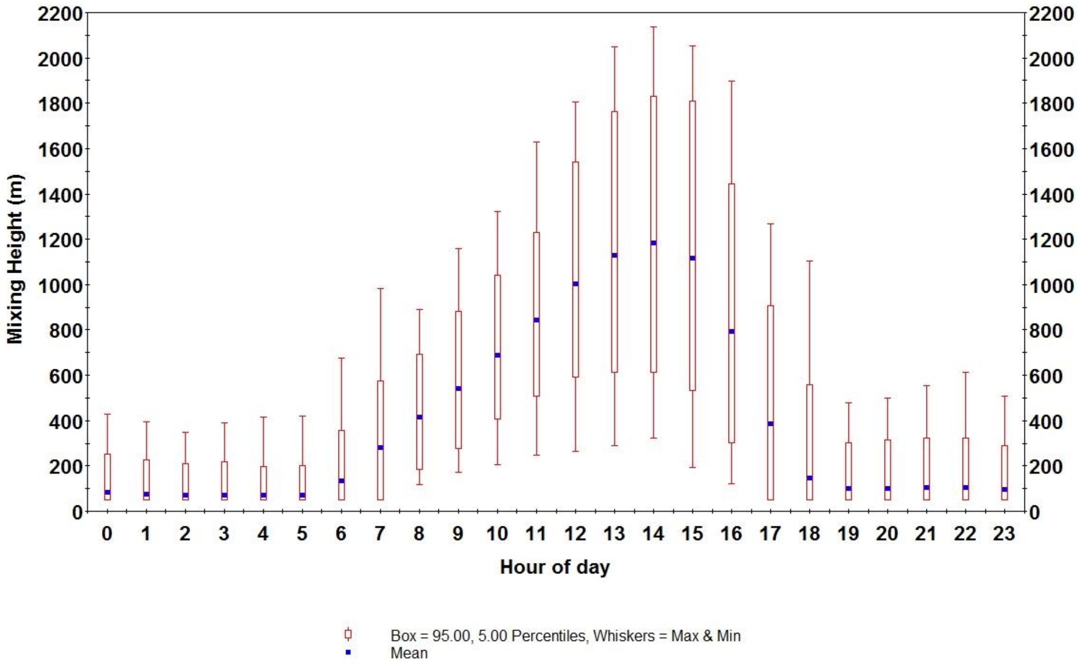

Figure 8	**Diurnal profile of mixing height at the Project site**		
Location: Taroborah, Central Queensland	**Period:** 2009	**Data source:** CALMET	**Units:** m
Type: Box and Whisker Plot	**Averaging Period:** 1-hour	**Prepared by:** M. Burchill	**Date:** June 2012

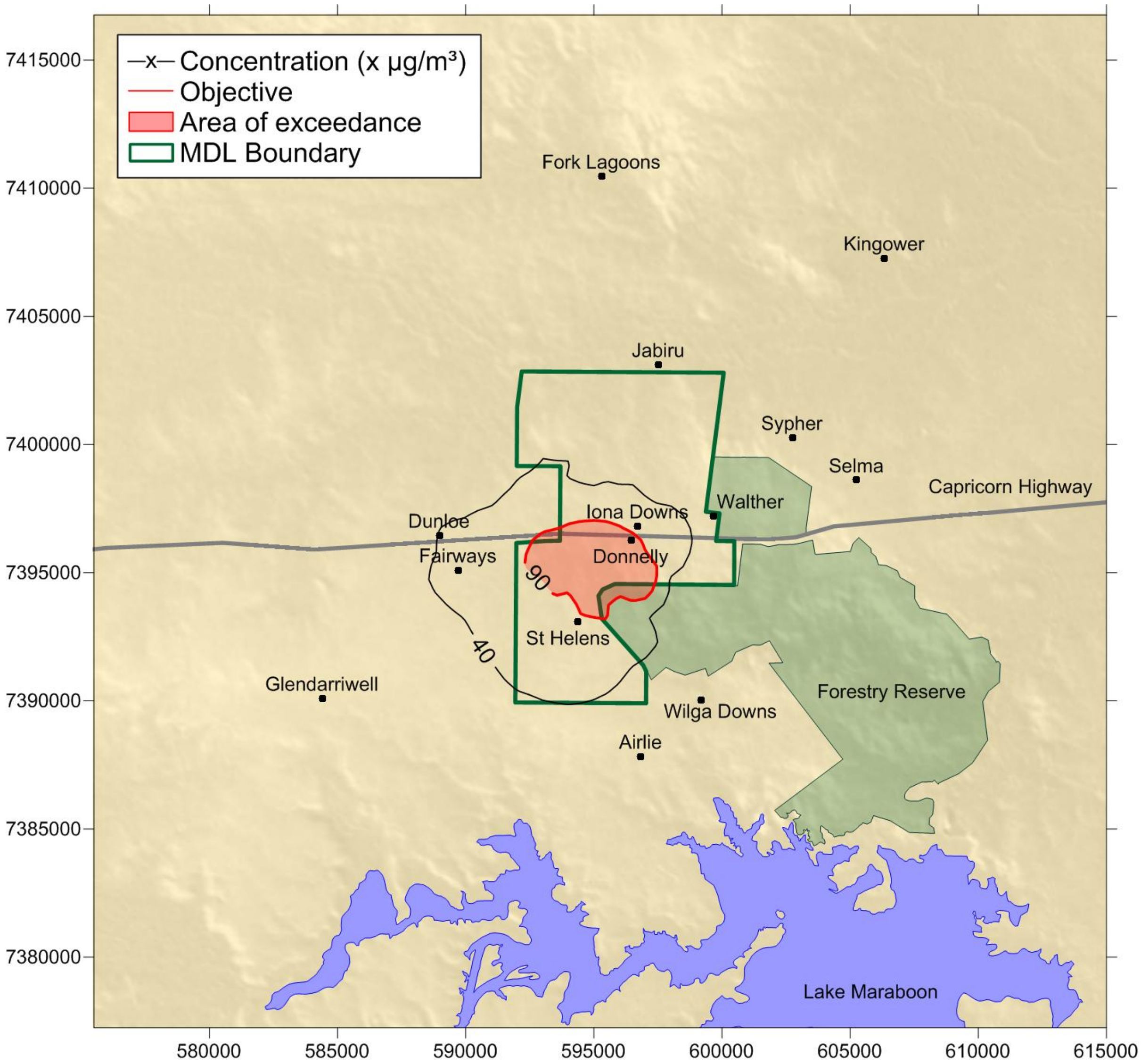

Figure 9 **Predicted annual average ground-level concentrations of TSP in Year 2 of the Project, including a background**

Location: Taroborah, QLD	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour Plot	**Objective:** 90 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

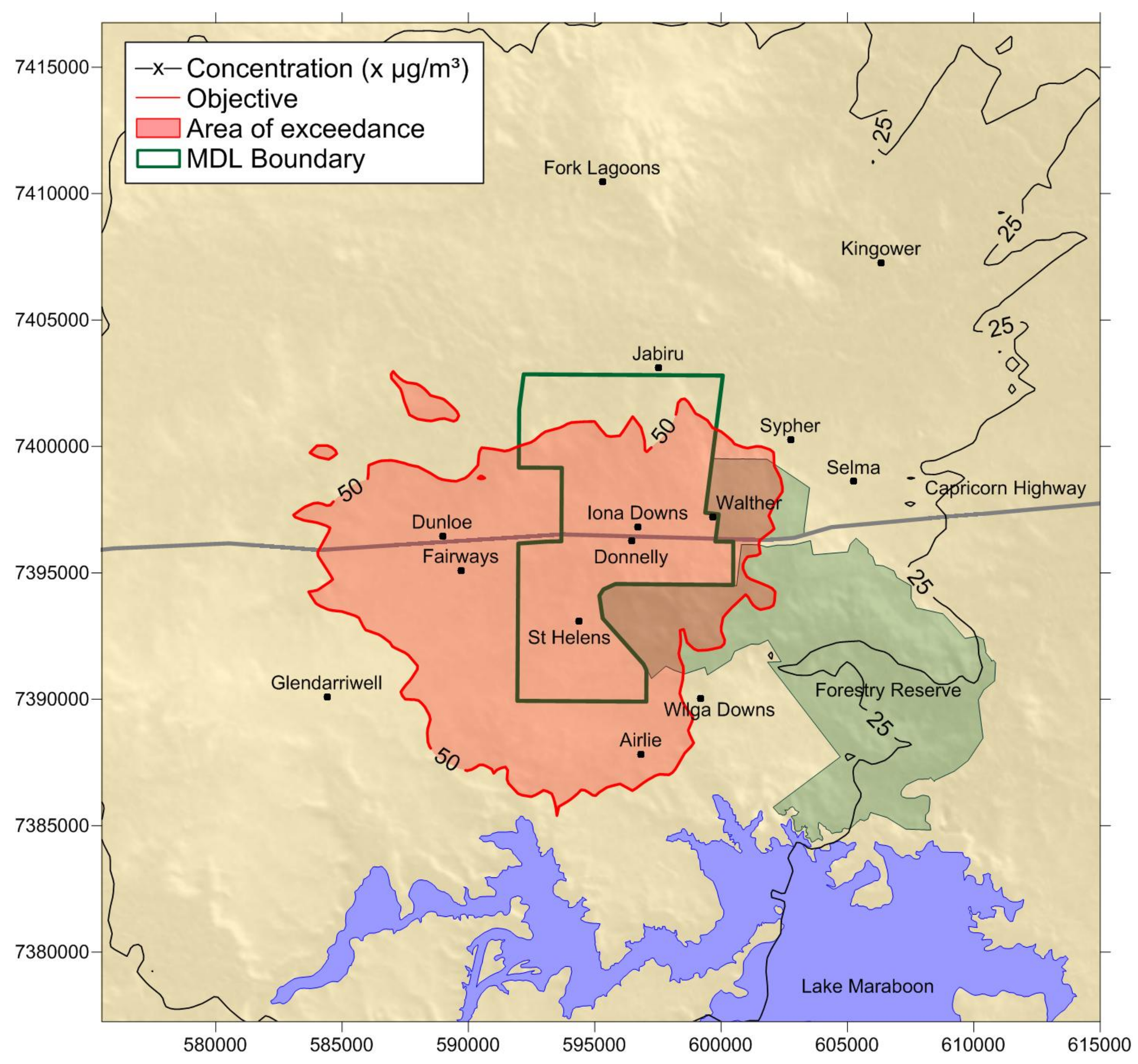

Figure 10 Predicted 6th highest 24-hour average ground-level concentrations of PM_{10} in Year 2 of the Project, including a background

