Appendix L
Air Quality Impact Assessment

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F I N A L   R E P O R T

Caval Ridge Air Quality Impact Assessment - Technical Report

Prepared for

BMA Coal

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11 May 2009

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The Caval Ridge Mine (the Project) comprises the development of a new open cut coal mine south of Moranbah. Additional coal will be imported from the existing Peak Downs Mine and will be processed at the Project Coal Handling and Preparation Plant.

The air quality assessment of the proposed Caval Ridge Mine has evaluated the existing climate and air quality in the region, estimated the emissions of dust from the Project and predicted the air quality impacts from the project.

Ambient air monitoring data from the Caval Ridge, Peak Downs and Poitrel monitoring sites has been used to estimate the background air quality within the study region. This data suggests that the existing air quality at this location is good with no exceedences of the EPP(Air) objectives for dust recorded at the Project site during 2008.

Mining activities for the Project have been evaluated for three scenarios:

- **Year 1**, representing construction of the initial box cut in the Horse pit, and mining operations in the Heyford pit (for which the box cut has already been completed);
- **Year 2**, representing the first year of mining operations on the western side of the proposed mining area; and
- **Year 20**, representing mining towards the eastern side of the mining lease and reflecting the increasing proportion of overburden removed as the mining depth increases.

The dust emissions from these activities have been assessed and used in dispersion modelling to predict impacts at nearby residential locations. For each of the years noted above, three scenarios have been modelled:

- Typical operations;
- Worst-case emissions; and
- Upset emissions.

Results of the dispersion modelling suggest that air quality impacts due to construction activities in Year 1 are below the EPP(Air) objectives for TSP, $PM_{2.5}$ and dust deposition at residential locations. Operational impacts in Year 2 and Year 20 also satisfy the EPP(Air) objectives for TSP, $PM_{2.5}$ and dust deposition for typical operating conditions.

The dispersion modelling highlights the potential for PM_{10} levels to exceed the EPP(Air) objective of 50 µg/m^3 for the 24-hour average concentration at some sensitive receptor locations for each of the Year 1, Year 2 and Year 20 scenarios modelled. A detailed investigation into modelled worst-case meteorological conditions highlights the strong dependence of the model results on the model default value of the mixing height which plays a key role in the calculation of night time impacts. This insight into the model behaviour has lead to BMA commissioning a model input validation exercise in order to assess the degree of overestimating of night time impacts that may be attributable to this tuneable parameter. This study is currently underway.

Impacts under worst-case short-term operating conditions, accounting for the possible proximity of key dust-generating equipment to either the north or south of each pit, show that high dust levels are possible to the north of the Project under adverse meteorological conditions. An ambient air monitoring program has been developed that will monitor the impact of dust-generating emission sources at sensitive receptor locations. The

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information obtained from the monitoring program will feed into the operational management of site-based dust emission sources.

Estimated impacts for upset conditions, namely the failure of dust suppression measures on the haul roads, shows that high dust levels are predicted for locations to the north and west of the Project. The occurrence of these upset conditions can be managed by BMA by ensuring that adequate dust suppression measures are maintained at all times.

Mitigation measures have been proposed for the project. These comprise a combination of the following:

- Engineering controls;
- Dust suppression measures;
- Rehabilitation of exposed surfaces;
- Operational procedures; and
- Measurement of ambient air quality.

The implementation of these procedures is expected to result in adequate management of dust emissions from the Project. The mitigation measures and procedures to minimise dust release from the site have been incorporated into the Environmental Management Plan for the Project.

Introduction Section 1

The Caval Ridge Mine (the Project) comprises the development of a new open cut coal mine south of Moranbah. Additional coal will be imported from the existing Peak Downs Mine and will be processed at the Coal Handling and Preparation Plant.

The air quality assessment for the proposed Caval Ridge coal mine (the Project), to be operated by BMA, has considered the potential release of dust from the site due to earth moving and mining activities associated with operation of the coal mine. This assessment evaluates the potential impacts, together with the proposed mitigation measures, to determine the potential impacts at local residential communities.

The air quality assessment comprises an evaluation of existing sources of air pollution which contribute to background levels of particulate matter and the local climate. These factors influence the way in which dust generated by the mine may affect ambient air quality in the region.

Dispersion modelling has been performed using the Queensland Environmental Protection Authority (EPA) approved Calpuff dispersion modelling package. An annual meteorological dataset has also been prepared using a combination of the CSIRO's prognostic meteorological model TAPM and the Calmet model. The meteorological data used considers the range of meteorological conditions that may occur over the year, and includes the worst-case meteorological conditions that are expected to arise on site.

A detailed emissions inventory has been established using activity data provided by BMA, in conjunction with emission factors from both the Australian National Pollutant Inventory (NPI) emission estimation manual and USEPA AP-42 emission estimation manual, which are used in the absence of site-specific data.

The predicted impacts from mine operation on local air quality are presented in this assessment, incorporating BMA's proposed air quality control methods to maintain air quality impacts to an acceptable level.

Environmental Values — Section 2

Environmental values considered in the assessment are the following:

- Legislation that is applicable to ambient air quality in Queensland;
- Climate of the region around Caval Ridge mine; and
- Existing air quality in the vicinity of the project.

Air emissions from the project comprise mainly particulate matter, also referred to as dust. Particulate matter for this project is described in three size categories: particulate matter less than 2.5 µm ($PM_{2.5}$) in diameter, particulate matter less than 10 µm (PM_{10}), and total suspended particulates (TSP). Minor pollutants that may be emitted from site operations include combustion pollutants from truck exhaust, namely sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) and trace quantities of volatile organic compounds (VOCs). Due to the scale of the emission of these minor pollutants, impacts of NO_2, SO_2 and VOCs have not been quantified as part of this assessment; further discussion is presented in Section 3.1.

2.1 Legislative Framework

2.1.1 Queensland

In Queensland, air quality is managed under the Environment Protection Act 1994 (*the Act*), the Environmental Protection Regulation 2008 [1] (*the Regulation*) and the Environmental Protection (Air) Policy 2008 [2] (*EPP (Air)*) which came into effect on January 1, 2009.

