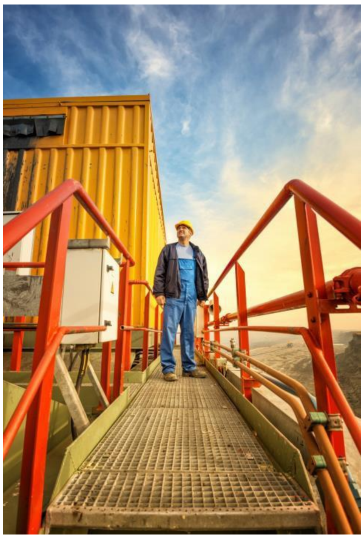

Taroborah Coal Project

Environmental Impact Statement

Section 4.6 – Environmental Values and Management of Impacts – Air Quality

Prepared for:

Shenhuo International Group Pty Ltd

AustralAsian Resource Consultants

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4.6 AIR QUALITY

Potential air quality impacts associated with the proposed mining operations of the Project were assessed by Katestone Environmental Pty Ltd (Katestone). Background concentrations of applicable pollutants were assessed during a five-month monitoring program, and dispersion modelling was employed to provide an assessment of the likely impacts of the Project on air quality values. The full Katestone report is included as Appendix 15. The following sections provide a pertinent synopsis of that report.

4.6.1 Description of Environmental Values

4.6.1.1 Local Meteorology

The following site specific meteorological data has been generated from a three-dimensional meteorological dataset using the prognostic model TAPM (developed by CSIRO, version 4.0.4, 2008) and the diagnostic meteorological model CALMET (developed by EarthTech, version 6.327, 2010).

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 (Katestone 2013).

The annual, diurnal and seasonal distributions of winds at the Project site are presented as wind roses in Figure 4.96 to Figure 4.98. These wind roses indicate the predominant winds are from the north-northeast through the east to the southeast.

The diurnal wind roses 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 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.

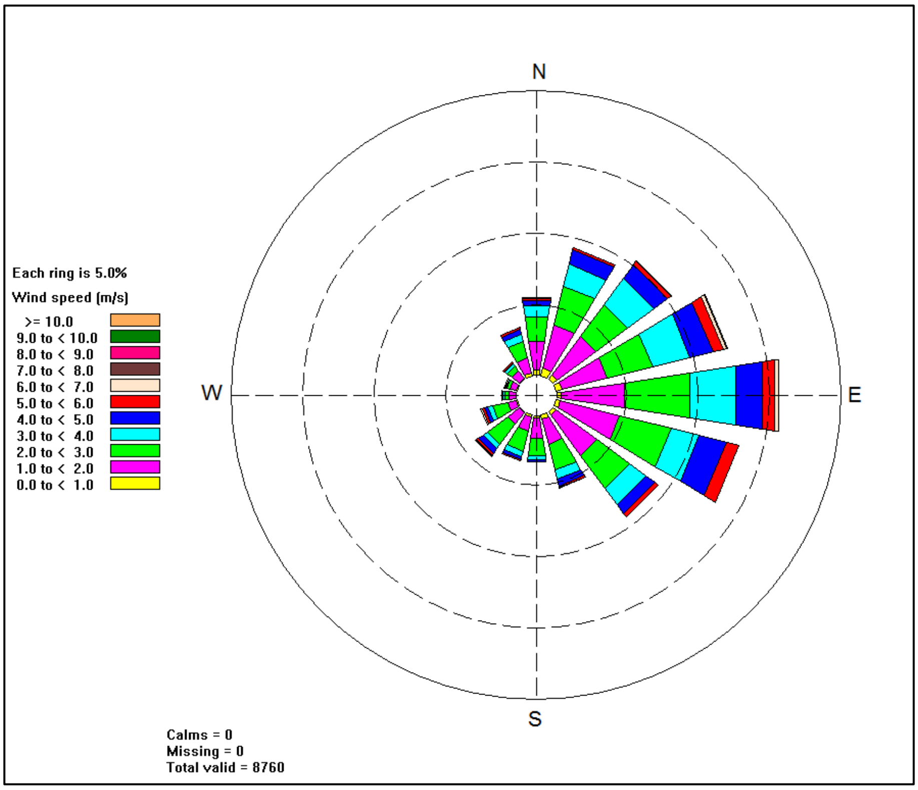

Figure 4.96 Annual distributions of modelled winds at the Project site

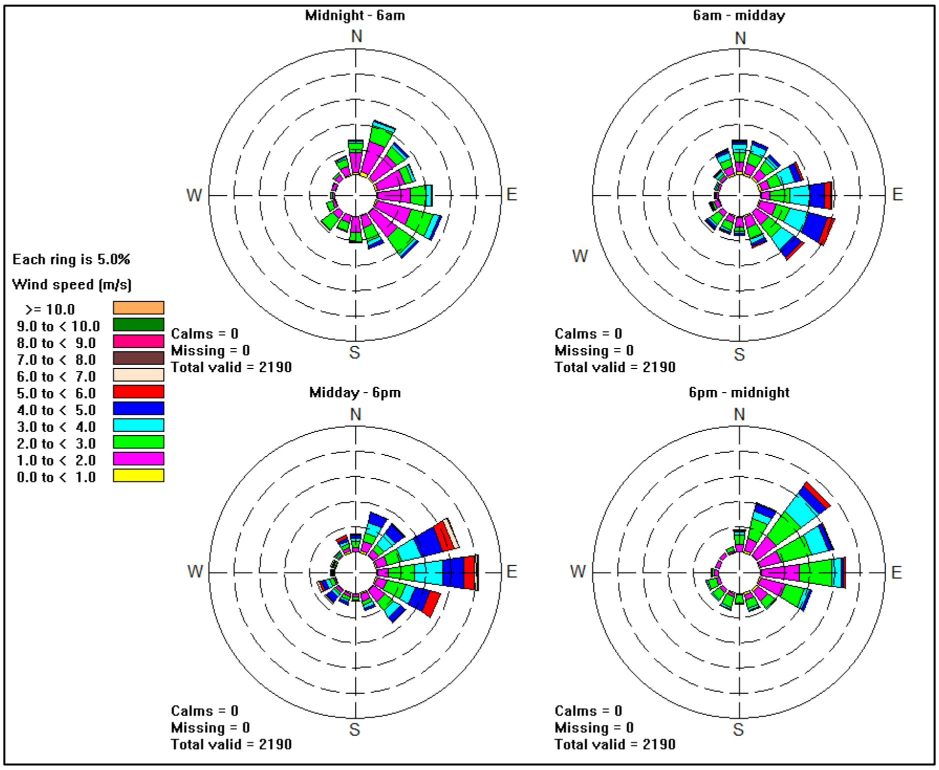

Figure 4.97 Diurnal distributions of modelled winds at the Project site

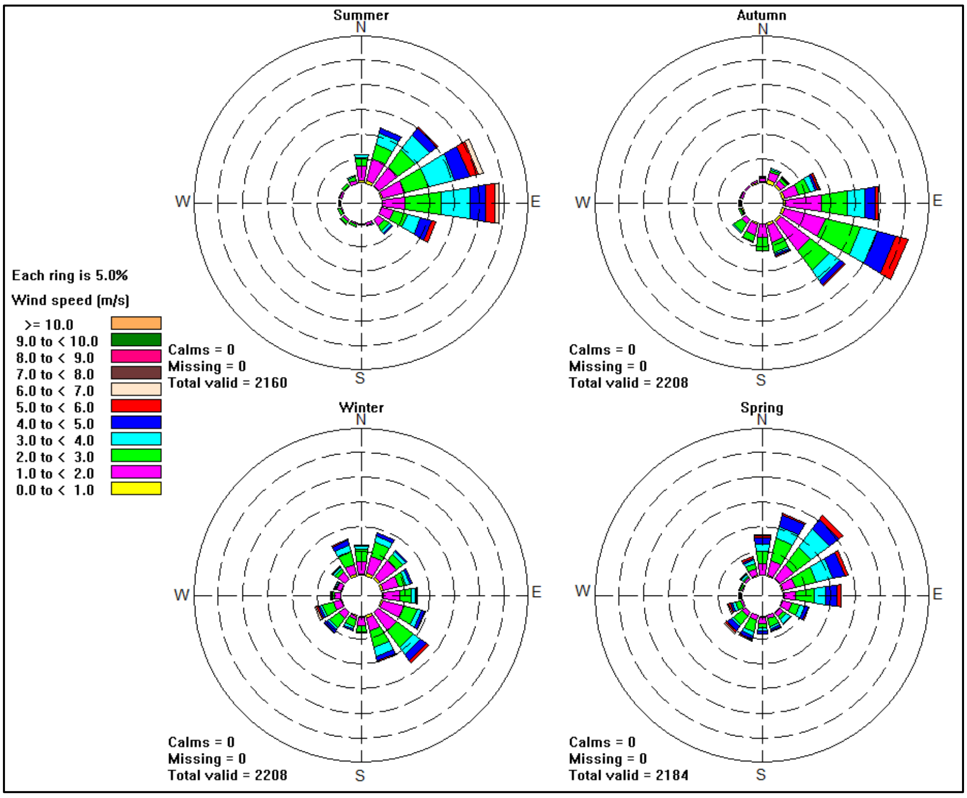

Figure 4.98 Seasonal distributions of modelled winds at the Project site

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 4.80 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 4.80 Frequency of Occurrence (%) of Surface Atmospheric Stability at the Project Site under Pasquil-Gifford Stability Classification Schemes.

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

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 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 the data shows that the mixing height develops around 7 am, increases to a peak around 2 pm before descending rapidly.

4.6.1.2 Existing Ambient Air Quality

Sources of Contaminants

The Project is located within the Bowen Basin region in central Queensland. As the largest coal basin in Australia, a large number of existing coal mines and mining communities also reside within the Bowen Basin region.

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 4.81. The largest dust emissions are reported from Ensham Coal Mine, which is located approximately 60 km east of the Project.

Table 4.81 NPI reported emissions for the period 2011 - 2012

Mine	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
Kestrel Mine	52	78,409	732,344	5,614	60
Minerva Mine	48	542,752	581,388	70,375	789

Ensham Coal Mine commenced operation in 1993 and produces approximately 7 Mtpa of high energy, low ash thermal coal. Coal mining is conducted by a large pre-strip fleet and four draglines. Once exposed, the coal is removed by loader or excavator and hauled by trucks to a coal processing and stockpiling area. Coal is reclaimed via an underground conveyor and railed to Gladstone.

The Gregory opencut operation was shut down late 2012 with underground operations continuing at the Crinum mine. Approximately 5 Mtpa of low ash, hard and weak coking coals plus a high volatile thermal coal are produced for export.

Kestrel Mine is an underground mine which uses the longwall and continuous miner method to mine approximately 3.5 Mtpa of high quality coking and thermal coal for export.

Minerva Coal Mine is an opencut mine producing 2.8 Mtpa of premium thermal coal for export. The mine has a remaining life of approximately 10 years.

As shown in Table 4.81, the NPI reported emissions are in direct proportion to the size of the operation under examination.

In addition to existing mines, there are a number of proposed mineral and energy projects currently progressing through the approvals process within this region that will potentially present additional sources of contaminants to the regional airshed.

Air Quality Monitoring

An on-site monitoring program has been conducted at six homesteads within the Project 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 4.82.

Table 4.82 Summary of On-site Dust Deposition Data (mg/m^2/day)

Monitoring Site	Maximum	Average
St Helens	45.9	34.8
Jabiru	39.3	36.1
Iona Downs	39.3	32.0
Airlie	59.0	40.7
Walther	39.3	28.7
Dunloe	36.1	24.3

The highest average dust deposition rate measured at any site is 40.7 mg/m2/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. Further to background ambient air quality predictions, the ambient air quality monitoring data from several mines in the region were considered during the air impact assessment as no government monitoring stations operate in the locality of the Project.

Sensitive Receptors

Sensitive receptors can be defined as human residences and places of work or recreation such as kindergartens, schools, hospitals, aged care facilities, office buildings, factories and workshops. Sensitive receptors are those which are likely to experience adverse effects due to the activities associated with the Project. The majority of sensitive receptors relevant to the Project were found to be homesteads, as illustrated in Figure 4.99 . Table 4.83 identifies the sensitive receptors closest to the Project.

No kindergartens, schools, hospitals, aged care facilities, office buildings, factories and workshops are known to exist locally.