Location: Taroborah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: 6th highest contours	**Objective:** 50 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

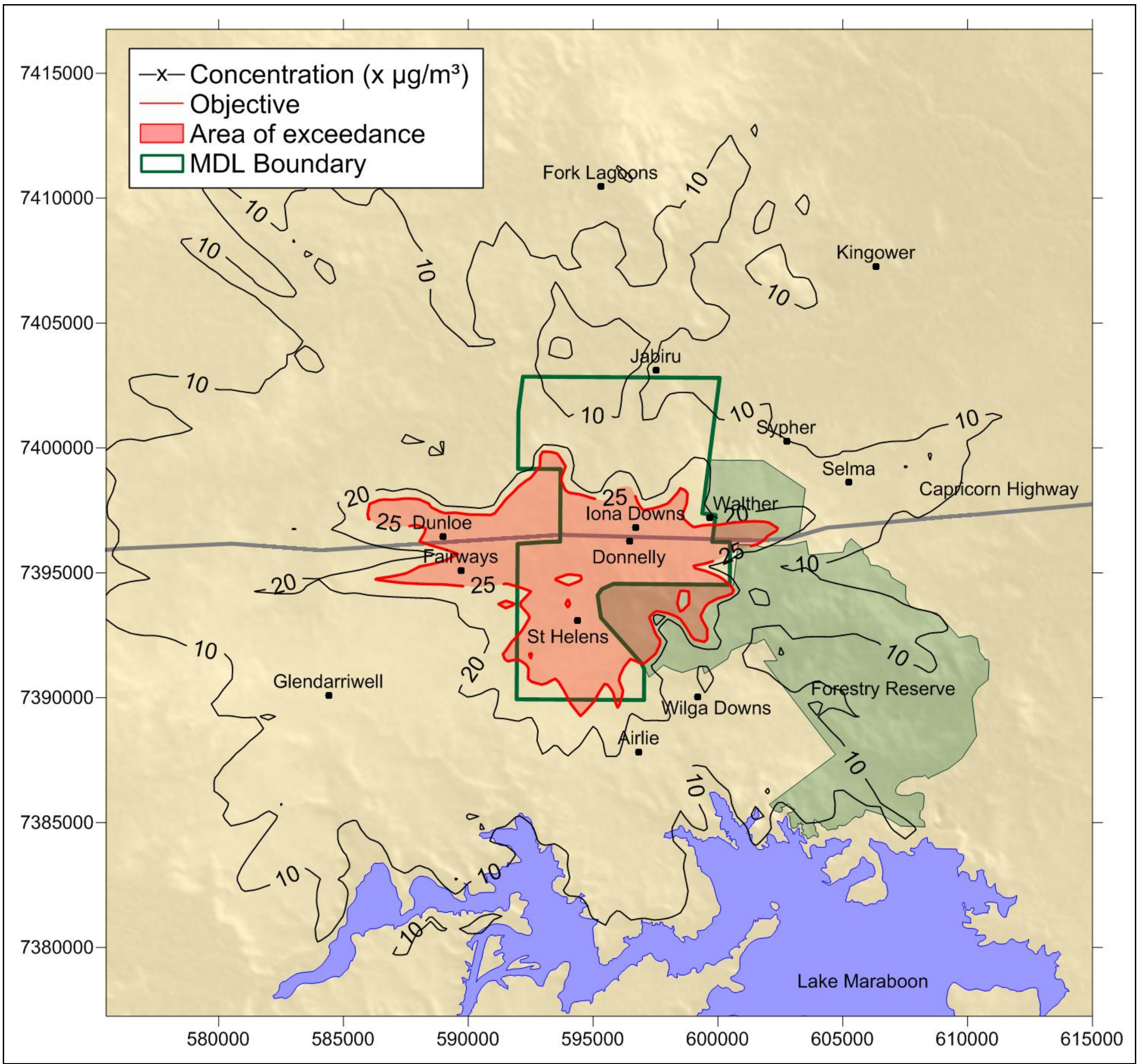

Figure 11 Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ in Year 2 of the Project, including a background

Location: Taroborah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Objective:** 25 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

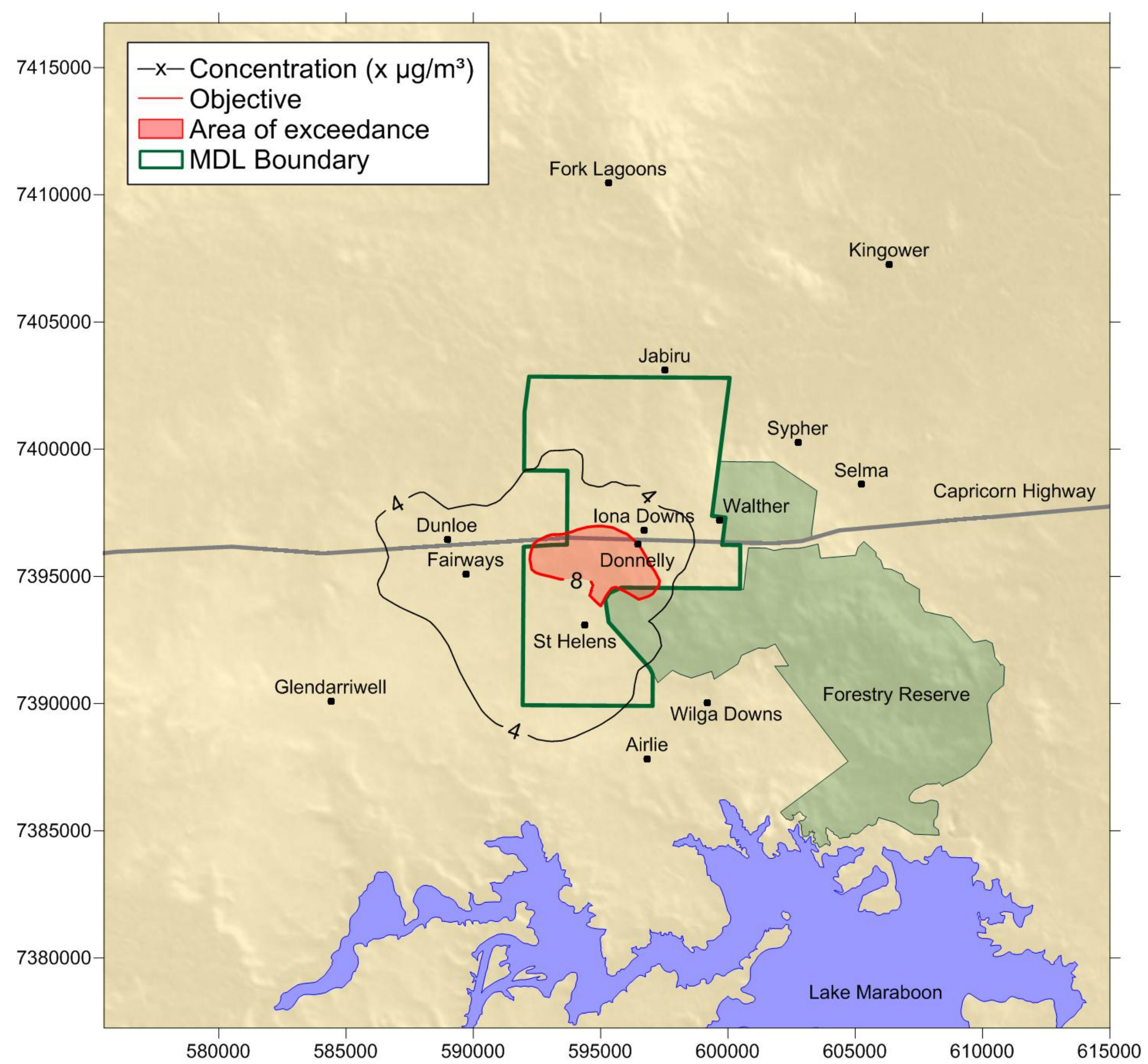

Figure 12 Predicted annual average ground-level concentrations of $PM_{2.5}$ in Year 2 of the Project, including a background

Location: Taroborah, QLD	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour Plot	**Objective:** 8 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