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

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

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

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

[1] Queensland Government, *Environmental Protection Regulation* 2008, Office of the Queensland Parliamentary Counsel.

[2] Queensland Government, *Environmental Protection (Air) Policy* 2008, Office of the Queensland Parliamentary Counsel

Section 2 Environmental Values

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

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

The Queensland EPA has also adopted a guideline for dust deposition of 4 g/m²/month to ensure adequate protection from nuisance levels of dust. This level was derived from ambient monitoring of dust conducted in the Hunter Valley, NSW in the 1980's. The former NSW State Pollution Control Commission set the level to avoid a loss of amenity in residential areas, based on the levels of dust fallout that cause complaints. The current guideline level adopted in NSW [3] is that the maximum total dust deposition level should not exceed 4 g/m²/month, and that the maximum increase in deposited dust is 2 g/m²/month.

2.1.2 National

National air quality guidelines are specified by the National Environment Protection Council (NEPC). The National Environment Protection Measure (NEPM) (Ambient Air Quality) was released in 1998 [4] (with an amendment in 2003), and sets standards for ambient air quality in Australia.

The NEPM (Ambient Air Quality) specifies national ambient air quality standards and goals for the following common air pollutants: carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), particulates (as PM_{10} and $PM_{2.5}$), and lead (Pb).

In 2004 the NEPM (Air Toxics) was released which included monitoring investigation guidelines for five compounds classified as air toxics: benzene, benzo (a) pyrene, formaldehyde, toluene and xylenes. These toxic air pollutants are not released in significant quantities from the Project and have not been addressed in the air quality assessment.

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

The NEPM standards are intended to be applied at monitoring locations that represent air quality for a region or sub-region of more than 25,000 people, and are not used as recommendations for locations near industrial facilities. This report has focussed on demonstrating compliance with the EPP (Air) air quality objectives.

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

[4] National Environmental Protection Council, *National Environment Protection Measure for Ambient Air Quality*, 1988, with amendment in 2003

2.1.3 Emission Standards

Emission standards are applicable for releases to air from stack sources, where the quantity of pollutants released to the atmosphere can be quantified through source testing. No such sources exist for the Caval Ridge Mine as there are no power generators or stack release points on site. Hence, the emissions from the site cannot be compared to emission standards.

2.1.4 Project Goals

The EPP(Air) objectives and Queensland EPA guideline for TSP, PM_{10}, $PM_{2.5}$ and dust deposition are included in Table 2-1.

Table 2-1 Summary of Project Goals for Particulate Matter

Pollutant	Averaging Period	Objective or Goal	Jurisdiction
Total suspended particulates	Annual	90 µg/m³	EPP(Air)
PM_{10}	24-hour	50 µg/m³	EPP(Air), NEPM (5 exceedences allowed)
$PM_{2.5}$	24-hour	25 µg/m³	EPP(Air), NEPM
	Annual	8 µg/m³	EPP(Air), NEPM
Dust deposition	Monthly	4 g/m²/month	Queensland EPA

2.2 Existing Climate

The climate at Caval Ridge has been documented in Section 4 of the EIS. The data for wind speed, wind direction, temperature, temperature inversion, stability class and mixing height are derived from meteorological modelling that has been conducted for the project. This is detailed further in Section 3.5 of this report.

2.3 Existing Air Quality

The Caval Ridge area has several operating coal mines, coal seam gas projects and a quarry in addition to agricultural activities such as cropping and grazing which are all sources of dust.

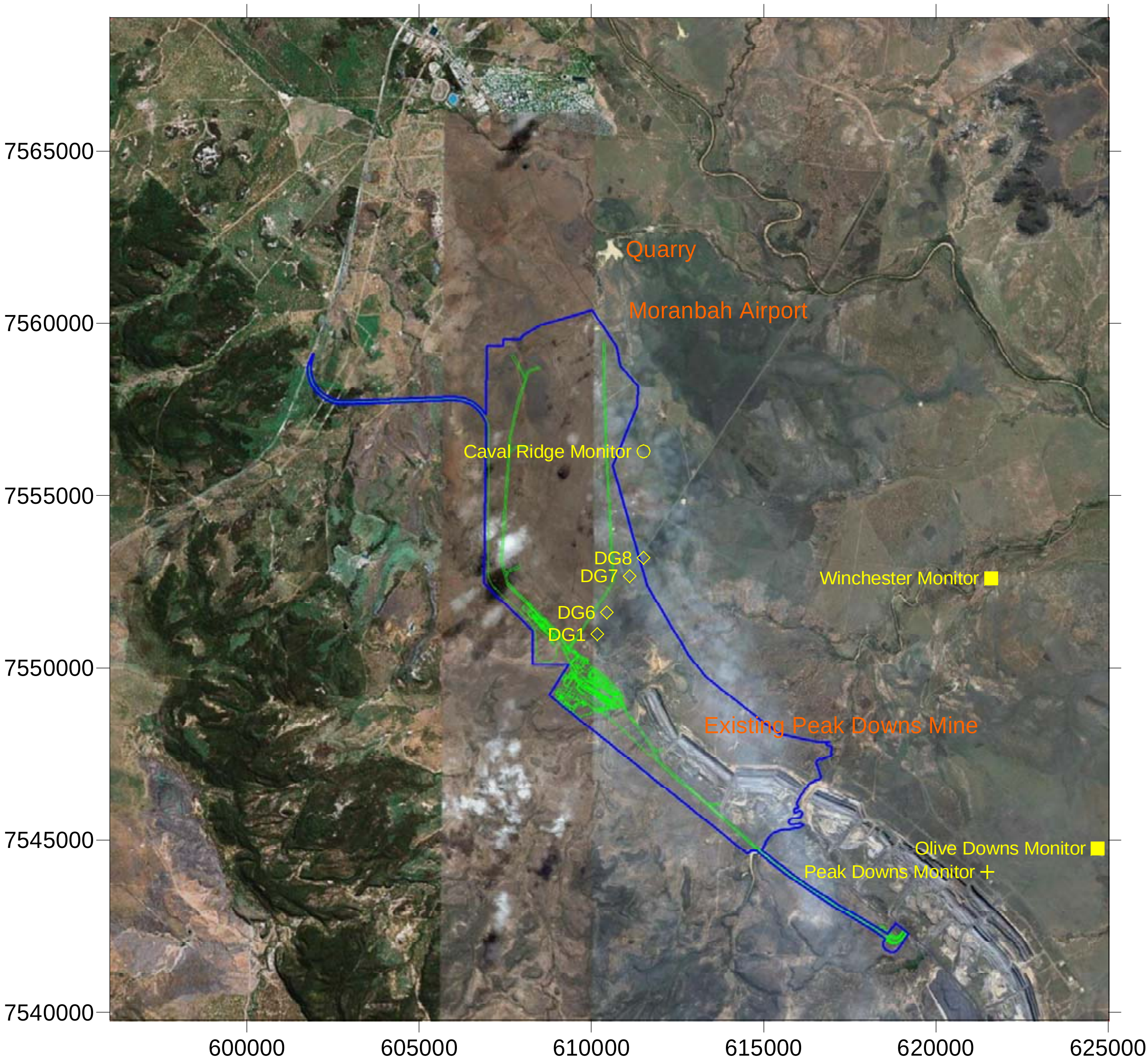
There are no EPA monitoring stations in the vicinity of the site; however BMA has provided ambient dust measurements from its nearby mining operations (Peak Downs and Poitrel). In addition, a site-specific monitoring station was installed in December 2007 to provide data on the existing levels of PM_{10} at the project site. The parameters measured and the location of each site is described below:

- **Peak Downs Mine**. Ambient PM_{10} and dust deposition. PM_{10} measurements were taken at a site to the east of current mining operations, near Dysart-Moranbah Road, which is approximately 0.7 km from current mining activities. Dust deposition measurements are available from four locations (DG1, DG6, DG7 and DG8) along the southern side of the Peak Downs Highway which are approximately 8 km north of current mining activity at Peak Downs Mine. Due to the changing operational boundaries with the establishment of Caval Ridge Mine, these locations will be within the Project boundary and close to the proposed CHPP. Measurements made at Peak Downs Mine are influenced by operations from the mine.

Section 2 Environmental Values

- **Poitrel Mine**. Ambient PM_{10} monitoring data are available for two residential locations near Poitrel, namely Olive Downs and Winchester. These monitors are located at homesteads and may be affected by farming activities, local access on unsealed roads and exhaust emissions from farm equipment.
- **Proposed Caval Ridge Mine**. Ambient PM_{10}. A dust monitor was installed in December 2007 on the eastern side of the project site, located on a property that is owned by BMA, but is currently leased for cattle grazing. The monitor was located to the west of the homestead, and more than 200 m from frequently-trafficked unsealed roads. Data are available from 18 December 2007 through 31 December 2008.

The locations of the monitoring sites in the vicinity of Caval Ridge Mine and important industrial sources in the vicinity of the site are shown on Figure 2-1.



Peak Downs PM_{10} Monitor
Peak Downs Dust Deposition gauges
Caval Ridge PM_{10} Monitor
Poitrel-operated PM_{10} Monitors

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance

URS

Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT

Title: **DUST MONITORING LOCATIONS AND INDUSTRIAL SOURCES IN THE VICINITY OF CAVAL RIDGE MINE**

Drawn: AB	Approved: CB	Date: 17-02-2009	Figure: 2-1	Rev:A
Job No: **4262 6158** /6161	File: 42626158-g-165.srf			A4

2.3.1 Ambient PM_{10} Monitoring

The time series of the 24-hour average ground-level concentration of PM_{10} obtained at the Caval Ridge site is presented in Figure 2-1 and summarised in Table 2-2. The minimum, maximum, average, 95th and 70th percentile concentrations recorded at each site are presented.

Over the duration of the monitoring period, there were no recorded exceedences of the EPP(Air) objective of 50 µg/m^3 at the Caval Ridge monitoring site.

Table 2-2 Measurements of PM10 Concentration in the Vicinity of the Project (µg/m³)

Averaging Time	Statistic	Caval Ridge	Peak Downs Mine	Olive Downs	Winchester
24 hour average	Minimum	2.3	1.0	0.0	0.0
	Maximum	36.6	49.5	94.0	69.3
	95th percentile	28.6	n/a	19.4	19.9
	70th percentile	18.8	n/a	11.0	11.0
	Average	15.7	22.8	10.0	10.2
Sampling dates		18-12-07 to 31-12-08	10-1-07 to 16-8-07	18-4-07 to 1-10-08	25-4-07 to 1-10-08
Sampling duration		12 months	8 months	18 months	18 months
Sampling frequency		Daily	Approximately every 10 days	Daily	Daily
EPP (Air) objective		**50**			

Included as Figure 2-3 is the 1-hour average concentrations of PM_{10} as measured at the Caval Ridge monitoring site. In order to focus on the trend of the data rather than the concentration levels that were recorded, the hourly concentrations have been scaled by the maximum hourly-average concentration recorded during the entire monitoring period. Also indicated in the figure are the wind directions associated with dust sources that may originate from the Peak Downs Highway, Peak Downs Mine, or Moranbah Airport. These have been overlaid on the data in order to highlight potential dominant dust emission sources. The clustering of data points within the band associated with the Peak Downs Highway is illustrative of the frequency of winds from the east and southeast (refer to Section 4 of the EIS). Elevated levels of dust are seen to occur from all directions with no dominant dust emission source(s) indentified as biasing the trend of the data at this location.