Table 4.83 Proximity and Direction of Sensitive Receptors to the Project

Receptor	Homestead	Distance (km)	Direction	Coordinates	
				Easting	Northing
1	St Helens*	Within MDL (South)		594385	7393080
2	Iona Downs	Within MDL (North)		596713	7396823
3	Walther	Within MDL (North)		599684	7397217
4	Donnelly	Within MDL (North)		596452	7396267
5	Jabiru	5	North	597530	7403116
6	Airlie	11	South	596837	7387833
7	Glendarriwell	15	South-West	584405	7390097
8	Dunloe	8	West	588975	7396455
9	Selma	9	East	605256	7398618
10	Fairways	8	West	589708	7395100
11	Kingower	13	North-East	606347	7407271
12	Sypher	6	East	602748	7400276
13	Fork Lagoons	12	North	595304	7410467
14	Wilga Downs	9	South-East	599200	7390042

Note *: The dwelling at St Helens is only periodically occupied

Homesteads identified as Donnelly and Iona Downs are considered highly sensitive due to their proximity to the opencut pit and underground mine domain. All homesteads within the Project boundary have been consulted and share open lines of communication with Shenhuo. The remaining sensitive receptors range from 6 km to 15 km from the centre of the Project.

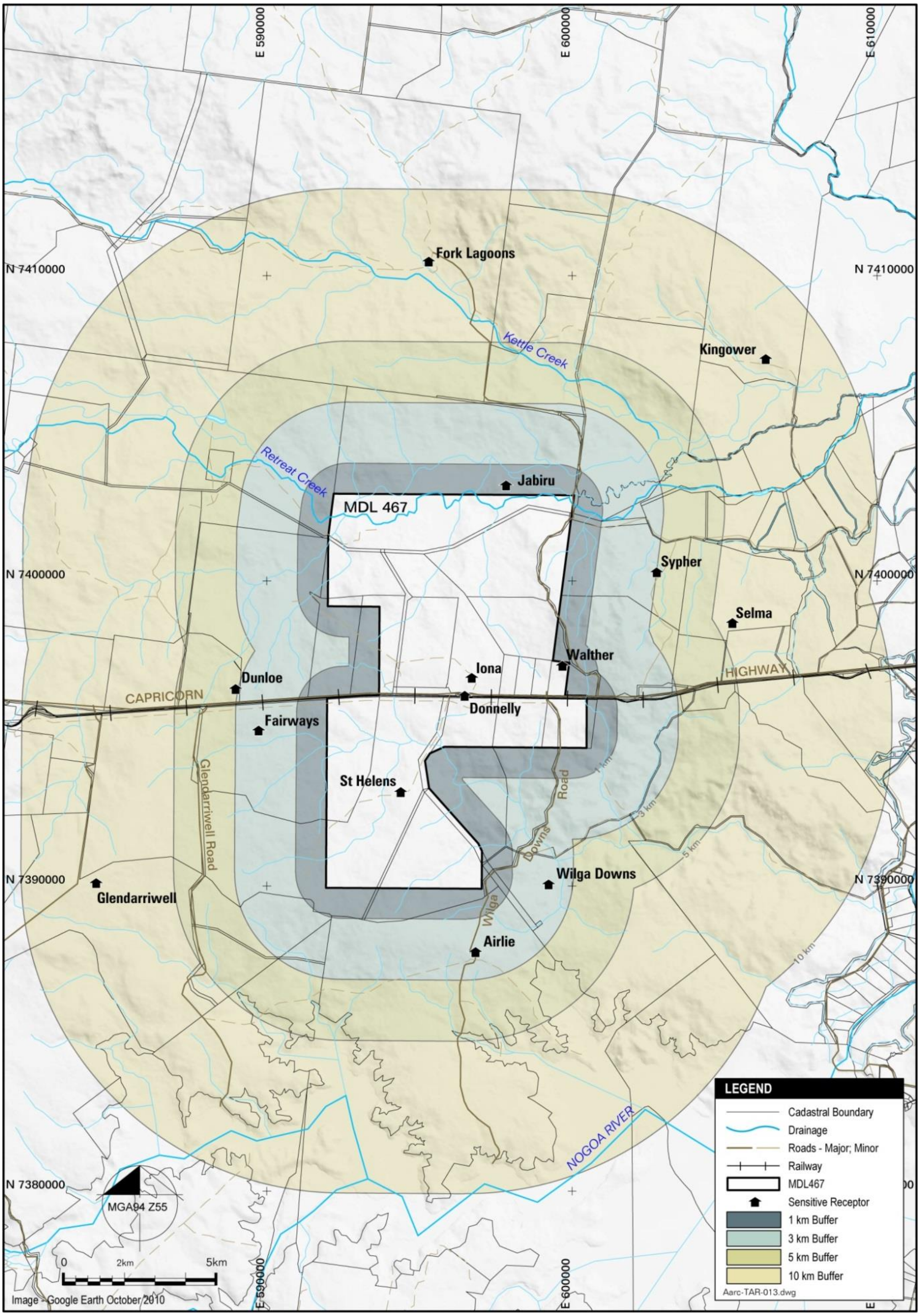

Figure 4.99 Sensitive Receptors in the Vicinity of the Project

4.6.1.3 Air Quality Objectives

Air pollution is determined by comparison of air quality monitoring data to recognised air quality standards. The predicted concentrations of pollutants associated with the Project have been compared against the *Environmental Protection (Air) Policy 2008* (Air EPP) to protect environmental values of the atmosphere that are conducive to the health and well-being of humans and biological integrity. Air quality objectives defined by the Air EPP are provided in Table 4.84.

In addition, the impact assessment criteria from the NSW Office of Environment and Heritage (OEH) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW Department of Environment and Conservation (DEC) 2005) have been used to define the annual dust deposition rate, for inclusion in the air impact assessment, as a dust deposition guideline is not defined in the Air EPP. The monthly dust deposition rate identified in Table 4.84 was recommended by the Department of Environment and Heritage Protection and has been adopted for the air impact analysis.

Table 4.84 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 $\mu g/m^3$	Air EPP
	Annual	8 $\mu g/m^3$	Air EPP
Particulate Matter (as PM_{10}) [b,c]	24-hour	50 $\mu g/m^3$	Air EPP
Particulate Matter (as TSP)	Annual	90 $\mu g/m^3$	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 exceedances allowed per year

d *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC 2005)

Odour Guideline

Odour protection criteria adopted for the Project have been procured from the guideline *Odour Impact Assessment from Developments* (EPA 2004). The guideline defines generic criteria for assessing odour annoyance based on tall stacks and ground-level sources. As such an odour performance criterion of 2.5 odour units (ou), 99.5th percentile for a 1-hour average has been adopted in accordance with the criteria defined (EPA 2004).

4.6.2 Potential Impacts and Mitigation Measures

4.6.2.1 Atmospheric Dispersion Modelling

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

The air quality impact assessment has focussed on the pollutants identified as most critical in terms of impacts to air quality, namely Total Suspended Particulates (TSP), Particulate Matter with a diameter of 10 µm (PM_{10}) and Particulate Matter with a diameter of 2.5 µm ($PM_{2.5}$). Dust deposition rates have also been assessed. Emission estimates for pollutants associated with the Project for inclusion in the model have been sourced from:

- Site layout plans, infrastructure and operating details of the Project; and
- 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 Years 2 and 5 of operations as these years 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 dispersion modelling was conducted 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.

The dispersion model CALPUFF (Version 6.267) was then 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 15.

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

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 detailed in Appendix 15. 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 provided in Table 4.85.

The background concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition used in this assessment are shown in Table 4.85.

Table 4.85 Summary of Background Concentrations (µg/m^3)

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]

Notes:
[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

Air Emission Inventory

The major sources of dust emissions will occur during opencut mining through the use of excavators and haul trucks to transport and remove 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 the following mine activities:

- Areas disturbed by mining;
- Spoil emplacement areas;
- ROM coal handling and processing;
- Haul roads;
- Topsoil and overburden removal, handling, transport and dumping;
- Drilling;
- Blasting;
- ROM coal stockpiles;
- Conveyors; and
- 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: Stationary Point and Area Sources (AP-42)* (U.S. Environmental Protection Agency (EPA) 1995) and in the National Pollutant Inventory Handbooks. Dust emission rates were 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 key factors that contribute to dust emissions include coal type, coal moisture content, coal particle size distribution, rainfall and the mitigation measures that may be employed. These key factors among others have been accounted for and dust emission rates have been calculated using 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 National Pollutant Inventory (NPI) *Emission Estimation Technique Manual for Mining* (2001). The dust controls included in the calculations for emissions from each of the sources are defined in Table 4.86.

Table 4.86 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 spoil dumps	Revegetated	99%

A summary of the total dust emission rates from the Project is shown in Table 4.87. Detailed emission calculations and a detailed breakdown of emissions for each activity are provided in Appendix 15.

Table 4.87 Summary of the 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	0.001	1.6	0.4	0.05
CHPP	6.6	1.2	0.1	10.3	1.8	0.2
Wind erosion of spoil dumps	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**

Modelling Results

The following results represent the air quality impact assessment for predicted cumulative ground-level concentrations of TSP, PM_{10}, $PM_{2.5}$ and dust deposition for operational Years 2 and 5 of the Project at 14 discrete receptors (refer to Table 4.88) identified within the modelling domain.

The predicted annual average TSP, $PM_{2.5}$ and dust deposition rate and the predicted maximum 24-hour average $PM_{2.5}$ concentrations are presented together with background concentrations and compared to the relevant air quality objective and guideline (detailed in Section 4.6.1.3). 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.

In addition, using a standard interpolation technique, contour plots indicative of ground-level concentrations or dust deposition rates have been created from predicted dust levels at a network of gridded receptors within the modelling domain and ambient background concentrations. It should be noted that the process of interpolation causes smoothing of the base data that can lead to minor differences between the contours and discrete model predictions.

Year 2

Predicted ground-level concentrations (including background levels) of PM_{10}, $PM_{2.5}$, TSP and dust deposition rates at the location of each sensitive receptor are presented in Table 4.88. Exceedances of the Air Quality Objectives are highlighted in bold red text.

Table 4.88 Predicted Ground-level Concentrations and Deposition Rates at Sensitive Receptor Locations During Year 2

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	Max. 24 hour average	Annual Average	Max. Monthly Average	Annual Average
Air Quality Objective	**90**	**-**	**50**	**25**	**8**	**120[1]**	**130[2]**
Background	**28.0**	21.0	**21.0**	**5.4**	**2.8**	**40.7**	**40.7**
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	**297.4**	**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

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

The air quality modelling results indicate 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 immediately north of the planned opencut;

- 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. Results were compared against the Air EPP objective of 50 $\mu g/m^3$ and ranged from 93.8 to 297.4 $\mu g/m^3$. The highest level of PM_{10} was recorded at Donnelly House;

- 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 (25 $\mu g/m^3$) ranging from 27.3 $\mu g/m^3$ to 54.5 $\mu g/m^3$ 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 annual average $PM_{2.5}$ (8 $\mu g/m^3$) was predicted to be exceeded by a fraction (8.1 $\mu g/m^3$) at one receptor, Donnelly House, 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 (130 mg/m^2/day) was predicted to be exceeded at one receptor, Donnelly House, by 33.2 mg/m^2/day; and

- 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 (120 mg/m^2/day**)** was predicted to be exceeded at three receptors located within the MDL including St Helens (133.4 mg/m^2/day), Iona Downs (152 mg/m^2/day) and Donnelly House (299.2 mg/m^2/day).

To illustrate the spatial distribution of dust levels Figure 4.100 to Figure 4.105 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 during Year 2.