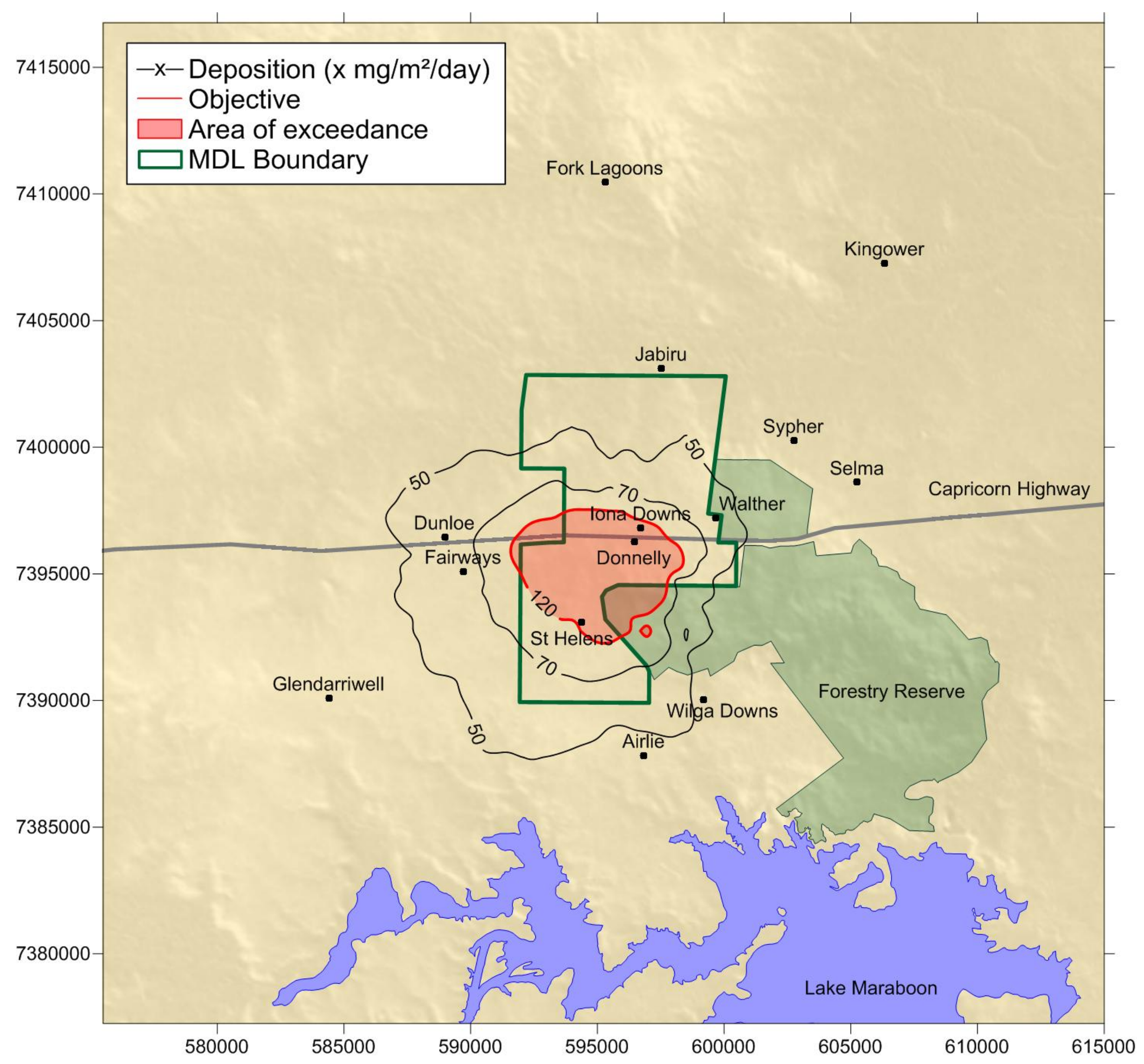

Figure 13 Predicted maximum monthly dust deposition in Year 2 of the Project, including background

Location: Taroborah, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** mg/m²/ day
Type: Contour plot	**Objective:** 120 mg/m²/day	**Prepared by:** A. Thomas	**Date:** November 2013

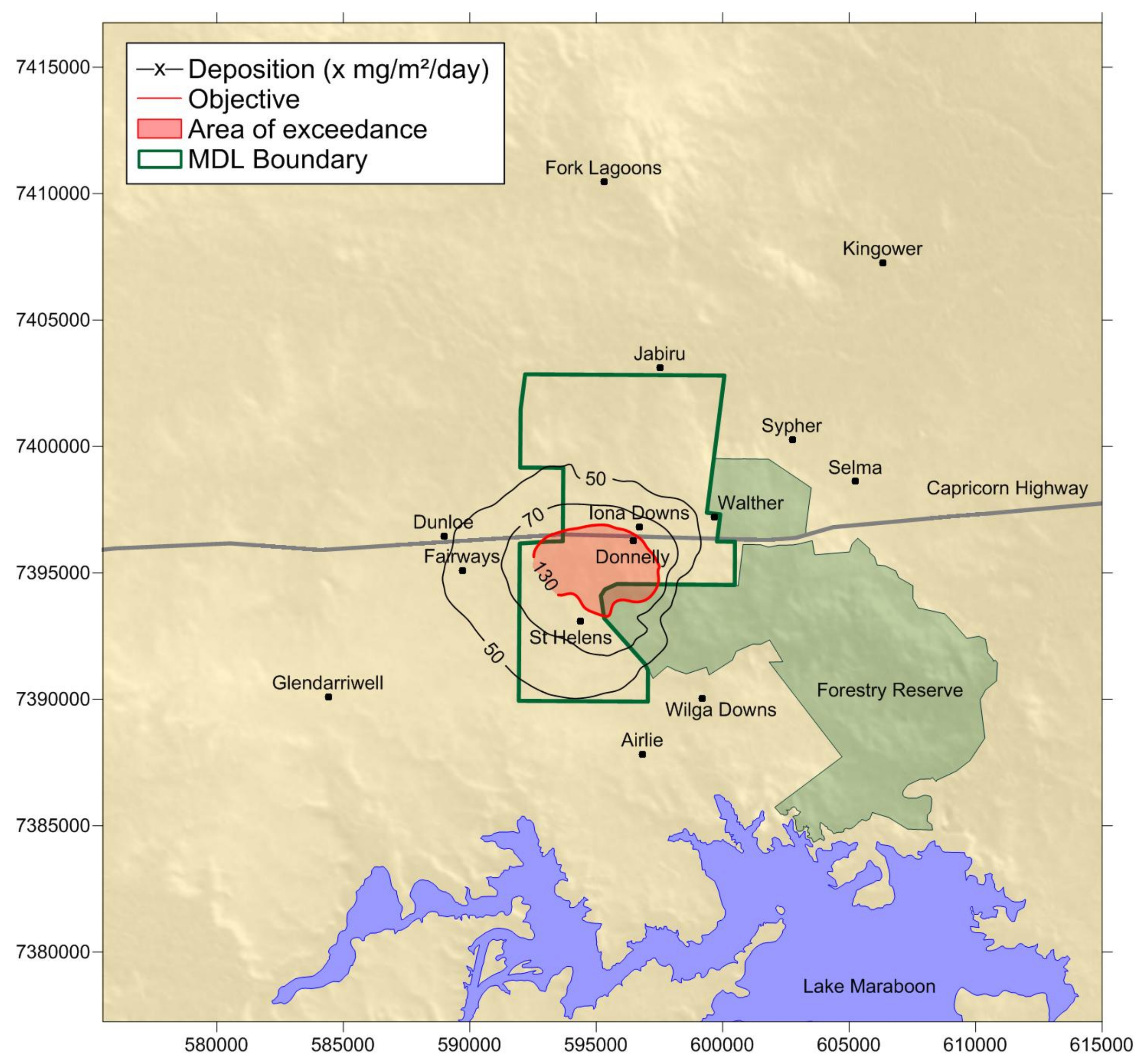

Figure 14 **Predicted annual average dust deposition rate in Year 2 of the Project, including background**			
Location: Taroborah, QLD	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/ day
Type: Contour plot	**Objective:** 130 mg/m²/day	**Prepared by:** A. Thomas	**Date:** November 2013

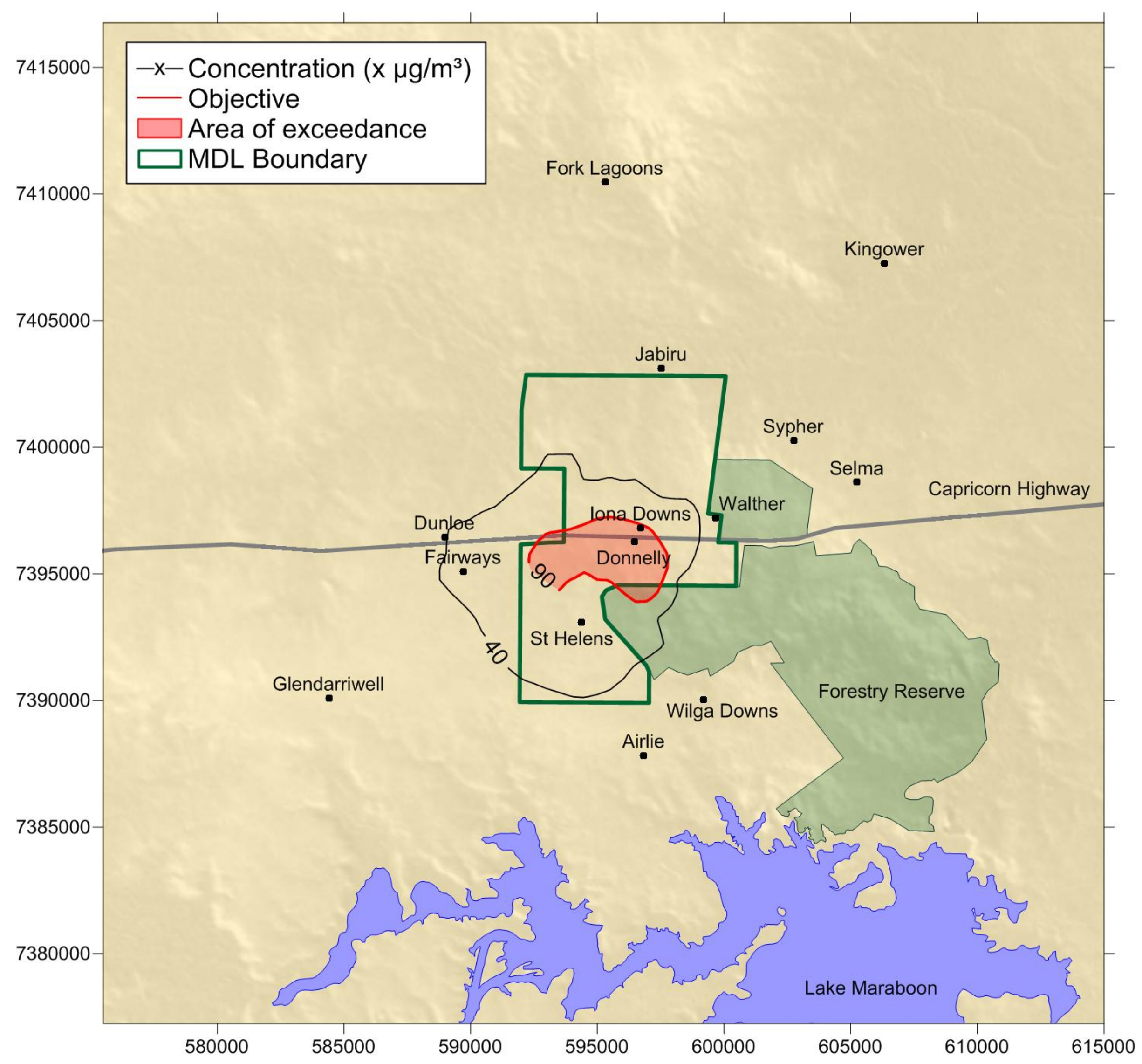

Figure 15 Predicted annual average ground-level concentrations of TSP in Year 5 of the Project, including a background