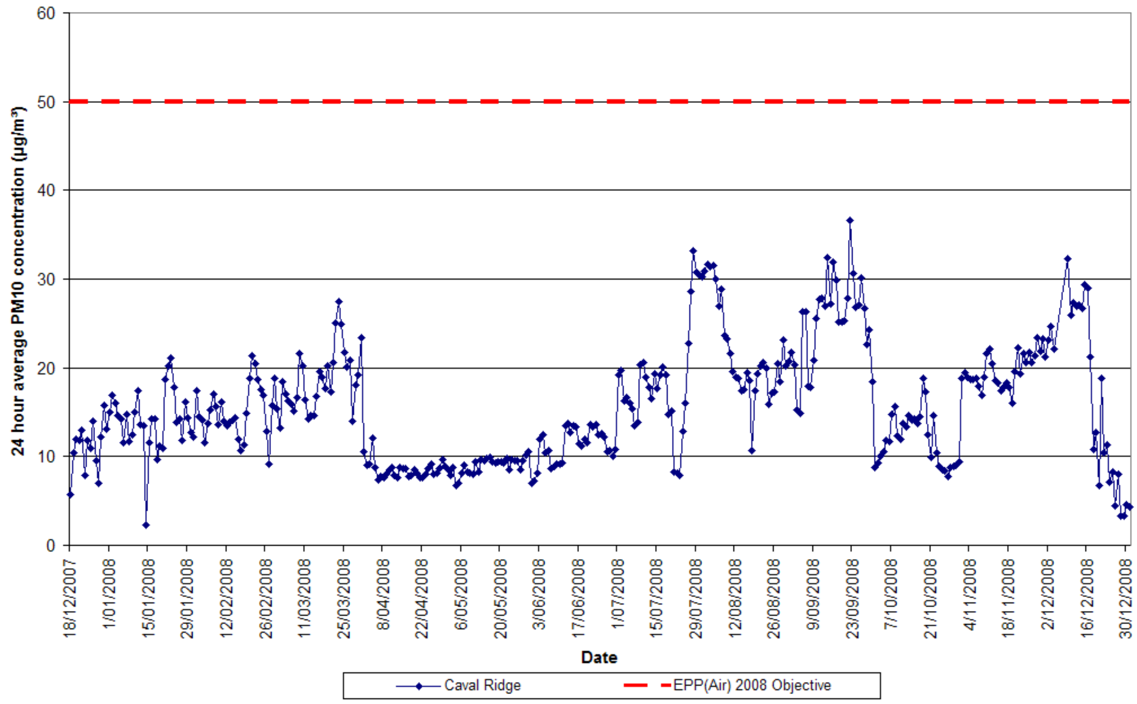


Figure 2-2 Time Series of the 24-Hour Average Concentration of PM10 Recorded at the Caval Ridge Monitoring Site, 18/12/2007 through 31/12/2008

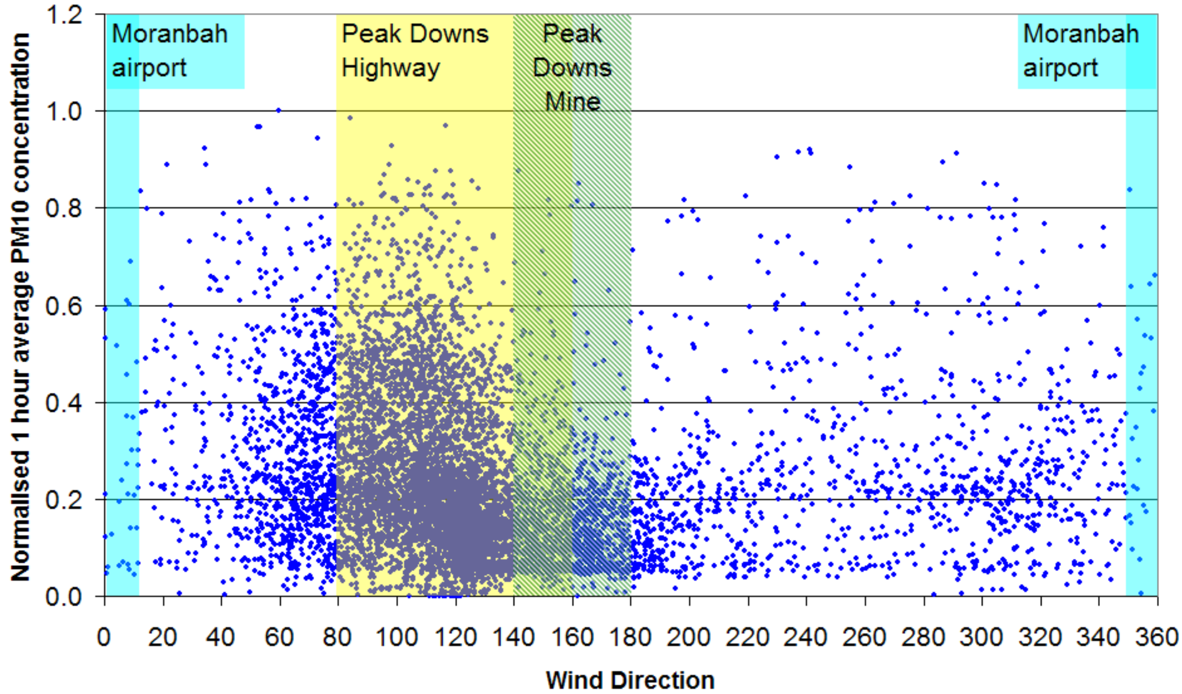


Figure 2-3 Normalised 1-hour Average Concentration of PM10 as a Function of Wind Speed, 18/12/2007 through 31/12/2008

2.3.2 Ambient Dust Deposition Monitoring

Measurements of dust deposition are available from dust deposition gauges that are maintained by Peak Downs Mine and located to the south of Peak Downs highway on the Project site. A summary of dust deposition records at these locations is presented in Table 2-3.