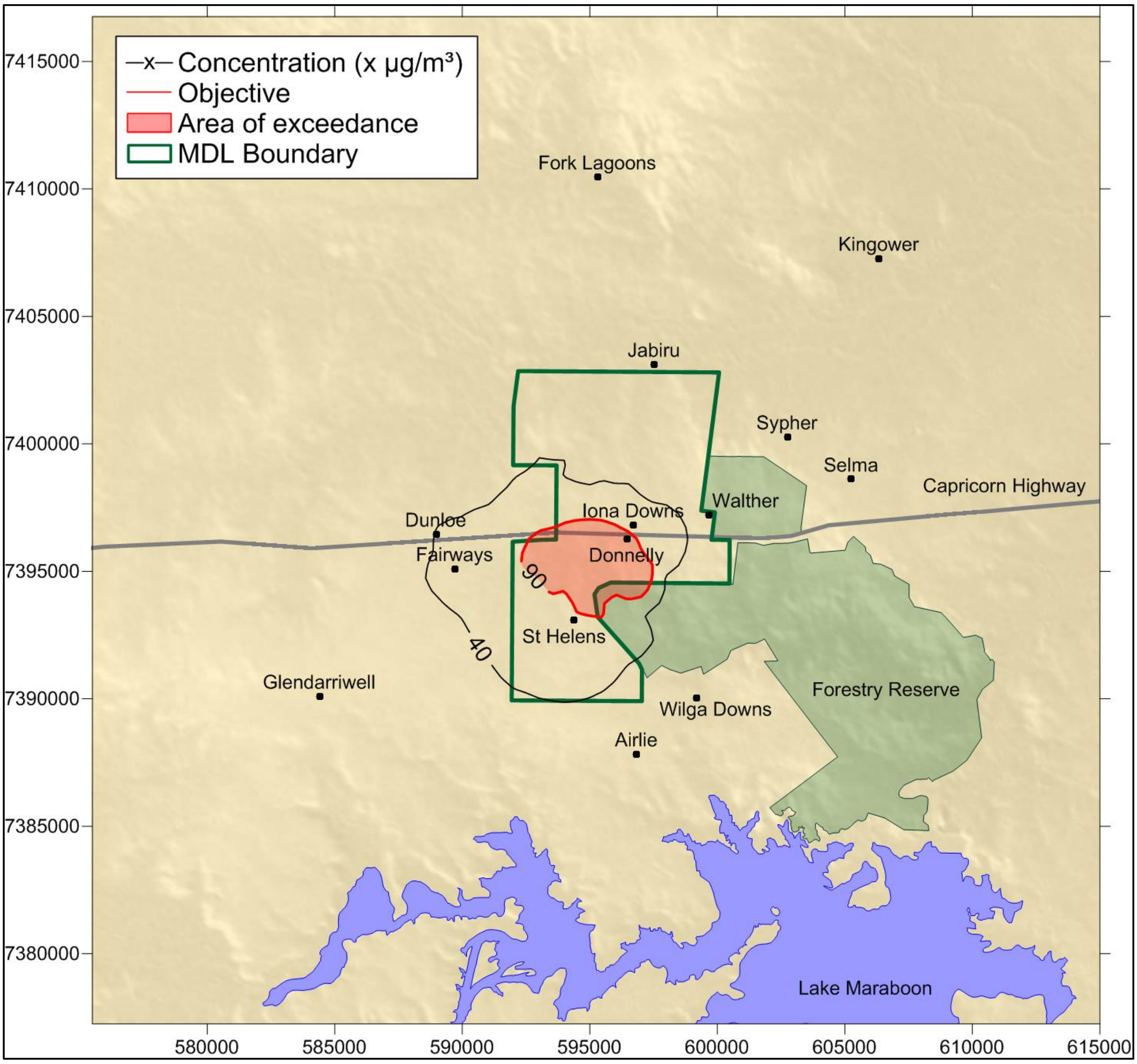

Figure 4.100 Predicted Annual Average Ground-level Concentrations (including background) of TSP in Year 2 of the Project – Objective 90 µg/m³

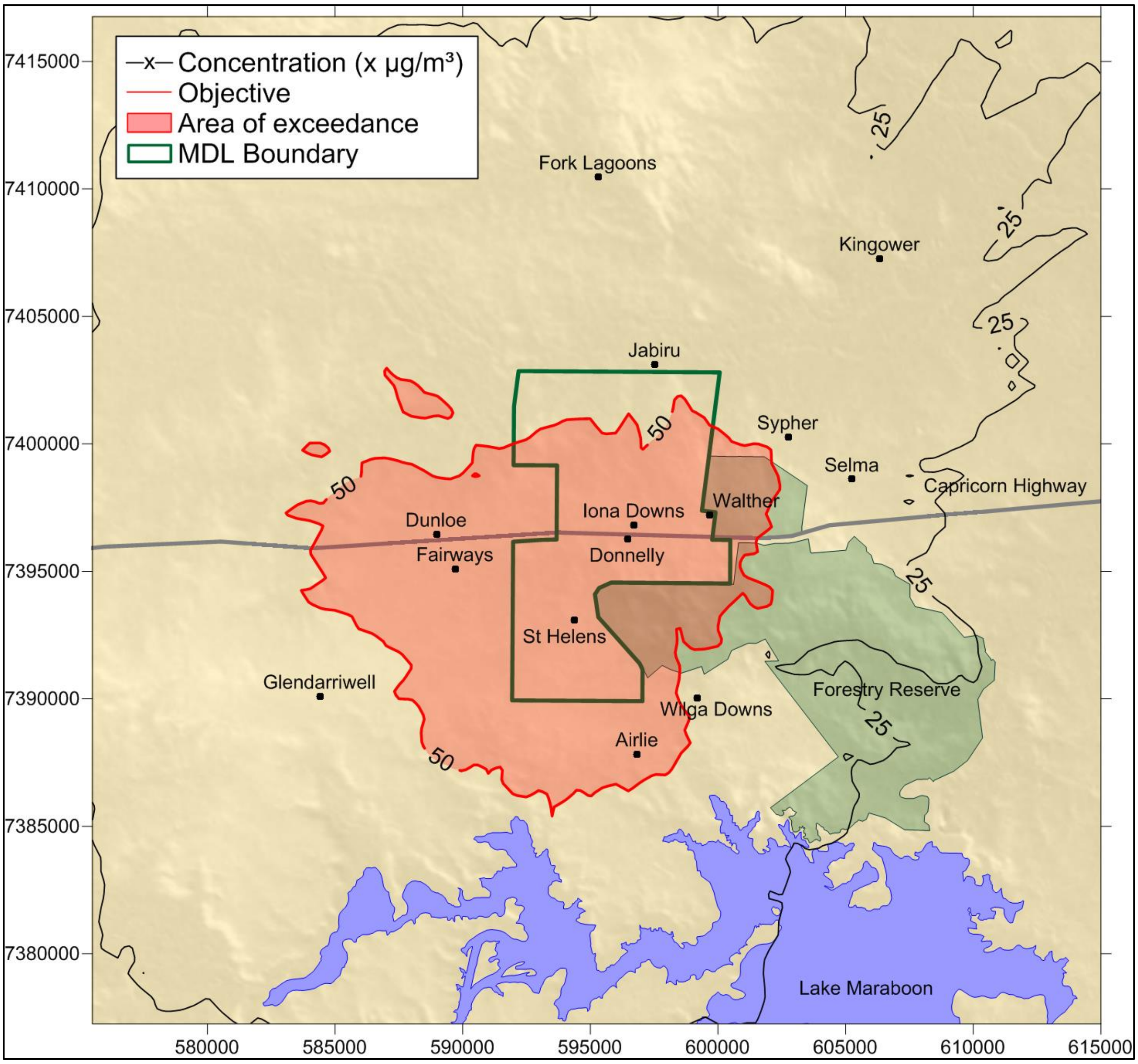

Figure 4.101 Predicted 6th Highest 24-hour Average Ground-level Concentrations (including background) of PM_{10} in Year 2 of the Project – Objective 50 µg/m³

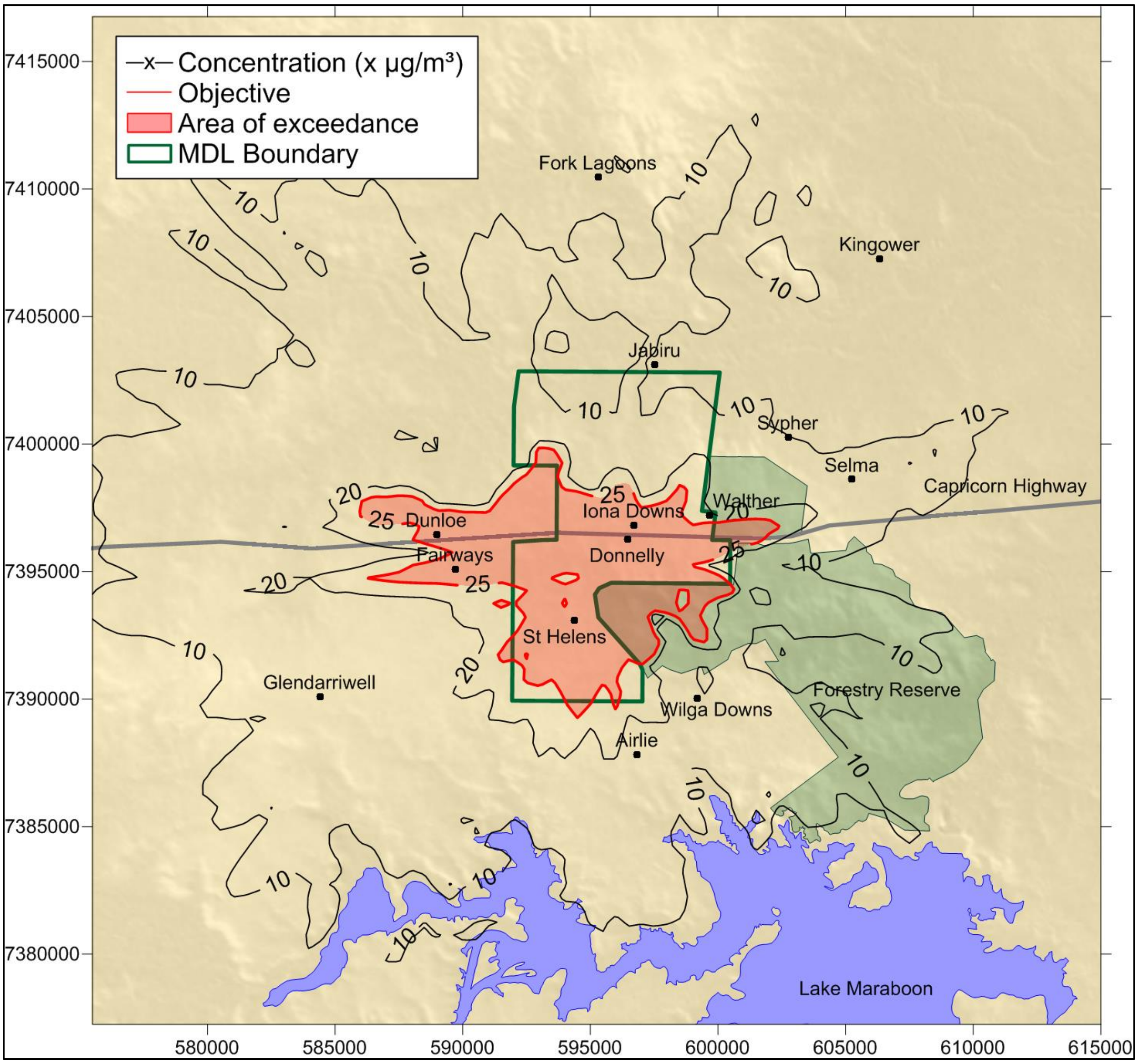

Figure 4.102 Predicted Maximum 24-hour Average Ground-level Concentrations (including background) of $PM_{2.5}$ in Year 2 of the Project – Objective 25 µg/m³

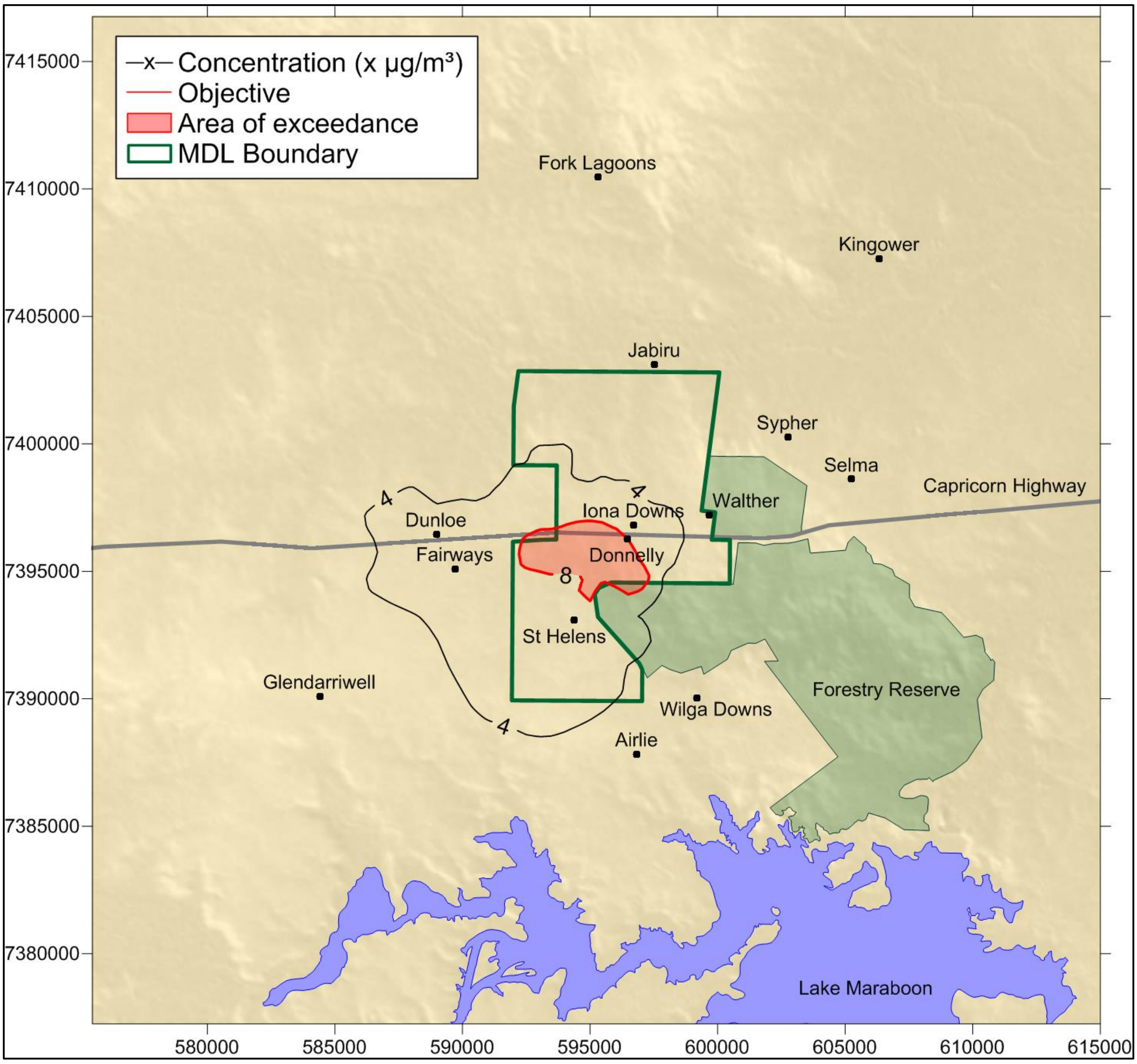

Figure 4.103 Predicted Annual Average Ground-level Concentrations (including background) of $PM_{2.5}$ in Year 2 of the Project – Objective 8 µg/m^3