Location: Taroborah, QLD	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour Plot	**Objective:** 90 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

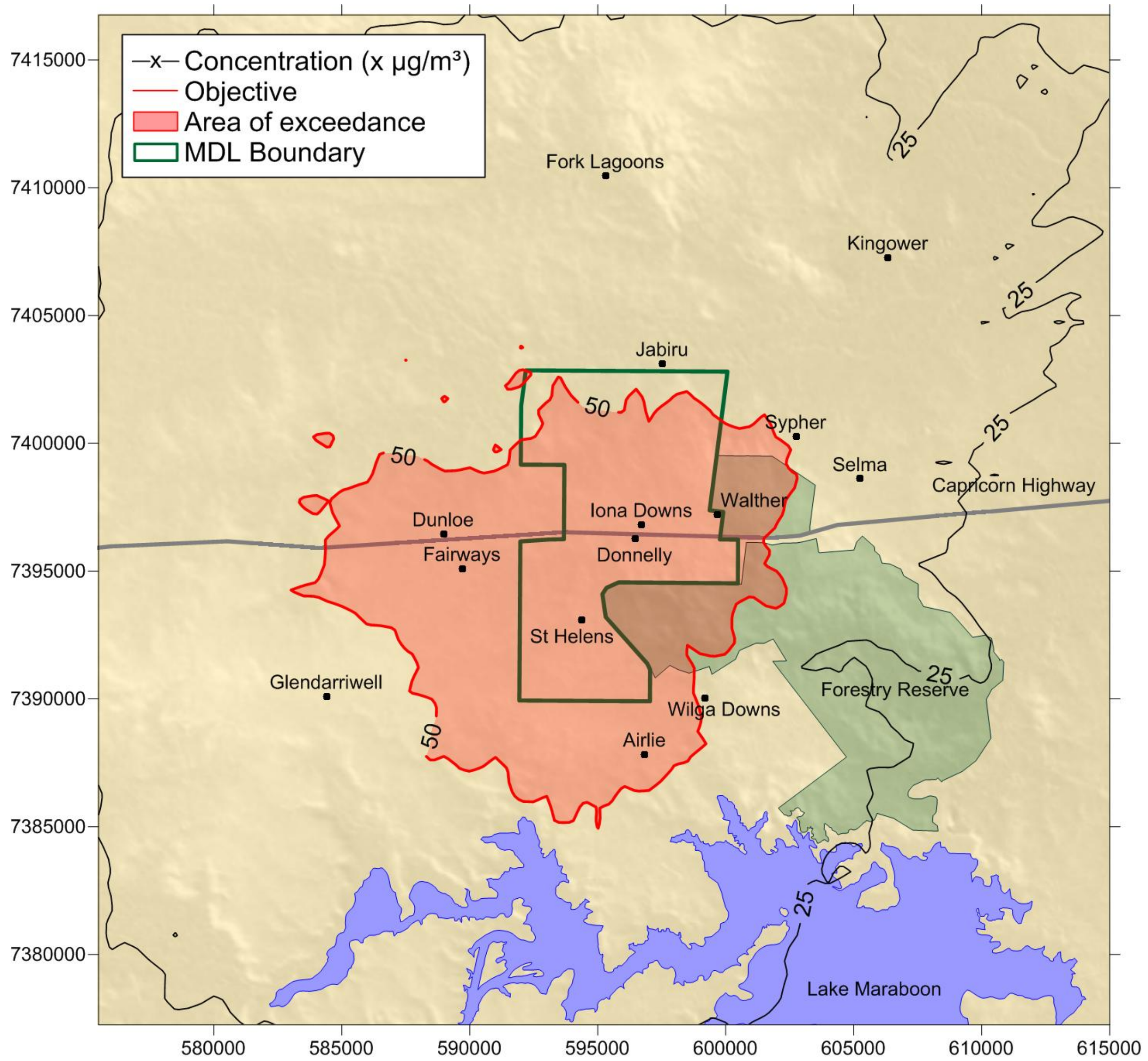

Figure 16	**Predicted 6th highest 24-hour average ground-level concentrations of PM_{10} in Year 5 of the Project, including a background**		
Location: Taroborah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: 6th highest contours	**Objective:** 50 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

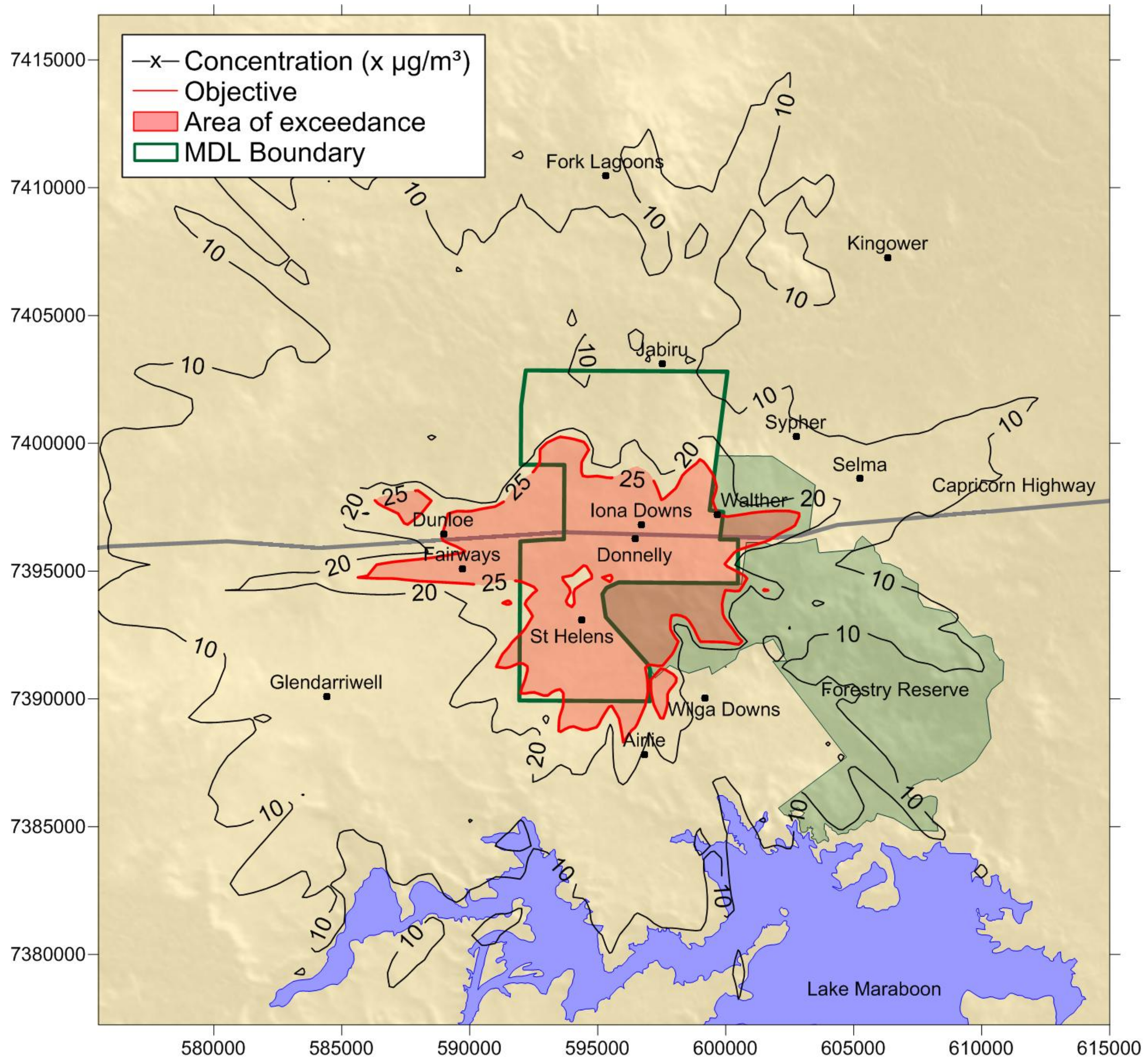

Figure 17	**Predicted maximum 24-hour average ground-level concentrations of $PM_{2.5}$ in Year 5 of the Project, including a background**		
Location: Taroborah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Maximum contours	**Objective:** 25 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