Table 2-3 Results of Dust Deposition (g/m2/month) for 2007 Measured On-site by Peak Downs Mine

Averaging Time	Statistic	Peak Downs Mine (for all on-site locations)
Monthly	Minimum	0.3
	Maximum	10.1
	Average	1.5
Sampling dates		1-1-07 to 31-10-07
Sampling duration		10 months
Sampling frequency		Monthly
QLD EPA guideline		**4**

Air Quality Assessment Methodology

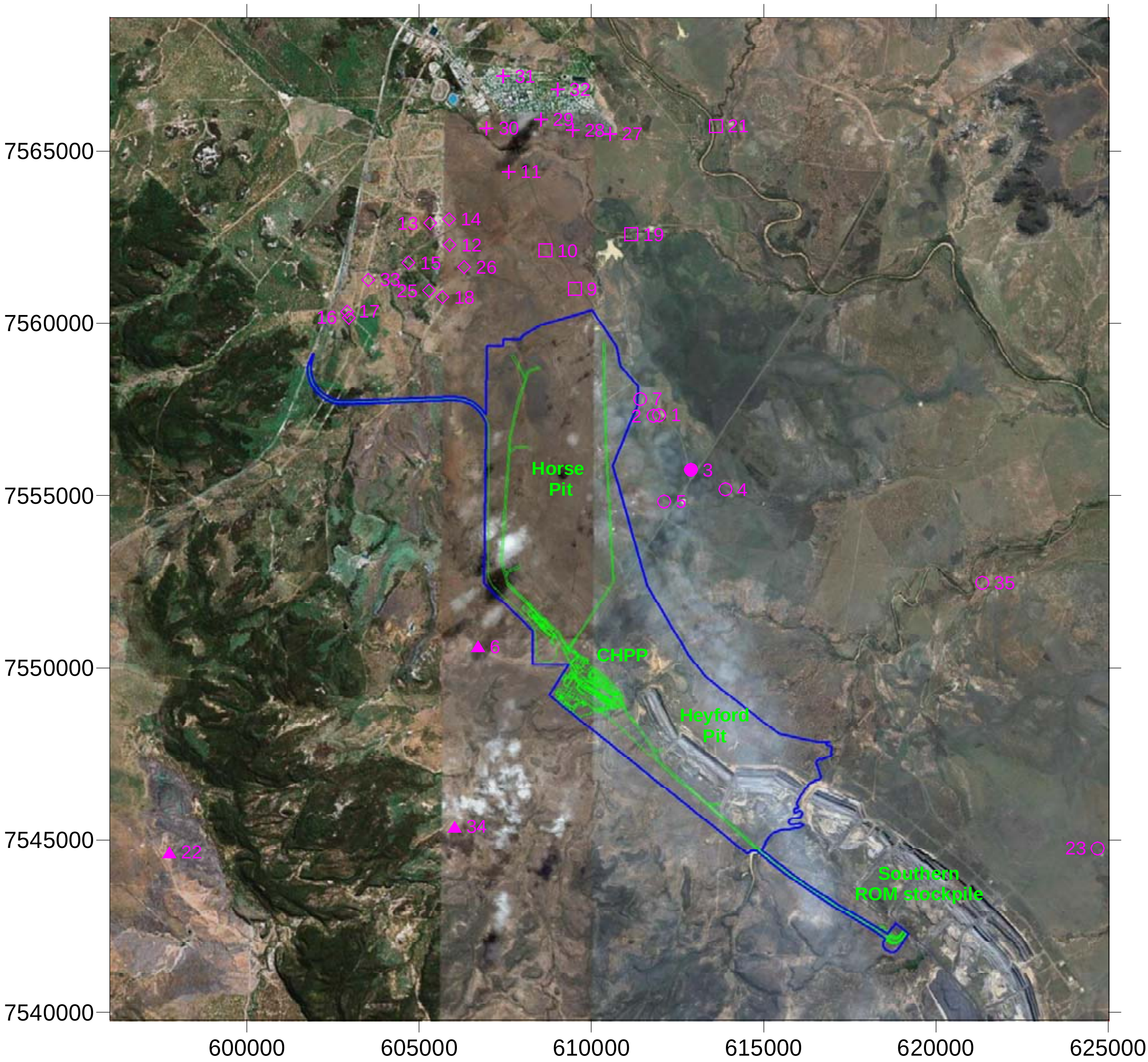
Dispersion modelling has been used to assess the likelihood of adverse air quality impacts at sensitive receptor locations. Air quality impacts resulting from emissions of dust from project-related activities under typical, worst case and upset operating conditions have been considered. The details of the assessment methodology are presented below. Results of the dispersion modelling are presented in Section 4 of this assessment.

3.1 Sensitive Receptor Locations

A review of surrounding land use information, aerial photographs and information provided by the Proponent has been used to identify nearby sensitive receptor locations. Here “sensitive receptor” is taken to mean individual residential locations in the vicinity of the Project as well as the town of Moranbah. For ease of analysis and presentation, receptors were combined into groups based on location as indicated in Table 3-1. The locations of these receptors in relation to Caval Ridge Mine are illustrated in Figure 3-1, with property details indicated where as appropriate.

3.1.1 Other Land Use Considerations

Located on the northeast boundary of the project site is the Moranbah Airport which is owned and operated by BHP Coal Pty Ltd. The airport is used primarily for the transport of coal mine workers into and out of the region. The airport normally operates during daylight hours but does have lighting capabilities in case of an emergency (for example the need to fly in a medical doctor). Flights are diverted to Mackay Airport located approximately 200 km to the northeast if required. Meteorological information is currently not being collected at the Moranbah Airport though it is understood that this capability is currently under investigation. Based on personal communication with an Airport representative, early morning fog occurs during winter an estimated 1 to 2 days per year on average and a maximum of 5 days per year. Particulate matter has the potential to act as cloud condensation nuclei and combined with elevated relative humidity levels may initiate the onset of foggy conditions. Due to the daytime-only operation of the airport combined with the infrequent occurrence of fog, impacts on emissions of dust from the Project on visibility and fog-potential at the airport have not been considered further.