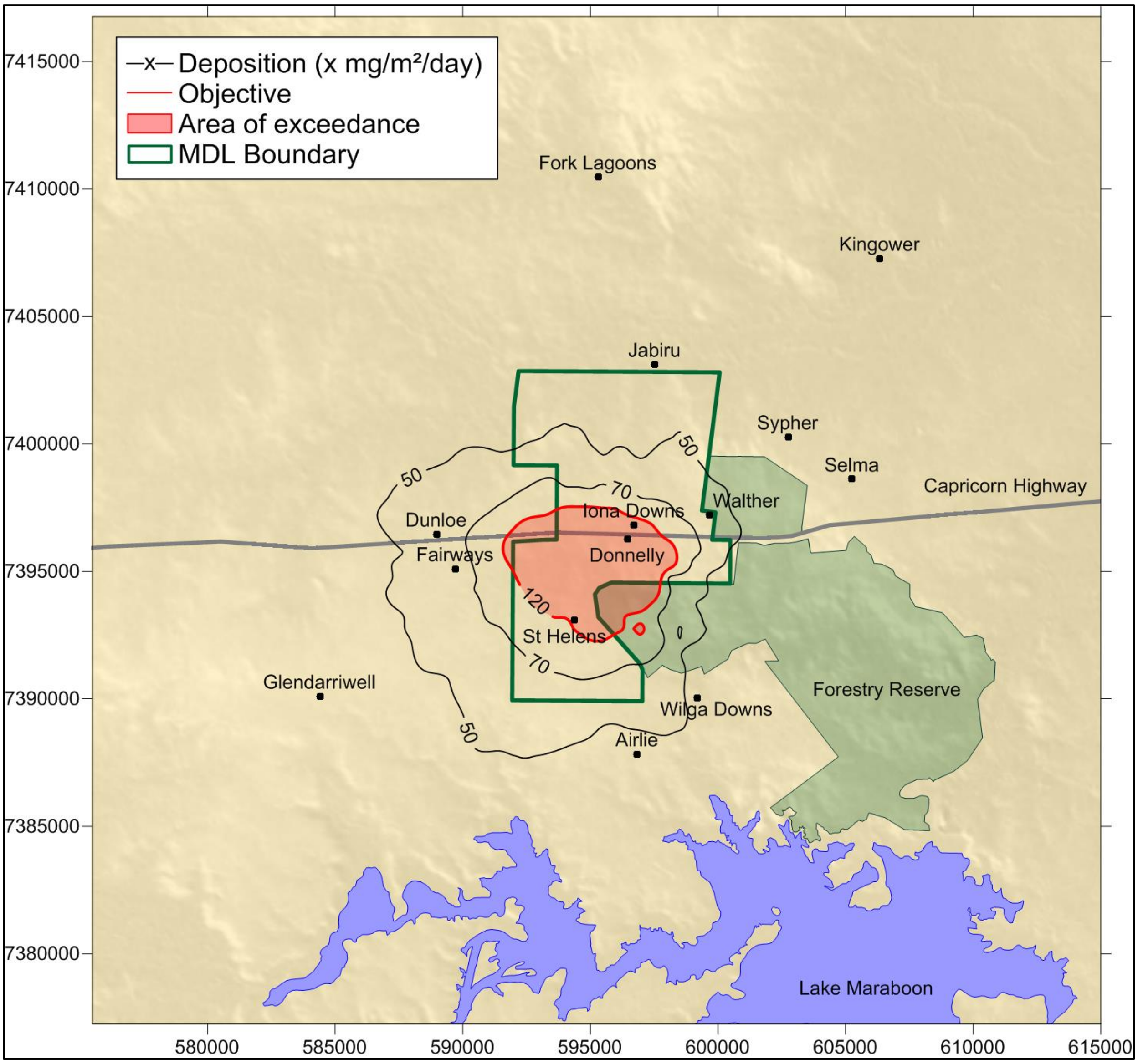

Figure 4.104 Predicted Maximum Monthly Dust Deposition (including background) in Year 2 of the Project – Objective 120 mg/m²/day

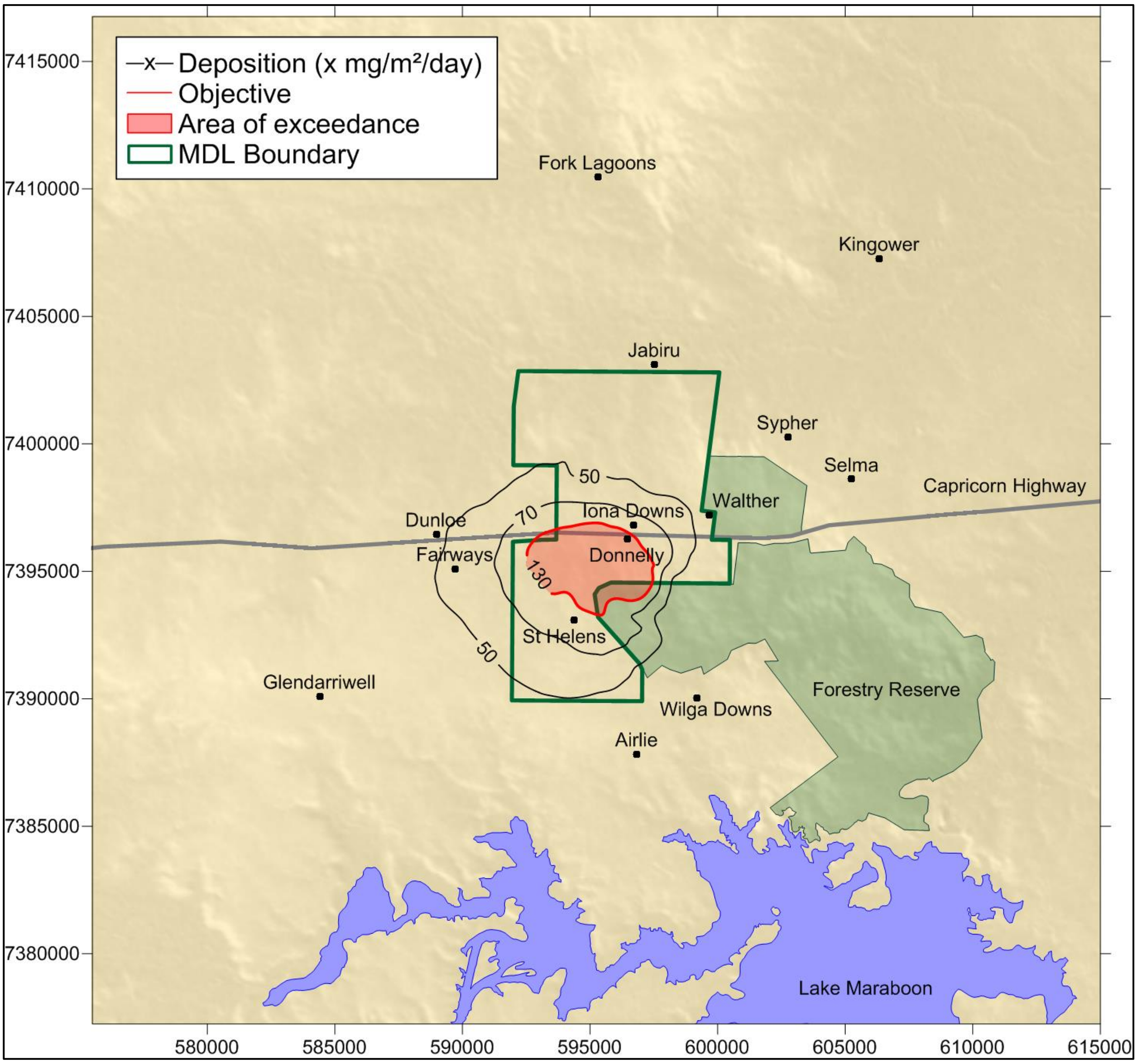

Figure 4.105 Predicted Annual Average Dust Deposition Rate (including background) in Year 2 of the Project – Objective 130 mg/m^2/day

Year 5

Predicted ground-level concentrations (including background levels) of PM_{10}, $PM_{2.5}$, TSP and dust deposition rates at the location of each sensitive receptor in Year 5 are presented in Table 4.89. Exceedances of the Air Quality Objectives are highlighted in bold red text.

Table 4.89 Predicted Ground-level Concentrations and Deposition Rates at Sensitive Receptor Locations During Year 5

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	Max. 24 hour average	Annual Average	Max. Monthly Average	Annual Average
Air Objective	**90**	**-**	**50**	**25**	**8**	**120[1]**	**130[2]**
Background	**28.0**	**21.0**	**21.0**	**5.4**	**2.8**	**40.7**	**40.7**
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

* Within the MDL.
[1]NSW OEH – amenity dust guideline
[2] EHP recommended guideline

The results of the air quality modelling indicate 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 both located in the near vicinity to the north of the opencut pit;

- 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 (50 µg/m^3) at a number of receptors, including three receptors that lie outside the MDL boundary. Exceedances ranged from 63.3µg/m^3 to 771.5µg/m^3. The largest exceedance recorded outside the MDL occurred at Fairways, 8 km west of the Project, with a 6th highest 24-hour average ground-level concentration of PM_{10} of 108.8 µg/m^3;

- 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 (25 µg/m^3) at a number of receptors, including two receptors that lie outside the MDL boundary. Exceedances ranged from 32.5 µg/m^3 at Fairways (8 km west of the Project) to 122.5 µg/m^3 recorded at Donnelly House (within the northern portion of the MDL);

- 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 $PM_{2.5}$ (8 µg/m^3) was predicted to be exceeded at two receptors; Iona Downs (8.2 µg/m^3) and Donnelly House (17.2 µg/m^3), 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 (130 mg/m2/day) was predicted to be exceeded at one receptor, Donnelly House (399.8 mg/m^2/day), which are located within the MDL; and

- 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 (120 mg/m^2/day) was predicted to be exceeded at two receptors, Iona Downs (240.3 mg/m^2/day) and Donnelly House (816.7 mg/m^2/day), which are located within the MDL.

Figure 4.106 to Figure 4.111 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.