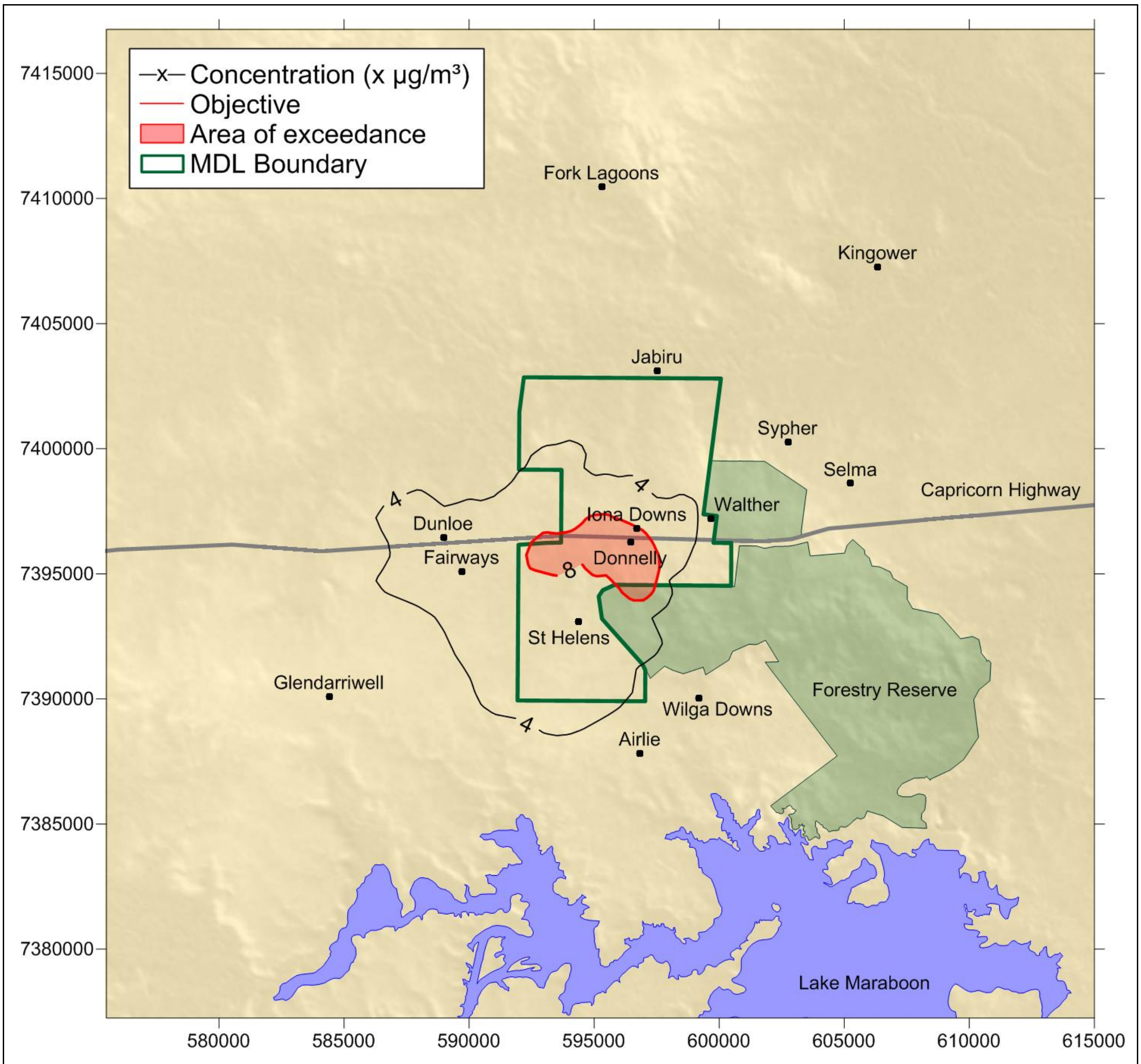

Figure 18 Predicted annual average ground-level concentrations of $PM_{2.5}$ in Year 5 of the Project, including a background

Location: Taroborah, QLD	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** µg/m³
Type: Contour Plot	**Objective:** 8 µg/m³	**Prepared by:** A. Thomas	**Date:** November 2013

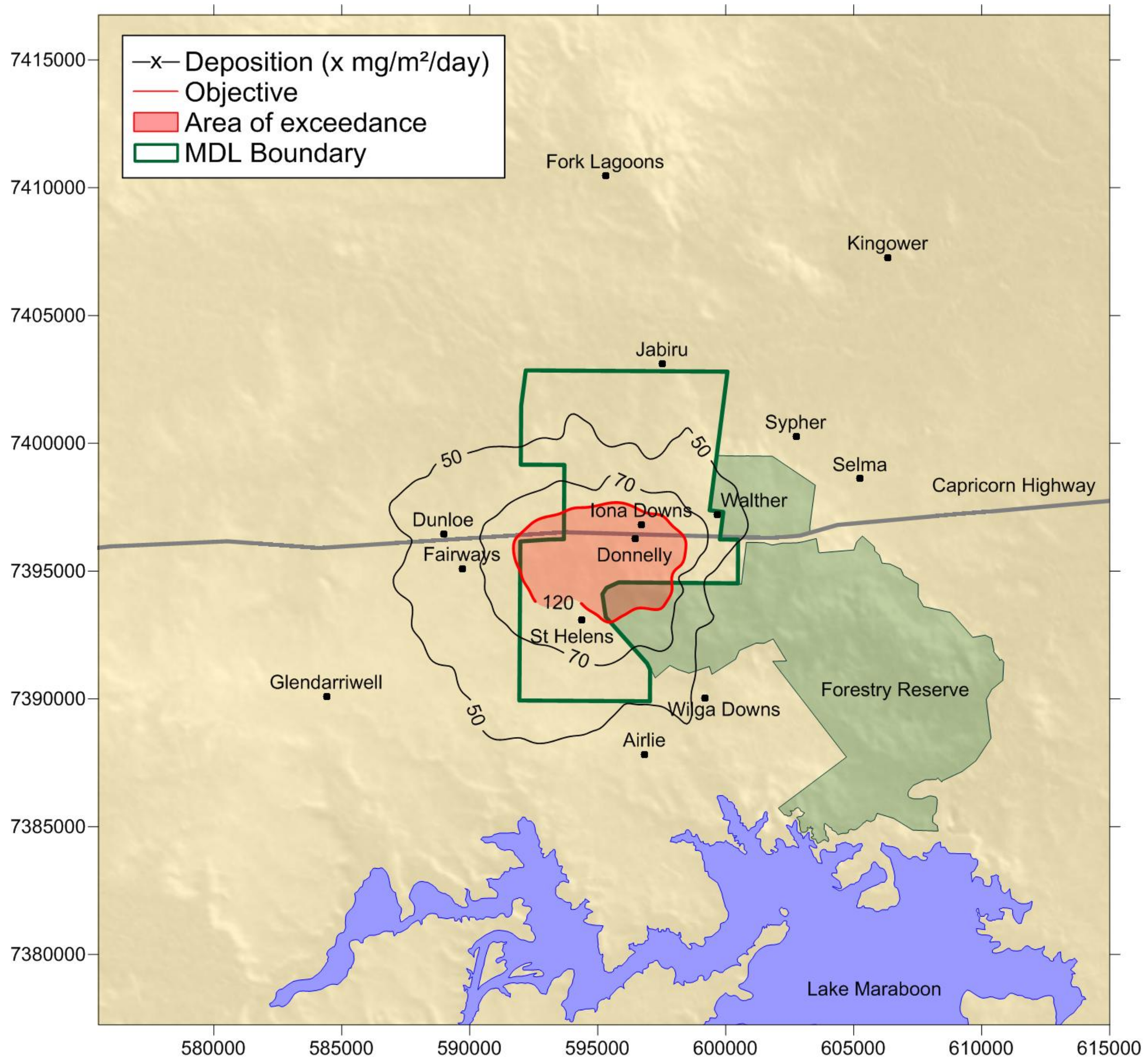

Figure 19 Predicted maximum monthly dust deposition in Year 5 of the Project, including background

Location: Taroborah, QLD	**Averaging period:** Monthly	**Data source:** CALPUFF	**Units:** mg/m²/ day
Type: Contour plot	**Objective:** 120 mg/m²/day	**Prepared by:** A. Thomas	**Date:** November 2013

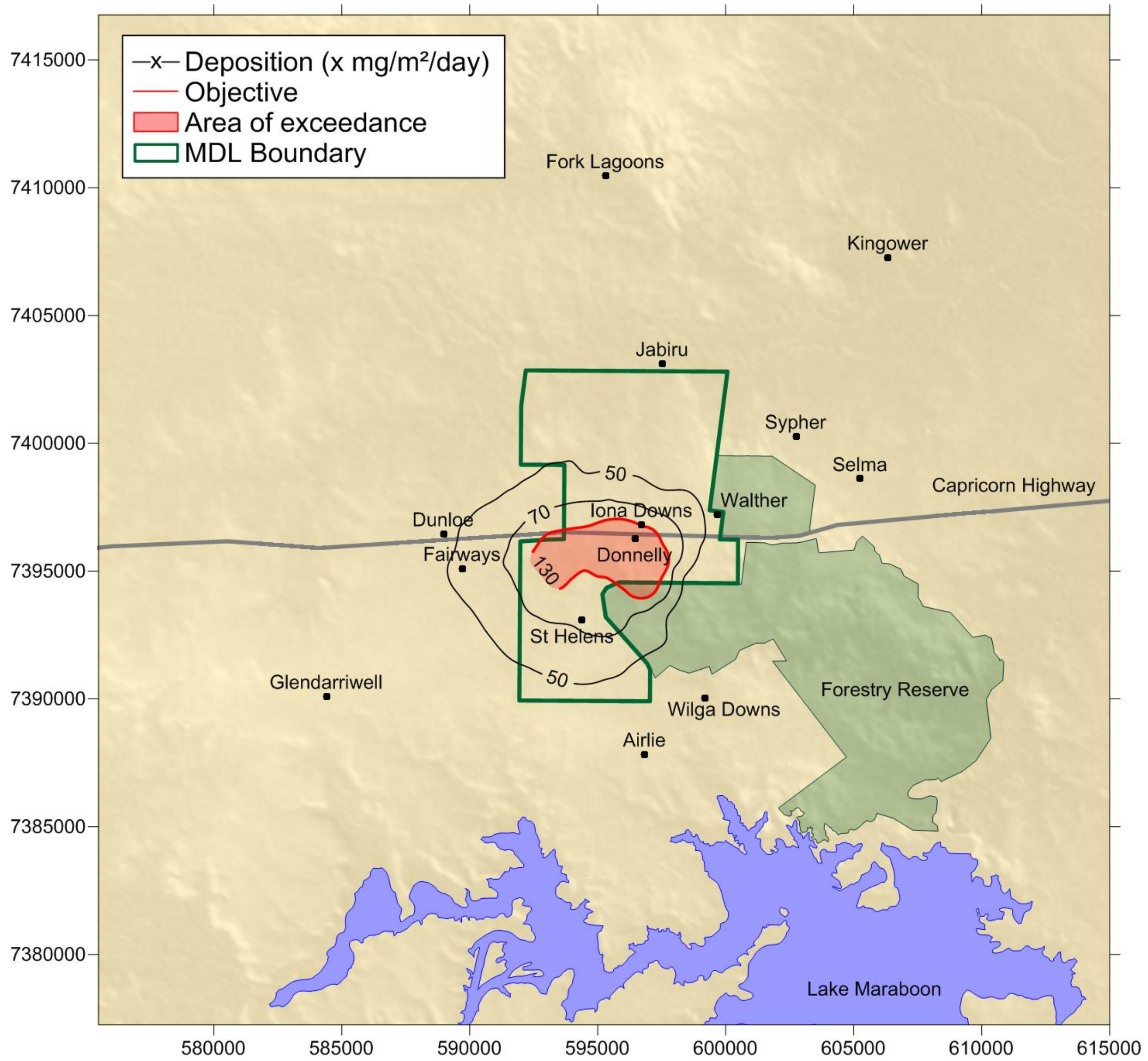

Figure 20 Predicted annual average dust deposition rate in Year 5 of the Project, including background