Receptor Groups used in Air Quality assessment

Moranbah	+	Homesteads East of site	○
Southern Moranbah	◇	Homesteads West of site	▲
Homesteads North of site	□	Commercial premises	●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT		Title: SENSITIVE RECEPTOR LOCATIONS IN THE VICINITY OF CAVAL RIDGE MINE
URS	Drawn: AB	Approved: CB	Date: 17-02-2009
	Job No: 4262 6158 /6161	File: 42626158-g-152.srf	Figure: 3-1	Rev:A A4

Table 3-1 Sensitive Receptor Locations in the Vicinity of the Project

Receptor Group	Receptor Description	Receptor Number for Air Quality Modelling	UTM Easting Coordinate (m)	UTM Northing Coordinate (m)
Moranbah	Moranbah town	11	607598	7564396
Moranbah	Moranbah town	27	610542	7565496
Moranbah	Moranbah town	28	609454	7565601
Moranbah	Moranbah town	29	608538	7565916
Moranbah	Moranbah town	30	606961	7565657
Moranbah	Moranbah town	31	607430	7567168
Moranbah	Moranbah town	32	609029	7566790
Southern Moranbah	Railway Siding Rd	12	605881	7562269
Southern Moranbah	Railway Siding Rd	13	605314	7562907
Southern Moranbah	Railway Siding Rd	14	605863	7563024
Southern Moranbah	Railway Siding Rd	15	604691	7561758
Southern Moranbah	Railway Siding Rd	17	602915	7560342
Southern Moranbah	Long Pocket Rd	18	605673	7560755
Southern Moranbah	Long Pocket Rd	25	605295	7560949
Southern Moranbah	Long Pocket Rd	26	606308	7561628
Southern Moranbah	Railway Siding Rd	33	603518	7561264
Homesteads N of site	Homestead on Moranbah Access Rd, Anglo Coal	10	608664	7562107
Homesteads N of site	Homestead - Grosvenor Downs	19	611156	7562578
Homesteads N of site	Homestead E of Moranbah (Flohr)	21	613617	7565727
Homesteads E of site	BMA Homestead (Percy Hornery)	1	611967	7557336
Homesteads E of site	BMA Homestead (Percy Hornery)	2	611804	7557308
Homesteads E of site	Homestead (Coolibah)	4	613889	7555181
Homesteads E of site	Homestead (Hornery)	5	612115	7554832
Homesteads E of site	BMA Homestead on Moranbah Access Rd	7	611410	7557801
Homesteads N of site	Homestead on Moranbah Access Rd, Anglo Coal	9	609528	7560998
Homesteads E of site	Homestead (Olive Downs)	23	624695	7544763
Homesteads E of site	Homestead (Winchester)	24	621596	7552598
Homesteads E of site	Homestead (Winchester)	35	621345	7552469
Homesteads W of site	Homestead (Rowe)	6	606708	7550623
Homesteads W of site	Homestead to W of site	22	597752	7544645
Homesteads W of site	Homestead on Peak Downs Highway	34	606026	7545393
Commercial premises	Shell Service Station	3	612880	7555741

3.2 Pollutants

Emissions from the Project are generated primarily from activities that move overburden and coal. The main pollutant of concern is dust and to a lesser extent emissions associated with the combustion of diesel fuel in mobile equipment.

The emissions and impacts of dust from Project-related activities, comprising total suspended particulates (TSP), particulate matter less than 10 µm in diameter (PM_{10}), particulate matter less than 2.5 µm in diameter ($PM_{2.5}$), and dust deposition have been considered in this assessment.

Air pollutants that result from the combustion of diesel fuel include sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and trace quantities of volatile organic compounds (VOCs). Due to the scale of diesel fuel that is estimated to be consumed on site and the proximity of the sensitive receptors to the Project site (Figure 3-1), these pollutants are not considered to be emitted in sufficient quantities to impact significant on air quality at sensitive receptor locations. Thus, air quality impacts associated with sulphur dioxide, nitrogen dioxide and VOCs have not been considered further.

3.3 Estimates of Background Air Quality

A description of the existing air quality environment based on data collected at the Caval Ridge monitoring site was presented in Section 2.3. This data has been used to estimate a background concentration of TSP, PM_{10}, $PM_{2.5}$ and dust deposition.

In general, the background concentration of a particular pollutant is meant to represent the air quality environment that would exist in the absence of contributions from anthropogenic sources. Thus the background concentration includes impacts from all naturally occurring emission sources. Depending on the study area and the pollutant(s) under consideration, natural sources may include (but may not be limited to): bush fires; dust storms; biogenic emissions; etc.

In practice however, monitoring is seldom conducted in areas absent of anthropogenic sources with roads, industry, agriculture and residential activities (as well as others) all potentially impacting on monitored pollutant levels to varying degrees. Thus depending on which emission sources are modelled explicitly and which sources (if any) are meant to be represented by the "background" concentration, there is the potential to double count the impact of emission sources when basing estimates on observational data.

The approach used to estimate background levels is further complicated in an air shed that may be influenced by existing (non Project-related) emission sources that are not explicitly represented in the dispersion modelling. In this case data used to represent background levels may be sensitive to the location of the monitoring site with levels potentially varying with (for example) wind speed, wind direction and atmospheric stability.

In practice, the interpretation of background air quality varies from assessment to assessment. Here "background" air quality is used to represent the current air quality environment as only Project-related dust emission sources have been explicitly modelled. The regional airshed, however contains emissions from dust generating activities at other mine sites (for example Peak Downs), local farming etc. and thus for this assessment the terminology "background" is synonymous with "existing" environment.

In Queensland a conservative approach to estimating background levels has typically been adopted where a single value corresponding to the 95^{th} percentile of the data has typically been used. Approaches vary however, with the Victorian EPA recommending the use of the 70th percentile[5]. The approach in NSW is different again with the data time series utilised when available[6].