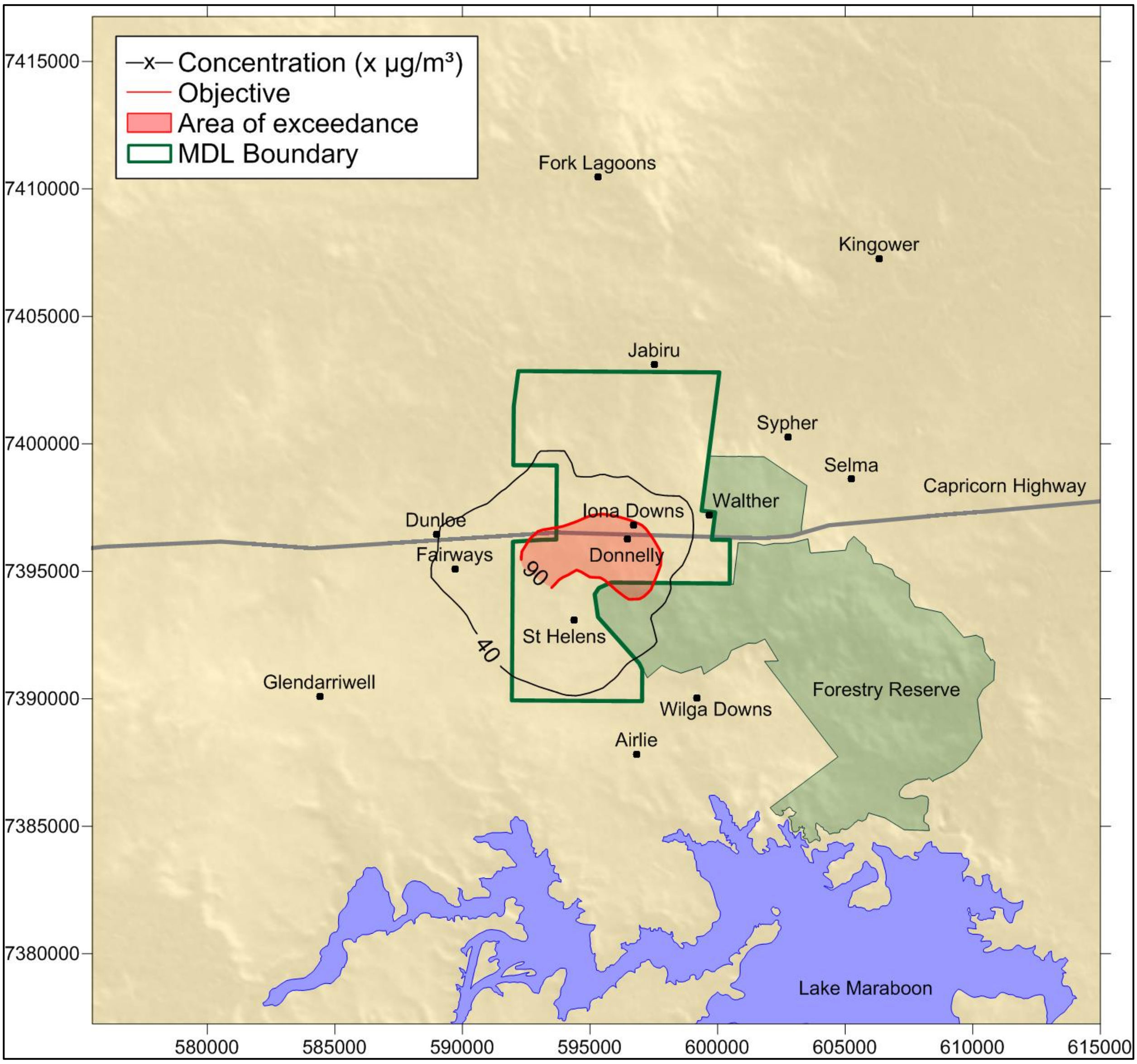

Figure 4.106 Predicted Annual Average Ground-level Concentrations (including background) of TSP in Year 5 of the Project – Objective 90 µg/m^3

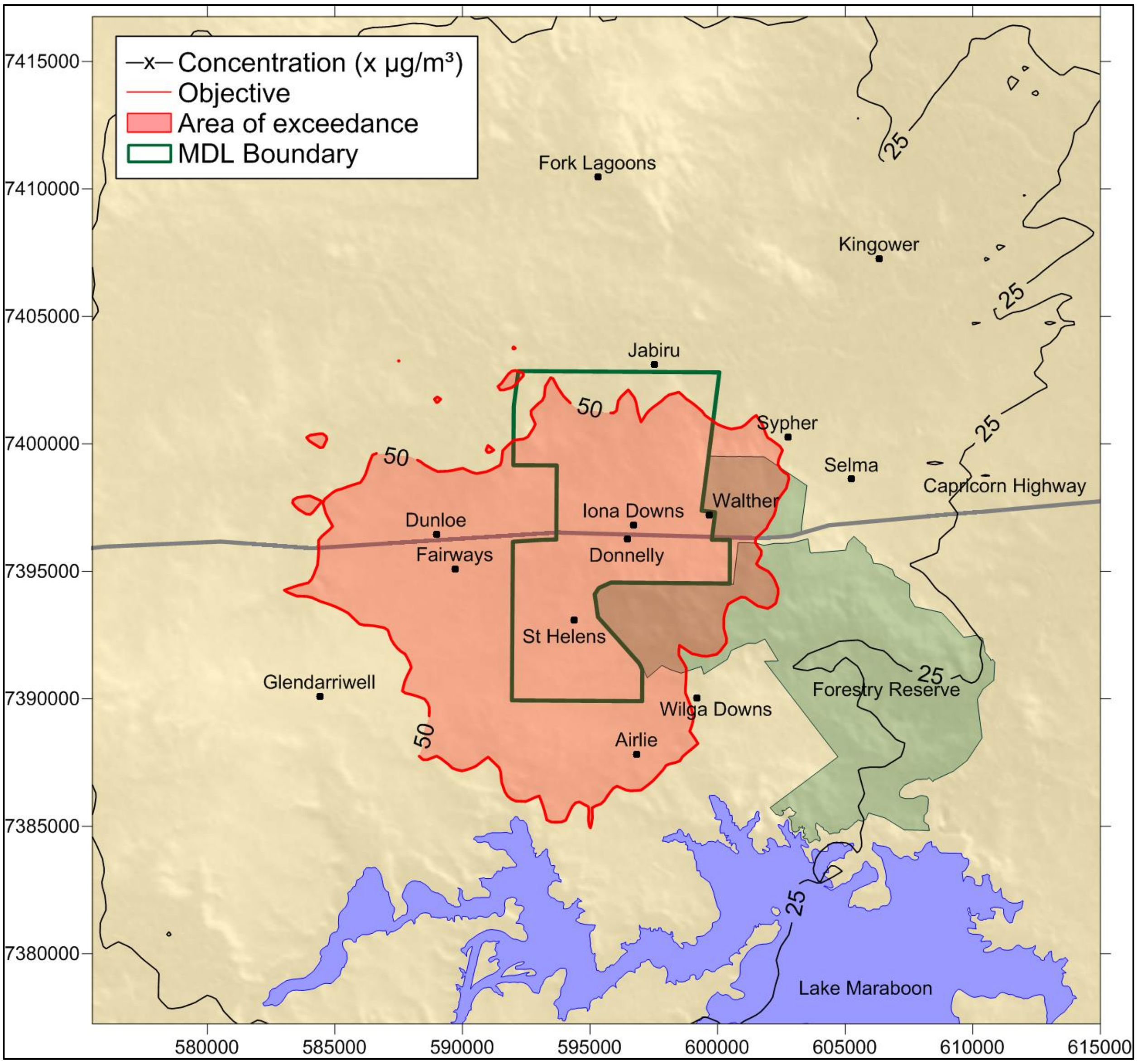

Figure 4.107 Predicted 6th Highest 24-hour Average Ground-level Concentrations (including background) of PM_{10} in Year 5 of the Project – Objective 50 µg/m³

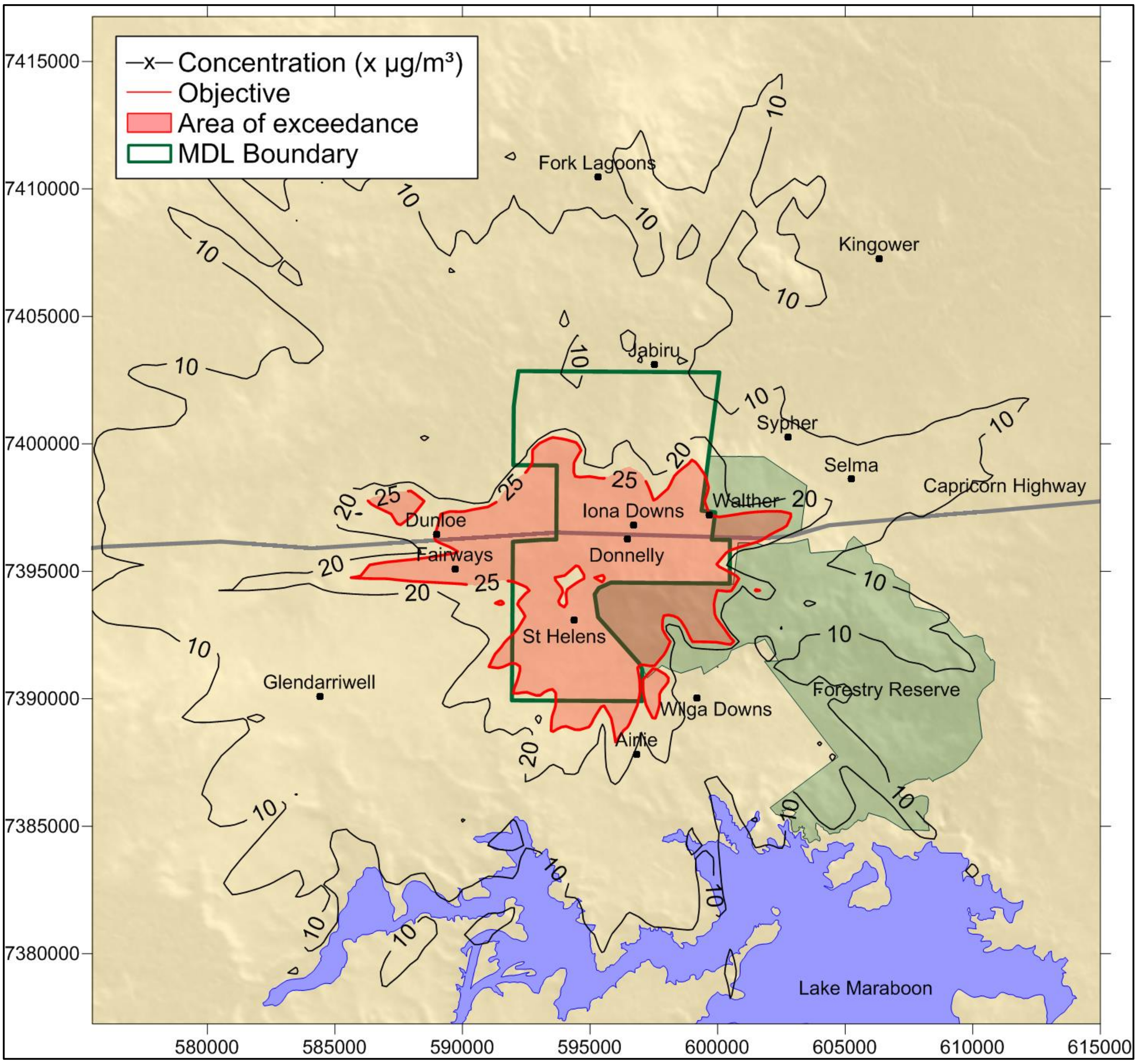

Figure 4.108 Predicted Maximum 24-hour Average Ground-level Concentrations (including Background) of $PM_{2.5}$ in Year 5 of the Project – Objective 25 µg/m^3

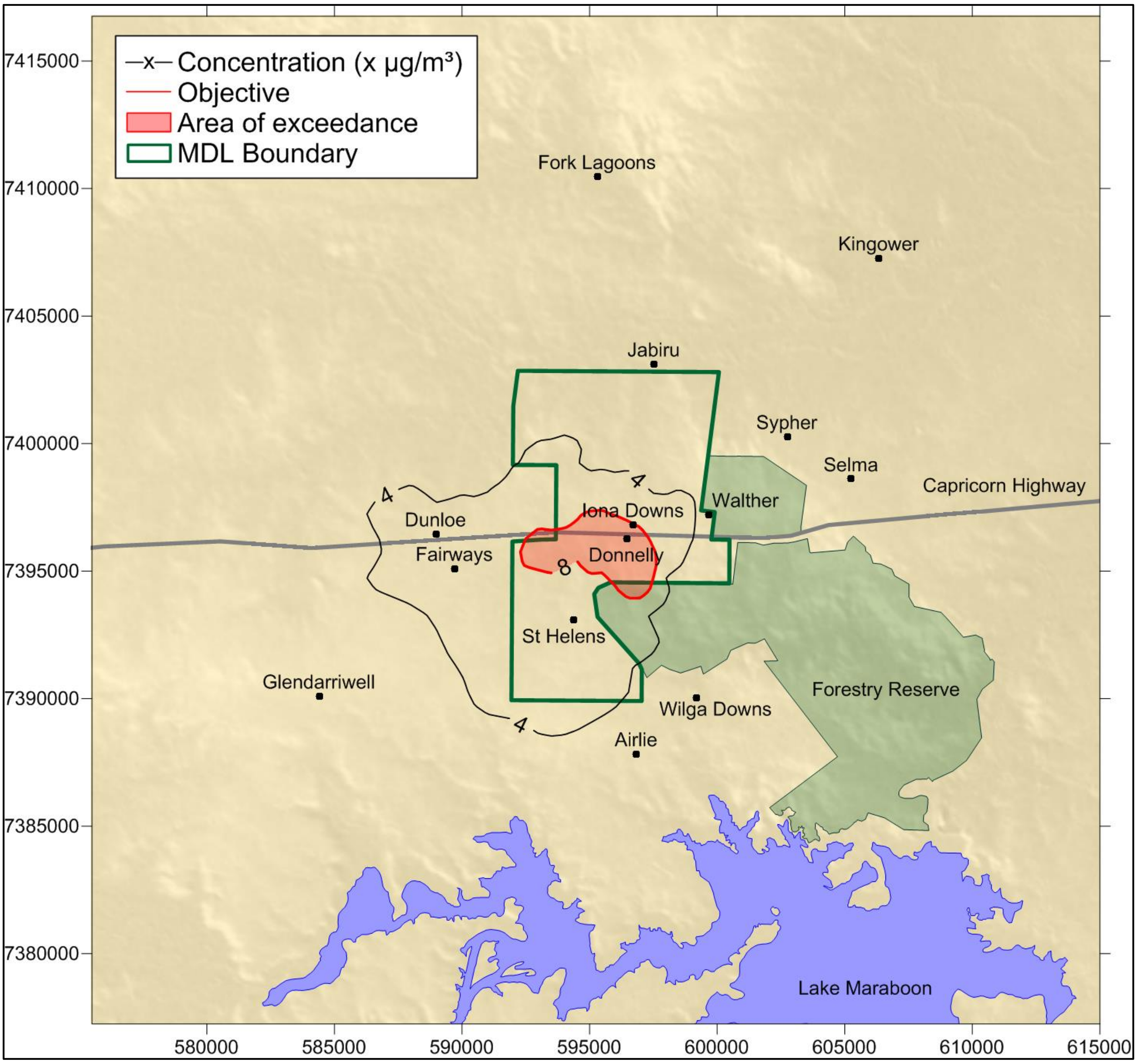

Figure 4.109 Predicted Annual Average Ground-level Concentrations (including background) of $PM_{2.5}$ in Year 5 of the Project – Objective 8 µg/m^3