Location: Taroborah, QLD	**Averaging period:** Annual	**Data source:** CALPUFF	**Units:** mg/m²/ day
Type: Contour plot	**Objective:** 130 mg/m²/day	**Prepared by:** A. Thomas	**Date:** November 2013

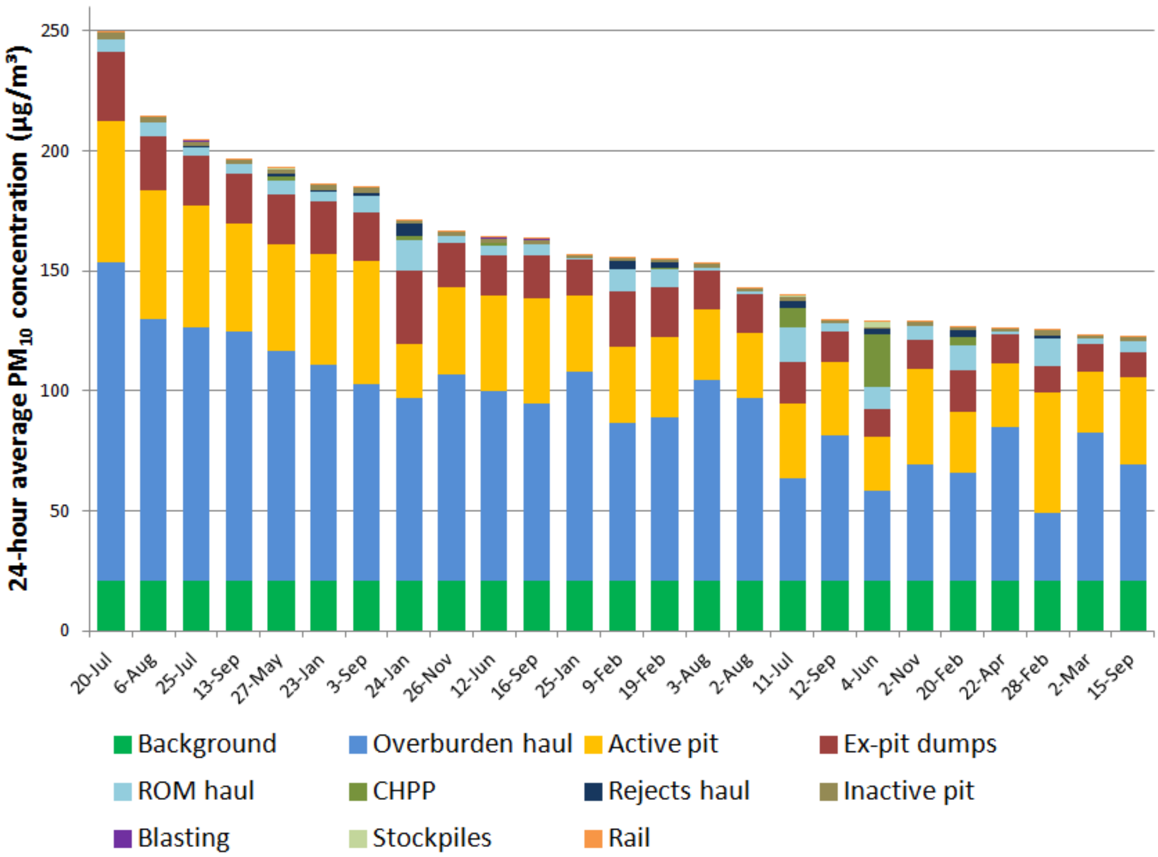

Figure 21	**Predicted 24-hour average PM_{10} concentration by source at St Helens for the 25 highest concentrations in Year 2 of the Project**		
Location: Taroborah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Stacked column graph	**Objective:** 50 µg/m³	**Prepared by:** M. Burchill	**Date:** February 2014

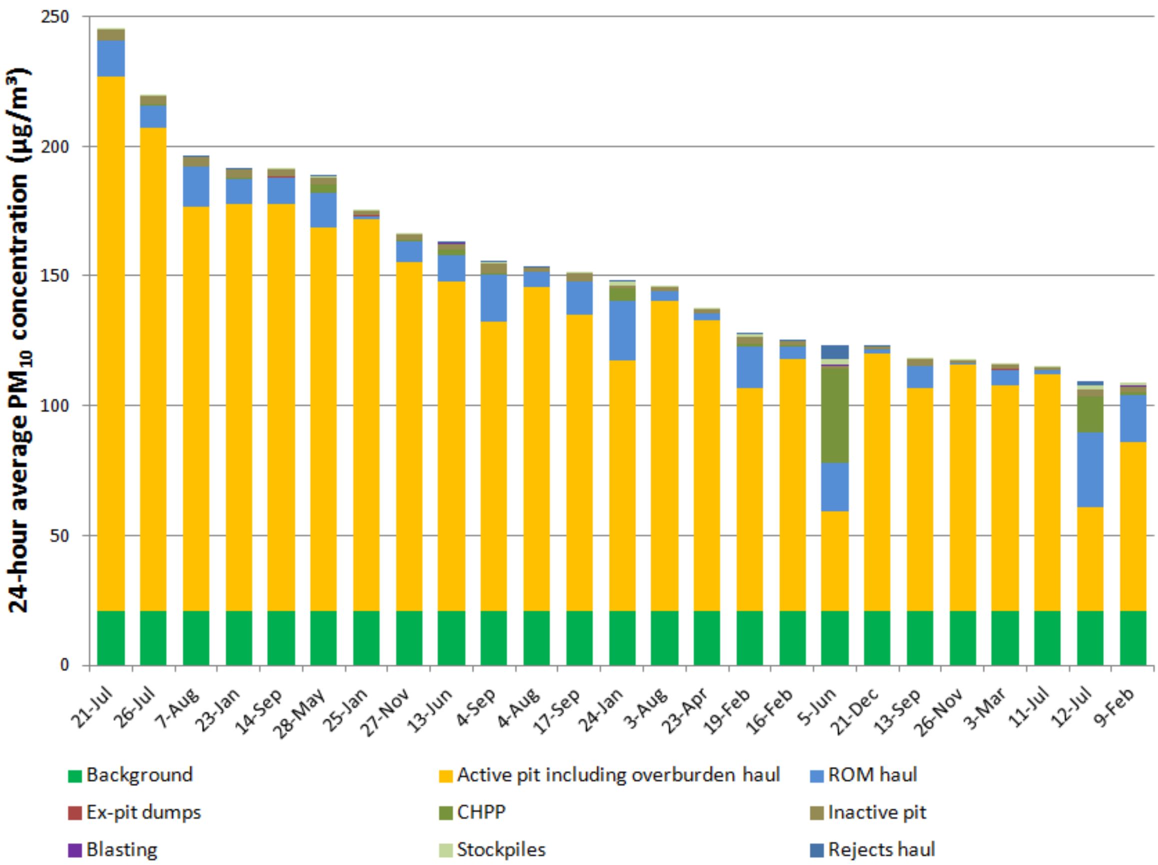

Figure 22 Predicted 24-hour average PM_{10} concentration by source at St Helens for the 25 highest concentrations in Year 5 of the Project

Location: Taroborah, QLD	**Averaging period:** 24-hour	**Data source:** CALPUFF	**Units:** µg/m³
Type: Stacked column graph	**Objective:** 50 µg/m³	**Prepared by:** M. Burchill	**Date:** February 2014

Appendix A
Air Dispersion Modelling

Contents

A1 Air dispersion modelling

The meteorological data for this study was generated by coupling TAPM, a prognostic mesoscale model to CALMET, a diagnostic meteorological model. The coupled TAPM/CALMET modelling system was developed by Katestone Environmental to enable high resolution modelling capabilities for regulatory and environmental assessments. The modelling system incorporates synoptic, mesoscale and local atmospheric conditions, detailed topography and land use categorisation schemes to simulate synoptic and regional scale meteorology for input into pollutant dispersion models, such as CALPUFF. Details of the model configuration and evaluation are supplied in the following sections.

A1.1 TAPM

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.5, was developed by the CSIRO and has been validated by the CSIRO, Katestone Environmental and others for many locations in Australia, in southeast Asia and in North America (see www.cmar.csiro.au/research/tapm for more details on the model and validation results from the CSIRO). Katestone Environmental has used TAPM throughout Australia as well as in parts of New Caledonia, Bangladesh, America and Vietnam. This model has performed well for simulating regional meteorological conditions. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM is a prognostic meteorological model which predicts the flows important to regional and local scale meteorology, such as sea breezes and terrain-induced flows from the larger-scale meteorology provided by the synoptic analyses. TAPM solves the fundamental fluid dynamics equations to predict meteorology at a mesoscale (20 km to 200 km) and at a local scale (down to a few hundred metres). TAPM includes parameterisations for cloud/rain micro-physical processes, urban/vegetation canopy and soil, and radiative fluxes.

TAPM requires synoptic meteorological information for the study region. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 m to 5 km above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM was configured as follows:

- Mother domain of 30 km with 3 nested daughter grids of 10 km 3 km and 1 km
- 50 x 50 grid points for all modelling domains resulting in a 50 x 50 km grid at 1 km resolution
- 25 vertical levels; from the surface up to an altitude of 8000 metres above ground level
- AUSLIG 9 second DEM terrain data
- The TAPM defaults for sea surface temperature and land use
- Default options selected for advanced meteorological inputs
- Year modelled; 1 January 2009 to 31 December 2009

A1.2 CALMET

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

CALMET (version 6.327) was used to simulate meteorological conditions in the study region. The CALMET simulation was initialised with the gridded TAPM three-dimensional wind field data from the innermost grid (250 m resolution). CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and three-dimensional divergence minimisation.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 80 by 80 grid points at 500 metre spacing
- Twelve vertical levels set at 20 m, 60 m, 100 m, 150 m, 200 m, 250 m, 350 m, 500 m, 800 m, 1600 m, 2600 m and 4600 m
- 365 days (1 January 2009 to 31 December 2009)
- Prognostic wind fields generated by TAPM input as MM5/3D.dat at surface and upper air for "initial guess" field

A1.3 CALPUFF

The CALPUFF dispersion model utilises the three-dimensional wind fields from CALMET to simulate the dispersion of air pollutants to predict ground-level concentrations across a gridded domain. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

CALPUFF (version 6.267) was used to simulate the dispersion characteristics and concentrations of pollutants generated by the proposed activities. Hourly varying meteorological conditions were obtained from CALMET at a grid resolution of 500 metres.