The 'appropriate' percentile may depend on a number of factors including (but may not be limited to):

- Representativeness of the data set in terms of location and local influences;
- The degree of wind direction dependence of elevated levels of pollutants recorded at the site;
- The dominance of a dust emission source(s) that is not explicitly accounted for in the dispersion modelling (This may suggest a spatially varying background level is more representative than a single value applied to all sites within the study region); and
- The degree of 'contamination' from a dust emission source(s) that are explicitly accounted for in the dispersion modelling.

For the purposes of this assessment, an estimate of the background concentration is required for the annual average concentration of TSP and $PM_{2.5}$, the 24-hour average concentration of PM_{10} and $PM_{2.5}$, as well as dust deposition.

Although local and regional activities will have an impact on air quality at the Caval Ridge monitoring site, the lack of dependence of the data on wind direction indicates an absence of a dominant emission source(s) at this location. Thus we have used the Victorian EPA recommended 70th percentile to represent the existing air quality environment within the area having the highest potential for impacts from dust emissions associated with the Project. The data presented in Table 2-2 suggests a background concentration of 18.8 µg/m³ for the 24-hour average concentration of PM_{10}.

The annual average of PM_{10} as measured at the Caval Ridge site was 15.7 µg/m³.

$PM_{2.5}$ and TSP concentrations have not been directly measured at the Project site.

Based on data collected in the vicinity of coal mines and presented in The Australian Coal Review[7], an average of 40% of TSP was found to consist of particles in the size range of PM_{10}. Particles in the size range of $PM_{2.5}$ were found to comprise only 4% of TSP or equivalently 10% of PM_{10}. This is in sharp contrast to the urban environment which is dominated by combustion sources of particulate matter and where TSP is found to be comprised of 60% of PM_{10}.

Thus for the purposes of this assessment and considering the predominantly rural environment within the study area, the following estimates of background levels of dust will be used (referring to Table 2-2 and Table 2-3):

- Annual average concentration of TSP of 26.2 µg/m³;
- 24-hour average concentration of PM_{10} of 18.8 µg/m³ (based on the 70th percentile);

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[5] Victorian Government Gazette, Special, Friday 21 December 2001.

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

[7] Claire Richardson, *Fine Dust: Implications for the Coal Industry*, The Australian Coal Review, April 2000.

- 24-hour average concentration of $PM_{2.5}$ of 2.9 µg/m³ (based on the 95th percentile for PM_{10}). The 95th percentile has been selected in order to provide a conservative estimate of the background levels of $PM_{2.5}$ within the more urbanised environment of Moranbah due to the dominance of combustion emission sources. This is likely to be an over estimate of $PM_{2.5}$ background levels in rural areas;
- Annual average concentration of $PM_{2.5}$ of 1.6 µg/m³; and
- Dust deposition of 1.5 g/m^2/month.

3.4 Air Emissions from the Project

Mining activities at Caval Ridge will take place at the Horse and Heyford pits, with a nominal production capacity of 5.5 Mtpa of product coal. In addition, a nominal 2.5 Mtpa of coal from Peak Downs Mine will be loaded from the Southern ROM and transported by overland conveyor to the Coal Handling and Preparation Plant (CHPP) at Caval Ridge for washing and export. The additional coal from the Southern ROM has been included in the total CHPP capacity of 8 Mtpa.

To represent the progressive development of the mine, three years of operation have been modelled:

- **Year 1**, representing construction of the initial box cut in the Horse pit, and mining operations in the Heyford pit (for which the box cut has already been completed) ;
- **Year 2**, representing the first year of mining operations on the western side of the proposed mining area; and
- **Year 20**, representing mining towards the eastern side of the mining lease and reflecting the increasing proportion of overburden removed as the mining depth increases.

The mining processes that will generate dust are as follows:

- Creation of initial box cut. This entails the use of the truck and shovel fleet to remove overburden and place in the box cut disposal area, located directly to the west of the box cut. This activity is the construction of Horse Pit (Year 1) but does not include construction of other infrastructure such as the CHPP.
- Pre-strip removal of overburden. The truck and shovel fleet is used to remove the overburden from the upper levels of the pit (close to the natural surface level). The overburden is dumped to in-pit dumps at the back of the working section of the pit, and located at the upper levels of the dumps. Pre-strip overburden material is used to fill in the 'valleys' created by progressive passes of the dragline.
- Dragline removal of overburden. The draglines operate close to the bottom of each pit, with two located in Horse Pit and one in Heyford Pit. These remove overburden and dump to the lower sections of the in-pit dumps. Each dragline has an accompanying dozer to assist its operation.
- Excavator removal of coal. The excavators operate on the coal seam, extracting coal and dumping into trucks for transport to the CHPP.
- Drilling and blasting. These activities will take place on both overburden and coal seams. Drilling takes place for approximately 12 hours per day, while blasting occurs up to several times per week. For

dispersion modelling purposes, blasting has been assumed to occur only at 11am each day to represent the daily nature of this operation, with blasting occurring in each pit.

- Dozers, shovels and graders. These units operate as support to the draglines, truck and shovel fleet, on the overburden dumps and on the coal stockpiles.
- Box-cut spoil disposal area and in-pit dumps. These overburden dump areas are sources of dust when there is activity on the stockpile, such as truck dumping or grader movement. The dumps are also a source of wind-generated dust prior to rehabilitation, which has been advised by BMA to take a period of 5 years for effective dust control from rehabilitation.
- Trucks on haul roads. Trucks are used to transport run-of-mine (ROM) coal to the CHPP for processing and to transport overburden to the dumps. Trucks are also used to transport the rejects from the CHPP to Horse Pit for co-disposal with the overburden. Truck movements generate dust on unsealed roads.
- ROM coal handling. The ROM coal handling area, adjacent to the CHPP, comprises several activities which are sources of dust. These are:
  - dumping coal at the ROM coal receival;
  - dozer operations;
  - coal crushing and sizing (grizzly, secondary and tertiary sizing);
  - conveying;
  - stacking and reclaiming coal on raw coal stockpiles;
  - transfer points; and
  - wind-generated dust on raw coal stockpiles.
- ROM coal from the Southern ROM. This coal is crushed at the Southern ROM receival station, which also includes dozer handling. It is transported by overland conveyor to the ROM coal stockpile. The additional 2.5 Mtpa of product coal (equivalent to approximately 5 Mtpa of ROM coal) has been accounted for in the throughputs of the raw coal stockpile, the CHPP, product coal stockpile and the train load-out.
- Coal Handling and Preparation Plant (CHPP). Once coal enters the CHPP, it is processed wet to remove dirt and to separate material that does not meet the product specification. These wet activities are not sources of dust.
- Product coal handling. The product coal leaves the CHPP with a high level of moisture, which is above the dust extinction moisture content[8], so the initial loading of product coal onto stockpiles is not considered to