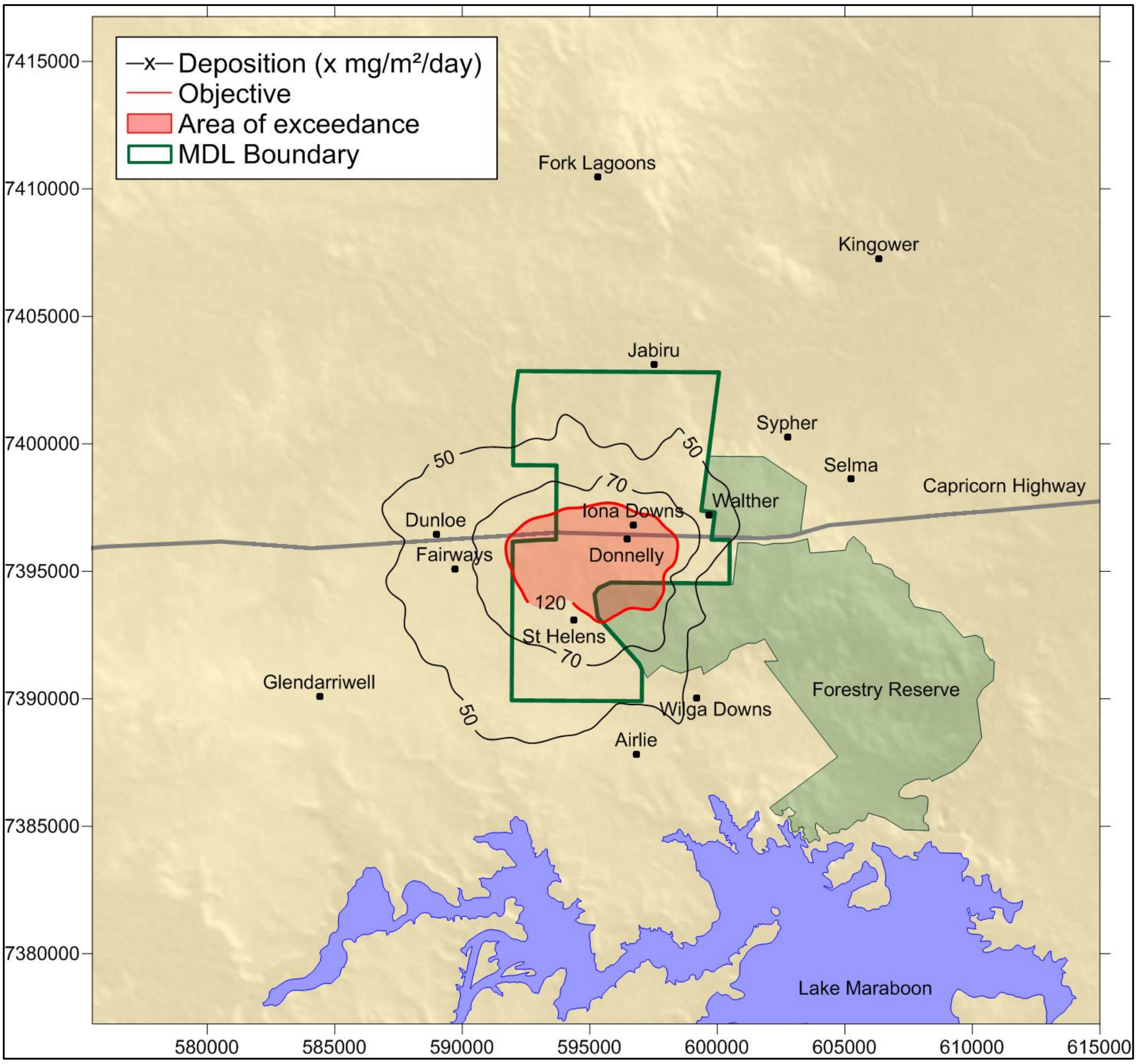

Figure 4.110 Predicted Maximum Monthly Dust Deposition (including background) in Year 5 of the Project – Objective 120 mg/m^2/day

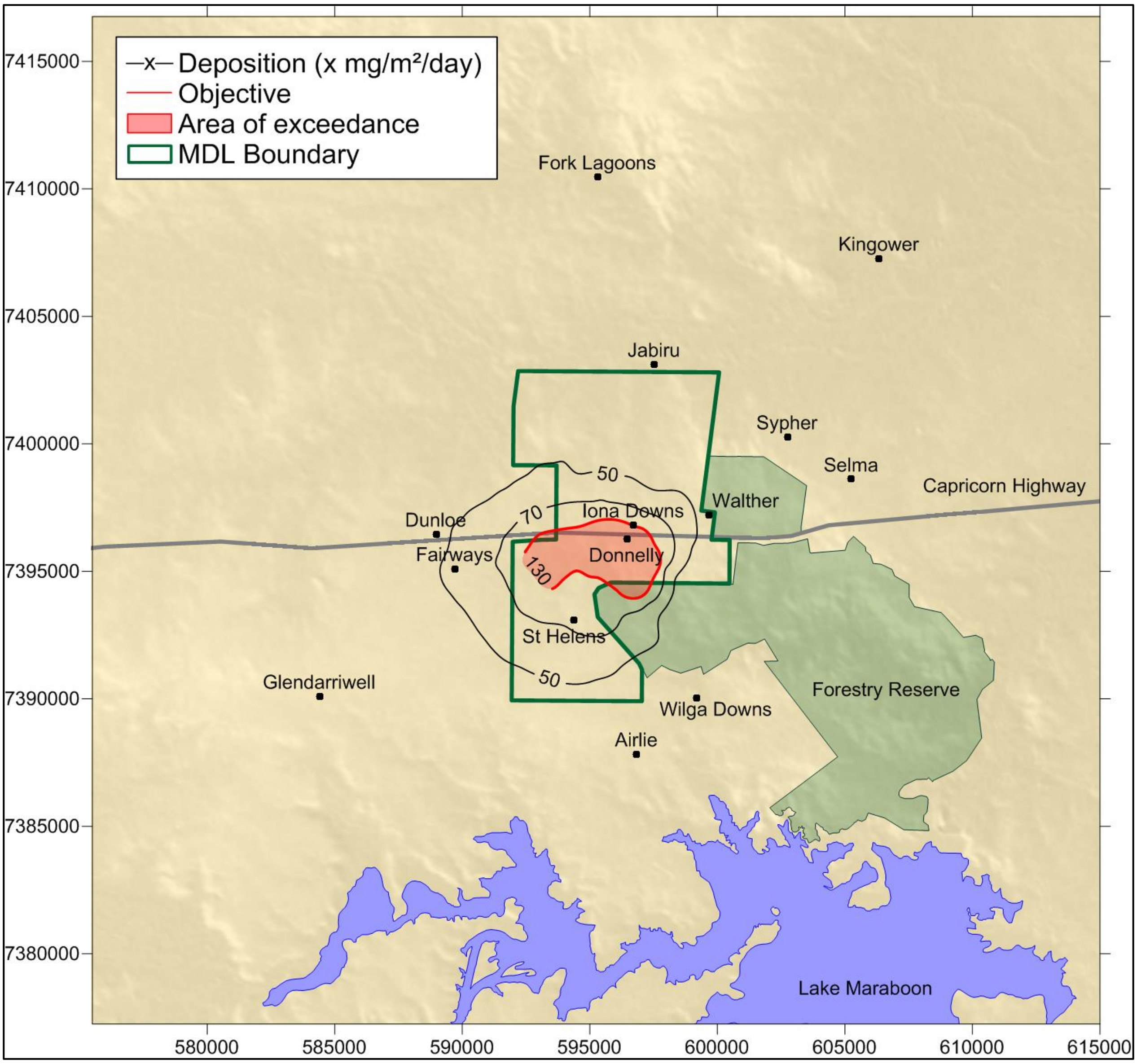

Figure 4.111 Predicted Annual Average Dust Deposition Rate (including background) in Year 5 of the Project – Objective 130 mg/m^2/day

Year 6

While Year 2 and Year 5 have been chosen for detailed emission and dispersion modelling of dust generated by the Project, total overburden removed in Year 6 is approximately 9% greater than that moved in Year 5. Therefore, as dust generation from the haul trucks associated with overburden removal represents the highest dust emitter of the various mining activities, it could be expected that total dust generation would be greater in Year 6 than in Year 5.

In order to ascertain the maximum dust generation from the proposed mine operations, and hence the greatest impact, Year 6 dust emission rates have also been modelled and compared to the Year 5 emission rates. The results are provided in Table 4.90.

Table 4.90 Estimated Dust Emission Rates for Year 5 and Year 6

Activity	Total dust emission rate (g/s)					
	Year 5			Year 6		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
In-Pit Activities including drilling, blasting and truck loading	4.7	2.5	0.4	4.7	2.5	0.4
Haul Roads	79.2	27.9	2.9	86.5	30.5	3.1
Conveyors	1.6	0.4	0.05	1.5	0.4	0.05
CHPP	10.3	1.8	0.2	10.6	1.9	0.2
Wind Erosion of stockpiles	3.4	1.7	0.3	3.4	1.7	0.3
Train loading	2.9	0.5	0.1	3.0	0.5	0.1
Rail line	0.01	0.004	0.001	0.01	0.004	0.001
Total	**102.1**	**34.8**	**3.9**	**109.6**	**37.4**	**4.1**

From the estimated emission rates presented in Table 4.90, it can be seen that:

- the overburden tonnage is 9% greater in Year 6 than in Year 5;
- the emission rates due to haul roads are estimated to be 9% higher in Year 6 than in Year 5; and
- overall project emissions for Year 6 are estimated to be 7 % higher for TSP, 8% higher for PM_{10} and 6% higher for $PM_{2.5}$ than for Year 5

With the change in emission rates from Year 5 to Year 6 and based on the modelling results for Year 5, the following has been inferred for Year 6.

- Concentrations of TSP, PM_{10} and $PM_{2.5}$ as well as dust deposition rate are likely to increase; however, the increase would not be greater than 9% at any receptor.
- The annual average concentrations of TSP would not exceed the objective at any additional receptors.
- The 6th highest 24-hour average concentrations of PM_{10} would not exceed the objective at any additional receptors.
- The maximum 24-hour average concentrations of $PM_{2.5}$ may exceed the objective at one additional receptor in Year 6 compared with Year 5. This receptor is the Walther residence. As shown in Table 4.89, the ground level dust concentration for Year 5 was predicted to be marginally below the objective of 25 µg/m³ at the Walther residence (24.9 µg/m³). Consequently, the estimated higher dust emission rates for Year 6 would likely result in a predicted exceedance of the objective in Year 6. And as PM_{10} concentrations at this receptor were predicted to exceed the objective in Year 5, the marginally higher prediction at the Walther residence for Year 6 does not significantly alter the outcome of the air quality assessment of the Taroborah Coal Project.

- The annual average concentrations of $PM_{2.5}$ would not exceed the objective at any additional receptors.

- The maximum monthly and annual average dust deposition rates would not exceed the guidelines at any additional receptors.

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. A detailed odour study has been undertaken simultaneously with the atmospheric impact assessment 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.

The odour assessment has been conducted in a conservative manner, as detailed design of the Project ventilation shaft has not yet been completed, to provide a quantitative basis to specify a minimum recommended separation distance that should be maintained between any vent shaft and nearby residences.