The dispersion model has been used to simulate the dispersion characteristics and pollutant concentration on a gridded receptor network corresponding to the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 80 by 80 grid points at 500 metre spacing
- 365 days (1 January 2009 to 31 December 2009)
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables
- Minimum turbulence velocity of sigma-v over land set to 0.2 m/s
- Minimum wind speed allowed for non-calm conditions set to 0.2 m/s
- Gridded receptor network corresponding to domain setting

All other options are set to default.

Appendix B

Methodology for Calculating Dust Emissions from Individual Emission Sources

Contents

Tables

B1 Conveyor emissions

Dust emissions from conveyors are wind speed dependent with stronger wind speeds causing dust particles to be entrained by the wind. The emission factor has been calculated from data reported by GHD-Oceanics (1975) for a measured conveyor TSP emission rate of 0.031 g/s/m at a wind speed of 10 m/s. The emission factor has been corrected to the mean wind speed at the project site using the following equation (derived from Witt, 1999):

$$EF_{TSP} = 0.031 \times 0.2 \times \frac{0.00006 \times U^2 - 0.0002 \times U^2 + 0.0001}{0.00006 \times 10^2 - 0.0002 \times 10^2 + 0.0001} g/m/s$$

where:

EF_{TSP}	=	emission factor for TSP (g/m/s)
U	=	mean wind speed (m/s)

The factor 0.2 is used to account for the difference in particle size distribution between particulate matter sampled in the GHD Oceanics study and the normal TSP size fraction of $PM_{30\text{-}50}$.

Of TSP emissions, 47% are estimated to be PM_{10} and 7% of TSP emissions are estimated to be $PM_{2.5}$. The particulate matter distribution is based on size ratios of dust emitted from transfers.

This emission factor is then multiplied by the length of the conveyor and the control factor for each conveyor, assuming 100% utilisation factor of each conveyor. It has been assumed that the conveyors are partially enclosed, providing an overall control efficiency of 40%.

B2 Transfer points

Transfer points are locations where coal or overburden is transferred from a haul truck to stockpile, from one conveyor to another or through a transfer station including surge bins and train loading.

The emission rates for overburden transfer points were calculated using the following equation (AP42, 2006A):

$$E = k \times 0.0016 \left(\frac{U}{2.2}\right)^{1.3} \left(\frac{M}{2}\right)^{-1.4} kg/Mg$$

where:

k	=	0.74 for particles less than 30 µm
	=	0.35 for particles less than 10 µm
	=	0.053 for particles less than 10 µm
U	=	mean wind speed (m/s)
M	=	material moisture content (%) with a moisture content of 7.9% adopted in this study for overburden

The emission rates for coal transfer points were calculated using the following equation (AP42, 2006A):

$$E = \frac{k}{M^a} kg/Mg$$

where:

k	=	0.58 for particles less than 30 µm
	=	0.045 for particles less than 10 µm
	=	0.011 for particles less than 2.5 µm
a	=	1.2 for particles less than 30 µm
		0.9 for particles less than 10 µm
		1.2 for particles less than 2.5 µm
M	=	material moisture content (%) with a moisture content of 12% adopted in this study for ROM coal, and 15% for product coal

B3 Bulldozing

The emission rate for bulldozing overburden has been calculated using the following equation for TSP (USEPA, 1998):

$$E = \frac{k \times s^a}{M^b} \quad kg/hr$$

where:

k	=	2.6 for particles less than 30 µm
	=	0.338 for particles less than 10 µm
	=	0.273 for particles less than 2.5 µm
a	=	1.2 for particles less than 30 µm
	=	1.5 for particles less than 10 µm
	=	1.2 for particles less than 2.5 µm
b	=	1.3 for particles less than 30 µm
	=	1.4 for particles less than 10 µm
	=	1.3 for particles less than 2.5 µm
s	=	silt content (6.9%)
M	=	material moisture content (7.9%)

It was assumed that the bulldozers operate for 12 hours/day.

B4 Wind erosion of stockpiles

The emission rate of dust from the stockpiles has been calculated using the following equation for TSP (USEPA, 1998):

For active stockpiles:

$$E = 1.8u\left(\frac{365-d}{365}\right) kg/ha/year$$

For exposed areas:

$$E = 0.85\left(\frac{365-d}{365}\right) Mg/ha/year$$

where:

u	=	average windspeed (m/s)
d	=	number of days per year with rainfall greater than 0.25mm

The fraction of PM_{10} and $PM_{2.5}$ in TSP are 50% and 7.5% respectively. These fractions were taken from AP42 Chapter 13.2.5.

B5 Haul roads

The dust emission rate from haul roads has been calculated using the following equation (USEPA, 2006C):

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

where:

k	=	4.9 for particles less than 30 µm
	=	1.5 for particles less than 10 µm
	=	0.15 for particles less than 2.5 µm
s	=	surface material silt content
W	=	mean vehicle weight (tons)
a	=	0.7 for particles less than 30 µm
	=	0.9 for particles less than 10 µm
	=	0.9 for particles less than 2.5 µm
b	=	0.45

B6 Graders

The dust emission rate from grading has been calculated using the following equation for TSP (USEPA, 1998):

$$E = k \times S^a$$

where:

S	=	mean vehicle speed (km/hr)
k	=	0.0034 for particles less than 30 µm
	=	0.0034 for particles less than 10 µm
	=	0.0001 for particles less than 2.5 µm
a	=	2.5 for particles less than 30 µm
	=	2.0 for particles less than 10 µm
	=	2.5 for particles less than 2.5 µm

B7 Drilling

The emission rate for drilling on overburden has been calculated using the following equation for TSP (USEPA, 1998):

$$E = 0.59 \quad kg/hole$$

The fraction of PM_{10} and $PM_{2.5}$ in TSP are 52% and 3% respectively. These fractions were taken from AP42 Chapter 11.9.

B8 Blasting

The emission rate for blasting on overburden has been calculated using the following equation for TSP (USEPA, 1998):

$$E = 0.00022\,(A)^{1.5}$$

where:

A	=	Horizontal area blasted (m^2)

The fraction of PM_{10} and $PM_{2.5}$ in TSP are 52% and 3% respectively. These fractions were taken from AP42 Chapter 11.9.

Blasting was assumed to occur during daylight hours only.

B9 Operations data

Table B1 Data inputs to the air quality emissions estimation

Parameter	Unit	Year 2	Year 5
Operation			
Production year		2	5
Year (ending December)		2019	2022
Open-cut Activities			
ROM coal	Mtpa	1.46	2.18
Product coal	Mtpa	1.24	1.93
Total waste	m³	16,383,489	29,962,033
Total overburden	bcm	13,002,112	23,851,677
Total overburden	Mtpa	29.9	54.9
Overburden density	t/bcm	2.30	2.30
Total holes drilled per year	#	7,739	13,563
Total blasts per year	#	99	174
Area per blast	m²	4,500	4,500
West Pit Activities			
ROM coal	Mtpa	1.46	2.18
Overburden	bcm	13,002,112	23,851,677
Overburden	Mtpa	31.40	54.9
Exposed Pit Area	ha	31.34	28.00
In-Pit Dumping Area - active	ha	28.32	16.22
In-Pit Dumping Area - inactive	ha	28.23	57.67
Rehabilitated Area	ha	0.00	55.21
Total holes drilled per year	#	7,739	13,563
Total blasts per year	#	99	174
Split of material between mining cells			`
Mining Cell W1 (Yr2)	%	35.1%	
Mining Cell E1 (Yr2, Yr5)	%	32.5%	50%
Mining Cell E2 (Yr2, Yr5)	%	32.5%	50%
Overburden waste swell factor	-	1.25	1.25
Rejects swell factor	-	1.20	1.20
Overburden fraction of Waste	-	0.87	0.87
Waste Dumped to:			
In-Pit West (Overburden)	m³	2,028,828	25,932,729
In-Pit West (Interburden)	m³	303,695	3,881,867
In-pit West (Rejects)	m³		147,437
Ex-Pit Southeast	m³	8,833,436	
Ex-Pit Southwest	m³		
Ex-Pit Northwest (Overburden)	m³	5,086,682	
Ex-Pit Northwest (Rejects)	m³	130,849	
Waste Dumped to:			
In-Pit West (Overburden)	Mtpa	3.7	47.7
In-Pit West (Interburden)	Mtpa	0.6	7.1
In-Pit West (Rejects)	Mtpa		0.3
Ex-Pit Southeast	Mtpa	16.3	
Ex-Pit Southwest	Mtpa		
Ex-Pit Northwest (Overburden)	Mtpa	9.4	
Ex-Pit Northwest (Rejects)	Mtpa	0.3	
Waste stockpile areas			
Ex-Pit Southeast - Active	m²	367,634	0
Ex-Pit Southeast - Inactive	m²	0	367,634
Ex-Pit Southwest - Active	m²	0	0
Ex-Pit Southwest - Inactive	m²	167,963	167,963
Ex-Pit Northwest - Active	m²	292,804	0
Ex-Pit Northwest - Inactive	m²	0	292,804