Table 4.91 summarises the available information for the design of the ventilation shaft. The odour concentration has been procured from previous studies outlining odour concentration measurements at an underground mine in the Hunter Valley, NSW (Holmes Air Sciences 2003).

Table 4.91 Underground Mine Ventilation Shaft Discharge Preliminary Design

Parameter	Preliminary Design
Volumetric flow rate	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 notes:
[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 15.

The odour assessment indicates that there is unlikely to be an odour issue from the ventilation shaft as 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.

Potential Impacts on Vegetation

The Fairbairn State Forest is classified as a Category C Environmentally Sensitive Area. The State Forest is located to the east and south of the Project site, in proximity to the opencut pit and other infrastructure which have the potential to generate dust. The effect of dust on vegetation is principally through interception of light by leaves and the consequential effects on the rates of photosynthesis and plant health and growth. However, there is no prescribed assessment criteria for dust loads on vegetation associated with reduced physiological activity.

A number of factors may influence the impacts of dust deposition on vegetation. These factors have been outlined in Appendix 15a and are described in Table 4.92 below.

Table 4.92 Factors influencing dust deposition and impacts on vegetation

Factors influencing the deposition of dust on the surface of leaves

• Rate of dust deposition;
• Duration of deposition;
• Particle diameter class distribution;
• Frequency of heavy rain events (e.g. > 5 mm);
• Frequency of strong wind events (e.g. > 5 m/s);
• Functional life of the leaf;
• Structural features of the plant that may lead to shedding or retention of particles:
  ○ Branching habit of the tree or shrub (erect or pendant leaf disposition and sparse branching minimise deposition in low winds);
  ○ Foliage density (dense foliage increases particle impaction);
  ○ Foliage element size (small cylindrical elements intercept particles more effectively per unit surface area than large flat elements);
  ○ Leaf orientation (horizontal display maximises particle retention, vertical display minimises retention in a low wind environment);
  ○ Stiffness of display of branches and leaves (stiff branches and leaves retain their profile in wind; flexible branches and leaves stream in wind, greatly reducing the surface area presented for deposition, and flapping with resulting dislodgment of particles);
• Structural features of the leaf that may lead to shedding or retention of particles:
  ○ Smoothness of leaf surface (this may differ between upper and lower surfaces, with the upper surface generally being smoother);
  ○ Presence of long, branched or expanded hairs on the leaf surface (more common on lower than on upper surfaces); and
  ○ Presence of salt or resin secreting glands on the leaf surface that may increase leaf surface wetness.
• Mean particle diameter. The interception of particles is affected by their diameter in relation to the size and density of the leaves (Raupach et al., 2001). Light interception by the dust on plant canopies is also affected by particle diameter (Doley, 2006) and the effects on photosynthesis can be described quantitatively (Doley and Rossato, 2010). It is also important to recognise that the shading effect of dust increases exponentially with decreasing particle diameter

Limited research has been conducted investigating the impact of dust from coal mining activities on vegetation However, recently a detailed study of the potential effects of quarry dust on vegetation communities was prepared by Doley (2013) for Boral's Gold Coast Quarry Project. The study assessed the potential impact of dust deposition on a *Eucalyptus pilularis* (blackbutt) dominated forest and on an area proposed to be used for ecological offsets. The study considered dust deposition rates of up to 400 mg/m²/day (as a maximum monthly rate), which is similar to the worst-case dust deposition rates predicted for the Project (refer to Table 4.93). The study used conservative assumptions that would likely overestimate the actual impact.

The study of the Gold Coast Quarry found the following (Doley, 2013):

- The overstorey *Eucalyptus pilularis* would be relatively unaffected by dust deposition at the maximum mean monthly rate;
- The understorey layer (small trees and large shrubs) may lose approximately 10% of their dry matter production potential – a reduction that was considered "...not likely to be deleterious for the species within this vegetation layer."; and
- A greater effect on ground species was predicted, with a possible loss of about one quarter of dry matter production potential in the proposed offset area (*Imperata cylindrica*-dominated cover). Within the *Eucalyptus pilularis* forest, a reduction of dry matter production potential of 50% was estimated, which could be detrimental for small ground cover species with horizontally displayed leaves.

The Fairbairn Forest Reserve encompasses approximately 10,000 ha of remnant vegetation. Several vegetation communities found on the Project site also extend into the Fairbairn State Forest. These communities are discussed in detail in Section 4.8 of the EIS and are outlined below:

- River Teatree Riparian Woodland;
- Brigalow Woodland; and
- Silver-leaved Ironbark Open Woodland

Research confirms that ground species within these communities are dominated by grasses similar to the offsets areas in the Gold Coast Quarry Study (Doley, 2013). Consequently, the Gold Coast Quarry study would suggest that dust deposition is unlikely to cause a significant impact on the Fairbairn Forest Reserve.

Within the Project boundary areas of Brigalow/Belah Low Open Woodland are also within close proximity to the opencut pit and other infrastructure and therefore may potentially experience dust deposition impacts. However, Raupach et al. (2011) suggests that the movement of air and the progressive interception of dust within the vegetation canopy will result in a decrease in concentration and therefore dust deposition rate.

Table 4.93 presents the highest predicted maximum monthly dust deposition rates within the Fairbairn State Forest for Years 2 and 5 of the Project. As previously described, these rates are considered to be an over-estimation beyond the forest edge nearest to the mine, as the various layers of forest canopy will intercept the dust, decreasing the concentration and deposition rate of dust (Katestone

2014).

Doley (2003) reports chemically inert dust (or dust which does not substantially alter substrate pH) will typically adversely affect plant growth where the dust load exceeds 5 g/m^2. These results suggest that plant growth will not be affected within the State Forest as 5 g/m^2 is far greater than the highest modelled dust deposition rates predicted for the Fairbairn State Forest (refer to Table 4.93).

Table 4.93 Highest Dust Deposition Rates Predicted within the State Forest

Mine Year	Max. Monthly Dust Deposition Rate ($mg/m^2/day$)	Annual Dust Deposition Rate ($mg/m^2/day$)
Year 2	389	244
Year 5	360	187

Source: Katestone 2014

In addition, as noted in Section 4.6.1.1, the prevailing winds in the region of the Project originate from the north-northeast through to the east to the southeast, influencing the prevailing direction of dust dispersal. Due to the location of the Fairbairn State Forest to the east/southeast of the Project site, prevailing winds will minimise potential impacts of dust on vegetation. Furthermore, a rain event of >5 mm may be assumed adequate to remove accumulated dust from plants.

4.6.2.2 Mitigation Measures

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

- Avoid;
- Recycle;
- Minimise; and
- Manage.

Avoidance of air emissions will be considered during the detailed design phase of the Project to further eliminate unnecessary emissions of dust. In consideration to the hierarchy for air emissions further reductions in emissions will be achieved through actions aimed at minimising and managing dust emissions through the various phases of the Project.

Construction Dust

Mitigation of dust during the construction phase will include restricting vehicle speeds and regular watering of roads and exposed areas to reduce wheel-generated dust. During high wind conditions, dust-generating activities such as earthworks may be restricted and the loads of haul vehicles will be covered when moving outside of the construction site. Stockpiled material will be vegetated as soon as practical or kept in appropriate enclosures to prevent windblown dust.

Before construction commences, a dust management plan will be incorporated in the construction management plan to assist in minimising dust nuisance. Dust mitigation measures that may be combined with the construction management plan include:

- 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 unfavourable 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 particulate emissions to meet vehicle design standards;
- Water down bunds and stockpiles to minimise dust lift-off;
- Water down 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; and
- Compact construction site and stabilise vegetation to minimise dust lift-off due to wind erosion.

Operational Dust

The extraction of coal from an opencut mine is a dust generating activity. 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; and
- Train loading.

An Air Quality Management Plan (AQMP) will be developed to assist with the implementation of minimisation and management strategies at the Project site.

Measures to minimise the potential impact of fugitive dust emissions will include proactive and reactive measures which mitigate all potential dust emission sources to reduce adverse impacts that the proposed mining activities may have on the health and amenity of the surrounding community. The AQMP will be developed considering the Air EPP objectives and emissions management hierarchy.

In accordance with leading industry practice, the AQMP may include the following proactive

components which shall be implemented 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; and
- 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.

The reactive component of the AQMP, analogous to a Trigger Action Response Plan (TARP), shall be implemented where necessary and may include:

- Implementation of additional mitigation measures when wind conditions become adverse, reducing activity rates, covering equipment or temporarily ceasing operations if absolutely necessary; and
- 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.

Routine elements of the AQMP are to include:

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

Dust and Meteorological Monitoring

It is the intention of the Project to implement the following monitoring routine following approval:

- Establish continuous real time monitoring of PM_{10} at representative sites of potential high dust occurrences; and
- 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 will occur in the vicinity of the most affected modelled receptors. Monitoring devices will likely be located upwind and downwind of the Project site and the system will be linked to the TARP, which will be activated once the rolling 24-hour average concentrations exceed 80% (40 µg/m^3) of the Air EPP objective of 50 µg/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 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; and
- Compliance with the Australian Standard for the siting of monitors.

4.6.3 Greenhouse Gas Emissions

A greenhouse gas assessment was conducted for the Project by Katestone in October 2013, which considers the potential impact of the Project on the global climate system by additions that it may make to net greenhouse gas emissions, assuming all other emitters remain constant.

4.6.3.1 Australian Policy and Regulation

The United Nations Framework Convention on Climate Change (UNFCCC) provides the basis for global action 'to protect the climate system for present and future generations'. Australia ratified the Convention in 1992. The Convention entered into force in 1994 after a requisite 50 countries had ratified it. There are now 193 Parties to the UNFCCC – almost all of the members of the United Nations.

Parties to the Convention have agreed to work towards stabilising 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'.

The Kyoto Protocol is an international agreement created under the UNFCCC in Kyoto, Japan in 1997. Australia's ratification of the protocol came into effect on 11 March 2008. The protocol aims to reduce

the collective greenhouse gas emissions of developed country parties by at least five per cent below 1990 levels during 2008 to 2012 – referred to as the first commitment period. Australia has a target for emissions of 108 percent of estimated emissions for 1990 or 591.5 Mt CO2-e.

At the United Nations climate change negotiations in Durban, South Africa in 2011, parties to the Kyoto Protocol decided to establish a second commitment period from 1 January 2013. A new global agreement that is intended to have legally binding commitments for all major emitters is due for finalisation by 2015 to come into effect in 2020 (Katestone 2013b).

The Australian Government has a constitutional power to ensure that Australia meets its international commitments, including those made under the UNFCCC. Due to the scale of the Project, there are several related national policies, statutes and regulations that are important to the development and operation of the Project, including:

- The *National Greenhouse and Energy Reporting* (NGER) *Act 2007* and regulations – The Project is anticipated to trigger the threshold for NGER and will have an ongoing obligation to estimate and report greenhouse gas emissions under the NGER Act;
- The *Clean Energy Act 2011* – Under current legislation, the Project will become a liable entity for the Carbon Pricing Mechanism, and based on its NGER report, have to surrender emissions units or pay a shortfall charge for each tonne of covered emissions each year. It is the stated intention of the new federal government to change this legislation; however, its policy is to retain NGER reporting; and
- The *Energy Efficiency Opportunities Act 2006* – The Project will identify, evaluate and report publicly on cost effective energy savings opportunities.

Further details of the applicable legislation and policies associated with greenhouse gas reporting for the Project is provided in Appendix 16.

4.6.3.2 Sources of Greenhouse Gas Emissions

Construction

The Project's construction phase will include the preliminary clearing of vegetation and construction of the mining infrastructure, including:

- CHPP facilities;
- Rail loop;
- Haul roads;
- Site buildings (such as workshops and administration buildings); and
- Exhaust ventilation shaft (production Year 5).

Construction activities will emit greenhouse gas emissions through, for example, the consumption of diesel fuel and the consumption of electricity to power equipment. The emissions associated with the construction phase were not able to be quantified at this current stage of Project design, but are expected to be minimal given the scale of construction activities.

Operations

Greenhouse gas emissions have been calculated for the following activities associated with the Project and the data are summarised in Table 4.94:

- Production of coal – activities related to the extraction of coal (fugitive) – opencut and underground mines;
- Consumption of diesel;
- Consumption of electricity; and
- Explosives usage.

Table 4.94 Summary of ROM Coal Production and Usage of Diesel, Electricity and Explosives for the Life of the Project

Year	ROM Coal Production (tpa)		Diesel Usage (kL)	Electricity Usage (MWh)	Explosives Usage (t)
	Underground	Opencut			
1	-	511,179	5,835	11,487	1,112
2	-	1,456,517	13,689	22,973	2,909
3	-	1,905,988	13,822	22,973	3,573
4	-	2,278,491	16,159	22,973	4,211
5	98,460	2,177,615	16,040	28,369	3,988
6	370,905	1,988,289	18,077	47,637	4,425
7	2,693,072	793,847	8,928	58,217	1,972
8	4,989,940	-	1,288	79,764	0
9	5,129,130	-	1,288	79,764	0
10	5,172,949	-	1,288	79,764	0
11	5,198,599	-	1,288	85,020	0
12	5,130,576	-	1,288	90,276	0
13	5,746,405	-	1,288	90,276	0
14	4,312,098	-	1,288	90,276	0
15	4,747,456	-	1,288	91,590	0
16	4,754,496	-	1,160	91,590	0
17	5,201,305	-	966	90,859	0
18	4,636,380	-	966	90,859	0
19	4,569,902	-	966	90,859	0
20	4,388,030	-	966	84,871	0
21	1,506,275	-	138	25,461	0

4.6.3.3 Methods for Estimating Greenhouse Gases

The main greenhouse gases influenced directly by human activities and included in carbon accounting are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and synthetic gases, such as sulphur hexafluoride (SF_6) hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). These gases vary in effect and longevity in the atmosphere, but scientists have devised a system named Global Warming

Potential to allow them to be described in equivalent terms to CO_2 (the most prevalent greenhouse gas) called equivalent carbon dioxide emissions (CO_2-e). A unit of one tonne of CO_2-e is the basic unit used in carbon accounting. An emissions inventory, or 'carbon footprint', is calculated as the sum of the emission rate of each greenhouse gas multiplied by the global warming potential. For example:

$$\textbf{tonnes } CO_2\textbf{-e} = \textbf{tonnes } CO_2 \times 1.0 + \textbf{tonnes } CH_4 \times 21 + \textbf{tonnes } N_2O \times 310$$

The Department of Climate Change and Energy Efficiency (DCCEE) monitors and compiles databases on anthropogenic activities that produce greenhouse gases in Australia. The DCCEE has published greenhouse gas emission factors for a range of anthropogenic activities. The DCCEE methodology for calculating greenhouse gas emissions is published in the National Greenhouse Accounts (NGA) Factors workbook (DCCEE 2010 and 2011a) and is based on Australian data. This workbook is updated annually to reflect current compositions in fuel mixes and evolving information on emission sources.

The scope that emissions are reported under, and the subsequent emission factors used are determined by whether an activity is within an organisation's boundary or not. Direct emission factors are used to calculate Scope 1 emissions from activities within the organisation's boundary. Indirect emission factors are used to calculate Scope 2 emissions from the generation of electricity purchased and consumed by an organisation. Scope 3 emissions occur as an indirect result of an activity. Scope 3 emissions related to electricity transmission losses and the off-site production of fuel have been accounted for during the assessment and are presented in.

The greenhouse gas intensity of each activity has been calculated using the simplified equation as follows:

Where:

GHG: Annual greenhouse gas emissions in tonnes of carbon dioxide equivalent (t CO_2-e)

E: Annual fuel input energy (GJ/yr)

EF: Emission factors for CO_2, CH_4 and N_2O (kg CO_2-e /GJ)

The total annual CO_2-e emissions are the sum of the CO_2-e emissions for each of the three greenhouse gases, CO_2, CH_4 and N_2O.

The emission factors that have been used to calculate greenhouse gas emissions are presented in Appendix 16.

4.6.3.4 Greenhouse Gas Inventory

The greenhouse gas emissions estimated for each year of operation of the mine are presented in Table 4.95 to Table 4.96. These figures include Scope 1 and 2 as well as Scope 3 components for which factors are included in the National Greenhouse Account Factors (electricity transmission losses and emissions related to fuel generation). A summary of the total greenhouse gas emissions is presented in Table 4.97.

Table 4.95 Estimated Scope 1 Greenhouse Gas Emissions for the Project (t CO_2-e)

Operational Year	Scope 1 Emissions							Total Emissions for Scope 1
	Fugitive emissions from extraction of coal (unground)	Fugitive emissions from extraction of coal (opencut)	Blasting of Material	Fuel Combustion				
				CO_2	CH_4	N_2O	Total CO_2-e	
1	0	153	189	15,587	45	113	15,744	16,087
2	0	437	495	36,564	106	264	36,934	37,865
3	0	572	607	36,920	107	267	37,293	38,472
4	0	684	716	43,163	125	312	43,599	44,999
5	30	653	678	42,844	124	310	43,277	44,638
6	111	596	752	48,285	140	349	48,774	50,234
7	808	238	335	23,848	69	172	24,089	25,470
8	1,497	0	0	3,441	10	25	3,476	4,973
9	1,539	0	0	3,441	10	25	3,476	5,015
10	1,552	0	0	3,441	10	25	3,476	5,028
11	1,560	0	0	3,441	10	25	3,476	5,036
12	1,539	0	0	3,441	10	25	3,476	5,015
13	1,724	0	0	3,441	10	25	3,476	5,200

Operational Year	Scope 1 Emissions							Total Emissions for Scope 1
	Fugitive emissions from extraction of coal (unground)	Fugitive emissions from extraction of coal (opencut)	Blasting of Material	Fuel Combustion				
				CO_2	CH_4	N_2O	Total CO_2-e	
14	1,294	0	0	3,441	10	25	3,476	4,770
15	1,424	0	0	3,441	10	25	3,476	4,900
16	1,426	0	0	3,097	9	22	3,129	4,555
17	1,560	0	0	2,581	7	19	2,607	4,168
18	1,391	0	0	2,581	7	19	2,607	3,998
19	1,371	0	0	2,581	7	19	2,607	3,978
20	1,316	0	0	2,581	7	19	2,607	3,924
21	452	0	0	369	1	3	372	824
Max	1,724	684	752	48,285	140	349	48,774	50,234
TOTAL	**20,594**	**3,334**	**3,772**	**288,530**	**834**	**2,085**	**291,449**	**319,149**

Table 4.96 Estimated Scope 2 and 3 Greenhouse Gas Emissions for the Project (t CO_2-e)

Operational Year	Scope 2 Emissions	Total Emissions for Scope 2	Scope 3 Emissions		Total Emissions for Scope 3
	Electricity Consumption		Electricity Transmission Losses	Fuel Generation	
1	10,108	10,108	1,378	1,194	2,572
2	20,216	20,216	2,757	2,800	5,557
3	20,216	20,216	2,757	2,828	5,584
4	20,216	20,216	2,757	3,306	6,063
5	24,964	24,964	3,404	3,281	6,686
6	41,920	41,920	5,716	3,698	9,415
7	51,231	51,231	6,986	1,826	8,813
8	70,192	70,192	9,572	264	9,835
9	70,192	70,192	9,572	264	9,835
10	70,192	70,192	9,572	264	9,835
11	74,818	74,818	10,202	264	10,466
12	79,443	79,443	10,833	264	11,097
13	79,443	79,443	10,833	264	11,097
14	79,443	79,443	10,833	264	11,097

Operational Year	Scope 2 Emissions	Total Emissions for Scope 2	Scope 3 Emissions		Total Emissions for Scope 3
	Electricity Consumption		Electricity Transmission Losses	Fuel Generation	
15	80,599	80,599	10,991	264	11,254
16	80,599	80,599	10,991	237	11,228
17	79,956	79,956	10,903	198	11,101
18	79,956	79,956	10,903	198	11,101
19	79,956	79,956	10,903	198	11,101
20	74,687	74,687	10,185	198	10,382
21	22,406	22,406	3,055	28	3,084
Maximum	80,599	80,599	10,991	3,698	11,254
Total	**1,210,756**	**1,210,756**	**165,103**	**22,098**	**187,201**

Table 4.97 A summary of the Total Greenhouse Gas Emissions for the Project (t CO_2-e)

Year	Scope 1	Scope 2	Scope 3	Total attributable emissions (Scope 1 & 2)
1	16,087	10,108	2,572	26,195
2	37,865	20,216	5,557	58,081
3	38,472	20,216	5,584	58,689
4	44,999	20,216	6,063	65,215
5	44,638	24,964	6,686	69,603
6	50,234	41,920	9,415	92,154
7	25,470	51,231	8,813	76,701
8	4,973	70,192	9,835	75,166
9	5,015	70,192	9,835	75,207
10	5,028	70,192	9,835	75,221
11	5,036	74,818	10,466	79,853
12	5,015	79,443	11,097	84,458
13	5,200	79,443	11,097	84,643
14	4,770	79,443	11,097	84,213
15	4,900	80,599	11,254	85,500
16	4,555	80,599	11,228	85,154
17	4,168	79,956	11,101	84,123
18	3,998	79,956	11,101	83,954
19	3,978	79,956	11,101	83,934
20	3,924	74,687	10,382	78,610
21	824	22,406	3,084	23,230
Max	50,234	80,599	11,254	92,154
Total	**319,149**	**1,210,756**	**187,201**	**1,529,904**

4.6.3.5 Potential Impacts on the State and National Greenhouse Gas Inventories

The data indicate emissions from electricity consumption are expected to have the greatest contribution to the total greenhouse gas emissions from the Project. Gases emitted from diesel combustion are the next largest contributor. Fugitive emissions and blasting emissions make up for the remainder of emissions. Fugitive emissions occur during the mining process due to the fracturing of coal seams, overburden and underburden strata. Direct measurement methods will be implemented for reporting during mine operation.

The peak annual emission rate of greenhouse gases (Scope 1 and 2) from the Taroborah Coal Project is 0.092 Mt CO_2-e in operational Year 6. This represents 0.02% of Australia's estimated 546.3 Mt CO_2-e of greenhouse gas emissions for 2011 (DCCEE, 2011b). The total greenhouse gas emissions reported during the 2009/2010 reporting period for Queensland were 134.3 Mt CO_2-e (DCCEE, 2012), excluding emissions and removals from Land Use, Land Use Change and Forestry (LULUCF). With the inclusion of emissions and removals from LULUCF, the total greenhouse gas emissions were 157.3 Mt CO_2-e. The peak annual emission rate of greenhouse gases from the Project would contribute approximately 0.06 % to this total.

The Project is expected to produce 77.8 Mt of saleable coal over a 21 year period to be used for electricity generation. Based on Australian Government emission factors (DCCEE, 2011a) the combustion of this volume of coal would release total Scope 1 emissions of 186 Mt CO_2-e to the atmosphere. Dividing the total emissions associated with combustion of the coal product by the anticipated mine life yields 8.85 Mt CO_2-e per year. For illustration purposes, this would equate to 1.6 percent of Australia's estimated domestic emissions in 2011, estimated to be 546.3 Mt (DCCEE, 2011b).

4.6.3.6 Greenhouse Gas Abatement Measures

The following direct greenhouse gas minimisation strategies are the preferred measures, consistent with best practice environmental management practices for the coal mining sector that shall be implemented for the Project where appropriate:

- Equipment purchase and energy efficiency;
- An energy efficiency audit will be undertaken, where appropriate, during the detailed design phase;
- The use of high efficiency electrical motors throughout the mine site and the use of variable speed drive pumps with high efficiency linings at the coal handling and preparation plant will be considered and implemented where practicable;
- Installing light sensitive switches on lighting equipment and energy efficient lamps throughout the Project site where practicable; and
- Installation of energy saving devices will be undertaken within the on-site buildings, where practicable.

Direct greenhouse gas minimisation strategies have been assessed to minimise greenhouse gas emissions resulting from Project activities through energy conservation.

No specific measures are proposed to mitigate coal seam gas emissions. An assessment of emissions is provided in Appendix 16 (Table 7), which shows that when considering emissions within the project context, as well as indirect emissions from electricity usage (Scope 1 and Scope 2), fugitive emissions

are predicted to be less than 2% of the total emissions. The coal is considered non-gassy, and as such there is little opportunity to further reduce these emissions.

During mine planning the following indirect strategies of greenhouse gas minimisation will be implemented:

- Haul truck scheduling, routing and idling times will be optimised to minimise the amount of diesel consumed;
- Pit access ramps will be optimised to minimise the amount of effort required for fully-laden trucks to climb;
- Haul roads will be compacted to reduce rolling resistance, where practicable;
- The location of ROM and overburden dumps will be optimised to minimise the amount of distance haul trucks need to cover whilst heavily laden;
- Adoption of a mining method that uses large equipment and economies of scale to significantly reduce greenhouse emissions;
- Extracting and transporting coal and overburden efficiently, thereby minimising the number of trips and fuel consumption;
- Recycling of refrigerants in equipment and air conditioning; and
- Minimising burning of vegetation if authorised under an approval.

Auditing and management of greenhouse gas minimisation will be undertaken using the following strategies:

- A greenhouse gas reduction management plan will be developed;
- Greenhouse awareness training at induction; and
- Development and maintenance of an inventory of emissions and sinks.

A Greenhouse Gas Reduction Management Plan will be developed for the Project that will include reporting and auditing procedures with the objective of achieving continual improvement in greenhouse gas emissions.

Auditing will include regular benchmarking studies to allow mine performance to be gauged relative to industry standards and, where the mine is not achieving these standards, programs will be implemented to achieve reductions.