Parameter	Unit	Year 2	Year 5
Bulldozing operating hours	hours/day	60	60
Underground Operations			
Underground ROM coal	Mtpa	0.00	0.098
Underground product coal	Mtpa	0.00	0.097
Conveyor length (portal to ROM stockpile)	m		1809
Meteorology			
Number of rain days above 0.25 mm	days	52	52
% of time wind speed greater than 5.4 m/s at 10 m height	%	20	20
Average wind speed at 10 m height	m/s	3.9	3.9
Wind speed corrected for conveyors	m/s	0.0567	0.057
Material Characteristics			
Silt Content - Coal (ROM/Product)	%	8.6	8.6
Moisture content - ROM	%	12	12
Moisture content - Product	%	15	15
Overburden silt content	%	6.9	6.9
Overburden moisture content	%	7.9	7.9
Haul Roads			
Silt content	%	8.4	8.4
tonnes to tons conversion		1.102	1.102
Haul Trucks - Overburden			
Truck type		Cat 789	Cat 789
Capacity	t	190	190.0
Actual truck load	t	179.7	179.7
Empty operating weight	t	140.9	140.9
Average truck mass	t	230.7	230.7
Number of trucks		13	14
Western Pit - InPit Dump of Overburden			
Distance per trip (one way) – W1	m	1365	
Distance per trip (one way) – E1	m	1052	1345
Distance per trip (one way) – E2	m	1552	870
Number of trips (total)	#	20,779	265,599
Total vehicle kilometres travelled (VKT) – W1	km	19,893	0
Total vehicle kilometres travelled (VKT) – E1	km	14,192	357,311
Total vehicle kilometres travelled (VKT) – E2	km	20,934	231,171
Western Pit - InPit Dump of Interburden			
Distance per trip (one way) – W1	m	116	
Distance per trip (one way) – E1	m	150	174
Distance per trip (one way) – E2	m	113	140
Number of trips (total)	#	3,110	39,758
Total vehicle kilometres travelled (VKT) – W1	km	253	0
Total vehicle kilometres travelled (VKT) – E1	km	302	13,857
Total vehicle kilometres travelled (VKT) – E2	km	228	11,157
exPit Waste Dump			
Distance per trip (one way) - In Pit– W1	m	591.3	0
Distance per trip (one way) - In Pit– E1	m	424.3	0
Distance per trip (one way) - In Pit– E2	m	323.1	0
Distance per trip (one way) - Out of Pit A	m	875.1	0
Distance per trip (one way) - Out of Pit B	m	3167.8	0
Number of trips (total)	#	90,471	0
Total vehicle kilometres travelled (VKT) - In Pit– W1	km	37,523	0
Total vehicle kilometres travelled (VKT) - In Pit– E1	km	24,922	0
Total vehicle kilometres travelled (VKT) - In Pit– E2	km	18,981	0
Total vehicle kilometres travelled (VKT) - Out of Pit A	km	55,529	0
Total vehicle kilometres travelled (VKT) - Out of Pit B	km	372,170	0
Haul Trucks – ROM/Rejects (ROM trucks haul rejects on return journey)			

Parameter	Unit	Year 2	Year 5
Truck type		Cat 777	Cat 777
Capacity	t	90	90.0
Actual truck load	t	88.27	88.3
Empty operating weight	t	74.3	74.3
Average truck mass - ROM haul	t	118.5	118.5
Average truck mass - ROM haul (one-way from pit to OC ROM SP)	t	118.5	118.5
Average truck mass - rejects haul	t	162.6	162.6
Average truck mass - empty (returning from rejects dump to W1)	t	112.0	84.3
Number of trucks	#	2	3
Distance per trip (one way) - In Pit– W1	m	591.3	0
Distance per trip (one way) - In Pit– E1	m	424.3	366.1
Distance per trip (one way) - In Pit– E2	m	323.1	540.5
Distance per trip (one way) - Out of Pit A	m	1579.8	
Distance per trip (one way) - Out of Pit B	m	3160.0	3510.0
Distance per trip (one way) - ROM stockpile to ex-pit rejects dump	m	2836	
Distance per trip (one way) - Ex-pit rejects dump to Mining Cell W1	m	875	
Distance per trip (one way) - OC ROM stockpile to rejects bin	m		327
Number of trips (total)	#	16,501	24,670
Total vehicle kilometres travelled (VKT) - In Pit– W1	km	6,844	
Total vehicle kilometres travelled (VKT) - In Pit– E1	km	4,546	9,031
Total vehicle kilometres travelled (VKT) - In Pit– E2	km	3,462	13,334
Total vehicle kilometres travelled (VKT) - Out of Pit A	km	9,142	
Total vehicle kilometres travelled (VKT) - Out of Pit B	km	67,712	86,591
Total VKT: OC ROM stockpile/rejects bin to ex-pit rejects dump	km	16,410	
Total VKT: Empty trucks from ex-pit rejects dump to pit	km	5,063	
Total VKT: OC ROM stockpile to rejects bin	km		8,067
Haul Trucks - Rejects			
Truck type		Cat 777	Cat 777
Capacity	t	90	90
Actual truck load	t	88.3	88.3
Empty operating weight	t	74.3	74.3
Average truck mass	t	118.5	118.5
Haul Roads - Graders			
Number of graders	#	2.0	3.0
Grader average speed	km/hr	12.0	12.0
Operating hours per grader per year	hrs/year	4289.0	4,289.0
Total distance travelled	VKT	102,936	154,404
CHPP			
ROM coal to Sizing Station (Open-cut and Underground)	Mtpa	1.46	2.28
ROM coal bypassed	Mtpa	0.87	1.45
ROM coal to Wash Plant	Mtpa	0.59	0.83
Product coal from Wash Plant	Mtpa	0.37	0.49
Rejects from CHPP	Mtpa	0.22	0.25
Conveyor lengths			
Conveyor from OC ROM stockpile to CHPP	m	150	150
Conveyor from secondary sizer to the CHPP bypass/CHPP feed split	m	138	138
Conveyor from ROM stockpile (bypassing CHPP) to Product stockpile	m	306	306
Conveyor which feeds the CHPP	m	281	281
Conveyor from CHPP to Product stockpile	m	288	288

Parameter	Unit	Year 2	Year 5
Conveyor to rejects bin length	m	131	131
Stockpile areas			
ROM stockpile area	m²	3769	3769
UG ROM stockpile area	m²	0	7121
CHPP feed stockpile area	m²	1523	1523
Product stockpile area	m²	9632	9632
Topsoil Stockpile Areas			
topsoil dump 1	m²	39,258	39258
topsoil dump 2	m²	33,012	33012
topsoil dump 3	m²	63,268	63268
topsoil dump 4	m²	34,628	34628
Screen Dump Area	m²	146,142	146142
Train Load Out			
Total Product loaded	Mtpa	1.24	2.03
Conveyor from Product stockpile to train loadout	m	181	181
Rail line			
Number of trains per day	#	0.69	1.12
Number of wagons per train	#	90	90
Length of wagon	m	16	16
Width of wagon	m	3	3
Area of wagon	m²	48	48
Total Area per Train	m²	4320	4320
Train Residence time on rail loop	minutes	90	90
Equivalent area	ha	0.019	0.030
Train Residence time on straight section of track	minutes	15	15
Equivalent area	ha	0.003	0.005

Table B2 Control factors applied to the emissions

Activity	Control Factor	Control
Unpaved haul roads	50%	Level 1 watering of haul roads
Sizing, crushing, transfers and conveyors at CHPP	40%	Partially enclosed
Wind erosion of screen dump, topsoil stockpiles and inactive stockpiles	99%	Rehabilitation
Train loading- conveyor	40%	Partially enclosed
Conveyors associated with underground mining	40%	Partially enclosed

B10 Estimated dust emission rates

Table B3 Estimated dust emission rates for operation of the project in Year 2 and Year 5

Activity	Year 2 Emission rate (g/s)			Year 5 Emission rate (g/s)		
	TSP	**PM_{10}**	**$PM_{2.5}$**	**TSP**	**PM_{10}**	**$PM_{2.5}$**
Open-cut pit activities	**3.0**	**1.6**	**0.3**	**4.7**	**2.5**	**0.4**
Drilling	0.1	0.1	0.004	0.1	0.1	0.01
Blasting	0.2	0.2	0.01	0.4	0.4	0.02
Overburden - Excavation	0.2	0.2	0.02	0.3	0.3	0.05
Overburden - Bulldozing	0.6	0.2	0.13	0.6	0.2	0.13
Overburden - Transfer to truck	0.2	0.2	0.02	0.3	0.3	0.05
Coal - Excavation	0.7	0.2	0.03	1.0	0.3	0.04
Coal - Transfer to truck	0.7	0.2	0.03	1.0	0.3	0.04
Wind erosion	0.4	0.3	0.05	0.3	0.3	0.05
In-pit waste dumping	0.05	0.02	0.004	0.6	0.3	0.05
Haul Roads	**77.3**	**23.9**	**2.4**	**79.2**	**27.9**	**2.9**
Overburden to InPit	5.2	1.9	0.2	55.5	20.6	2.1
Interburden to InPit	0.1	0.03	0.003	2.4	0.9	0.1
Overburden to ExPit East	58.9	18.1	1.8			
ROM to ROM stockpile	8.7	2.5	0.2	10.4	3.1	0.3
Rejects	1.9	0.5	0.1	7.6	2.2	0.2
Graders	2.5	0.8	0.1	3.3	1.2	0.1
Conveyors	0.4	0.1	0.01	1.6	0.4	0.05
CHPP	6.6	1.2	0.1	10.3	1.8	0.2
Wind erosion of stockpiles	10.3	5.1	0.8	3.4	1.7	0.3
Train Loading	1.8	0.3	0.03	2.9	0.5	0.1
Rail line	0.005	0.002	0.000	0.01	0.004	0.001
Total	***99.3***	***32.2***	***3.7***	***102.1***	***34.8***	***3.9***

B11 References

GHD Oceanics, 1975. Hay Point Environmental Planning Study, report to the Queensland Coordinator General.

United States Environmental Protection Agency (US EPA) 1998, “Western Surface Coal Mining”, AP-42 Chapter 11.9 Appendix F, US EPA Office of Air Quality Planning and Standards

United States Environmental Protection Agency (US EPA) 2006A, “Aggregate Handling and Storage Piles”, AP-42 Chapter 13.2.4, US EPA Office of Air Quality Planning and Standards

United States Environmental Protection Agency (US EPA) 2006B, “Industrial Wind Erosion”, AP-42 Chapter 13.2.5, US EPA Office of Air Quality Planning and Standards

United States Environmental Protection Agency (US EPA) 2006C, “Unpaved Roads”, AP-42 Chapter 13.2.2, US EPA Office of Air Quality Planning and Standards

Witt P, Carey K and Nguyen T 1999, Prediction of dust loss from conveyors using CFD modeling, Second International Conference on CFD in the Minerals and Process Industries, CSIRO, Melbourne