[8] Dust extinction moisture (DEM) content is the lowest moisture content at which wind-generated dust from the material does not occur. A study by Ports Corporation of Queensland from 2006 (Abbot Point Coal Terminal Expansion Stage 3 - predicted average terminal dust emissions at throughput levels of 15 Mtpa and 50 Mtpa, accessed from http://www.pcq.com.au in November 2008) shows that the DEM is between 5 and 7% moisture content for Queensland coals.

be a source of dust. Reclaiming of the product coal can generate dust, as the coal may be on a stockpile for up to one week. The product coal stockpile is a source of wind-generated dust.

- Rejects handling. Rejects from the CHPP are trucked back to Horse Pit for co-disposal with the overburden. The truck movements and dumping activities have been accounted for in the assessment.
- Train load out. The train load out facility entails the dumping of product coal into the rail wagons.

The modelling of typical mine operations has been based on the average annual emissions from the site, occurring at any location over the pit area. This represents the spatial extent of dust emissions that may arise from any part of the mine according to the activities at each location. A meteorological data for one year has been used so that a range of meteorological conditions is considered, particularly the distribution of wind direction in the locality.

In addition to typical operations that are conducted on site, a worst-case scenario with pit activities occurring to the north or south of each pit has been modelled. An upset condition, based on inadequate dust control from haul roads, has also been modelled.

3.4.1 Emission Factors and Control Measures

Emission Estimation Methodology

Data on the emissions of dust from the proposed Project cannot be obtained from direct measurement, as the project is not yet operational. The National Pollutant Inventory (NPI) has a series of Emission Estimation Technique Manuals that are intended to provide data on emissions of air pollutants during typical operations, and which are based on measurements of dust emissions from other operational coal mines in Australia. The NPI Emission Estimation Technique Manual for Mining (NPI, 2001) has been used to provide data to estimate the amount of TSP and PM_{10} emitted from the various activities on a mine site, based on the amount of coal and overburden material mined as provided by BMA. The emission factor for truck movements on haul roads has been derived from the US EPA's AP42 emission estimation manual for unpaved roads.

Site-specific parameters were used to derive emission factors for trucks on unpaved roads, draglines, excavators, shovels, graders, dozers and blasting. The input parameters used for the assessment are listed in Table 3-2. These parameters were derived from estimated site data provided by BMA. Silt content data were obtained for a similar coal mine in the area (Goonyella Riverside Mine). For estimation of dust emissions from unpaved roads, the average loaded and unloaded vehicle masses for the various hauling operations on site are listed in Table 3-3. Default emission factors were used for wind blown dust, dumping of overburden and coal, loading and unloading stockpiles, loading to trains and for transfer points.

Table 3-2 Emission Factor Input Parameters

Parameter	Material			Units
	Overburden	Coal	Road Material	
Moisture Content	1.8	8.1	1.8	%
Silt Content	14	5	4	%
Blasting Area	10,000			m^2
Dragline Drop Distance	30			m
Mean Wind Speed	2.5			m/s
Density of Overburden	2.2			t/bcm

Table 3-3 Vehicle Masses for Hauling Fleet

Vehicle Mass	Overburden Hauling	Coal Hauling	Reject Hauling	Units
Empty	230*	280	135	t
Full	440*	480	350	t

*Weighted fleet average

Equipment Deployment

The typical numbers of each type of equipment that is to be used at Caval Ridge mine have been provided by BMA. The best possible operation of a coal mine is achieved by moving equipment between the pits when required, in addition to the normal progression of mining along the length of the pit, to optimise equipment availability and productivity. Mine equipment scheduling also has to be flexible to accommodate equipment breakdowns whilst achieving the desired product coal specification. Therefore, the equipment used in each pit will change in time and with location.

For these reasons, a complete description of the deployment of equipment at any point in time or any location on the mine is not possible. Based on discussions with BMA on the typical mode of operation for the mining activities, the following allocation of equipment has been used for each pit, haul roads, the CHPP and the Southern ROM loading area:

- The pre-strip fleet comprises one shovel and two excavators. As the shovel is associated with higher emissions (due to the higher rate of excavation) it has been located in the northern end of Horse Pit in order to conservatively model impacts to the north of the Project. The other excavators and associated equipment have been located in the south of Horse Pit and in Heyford Pit;
- BMA has advised that two draglines will be used in Horse Pit, each operating in half of Horse pit (north and south sections). An additional dragline will be used in Heyford Pit;
- Three excavators (each with a dozer) are used for the coaling fleet. This equipment may move around either of the pits at any time to produce the optimal coal specification, hence for the purposes of modelling these have been allocated with two units in Horse Pit (northern and southern sections) and one in Heyford Pit. This is a conservative assumption for receptors located to the north of the Project;

Section 3 Air Quality Assessment Methodology

- Blasting has been assumed to take place at any location over both Horse and Heyford Pits. The exact location of overburden blasts will depend on the conditions encountered on site as mining progresses;
- Coal and overburden hauling will take place continuously, with coal taken from the pits to the CHPP and overburden transported to the in-pit dumps. Reject material will be taken from the CHPP to Horse Pit only. The number of vehicle movements on the haul roads has been estimated from the known tonnes of material moved per year, the truck capacity and from data provided by BMA on the proportion of material that will be trucked using each of the ramps in the pits. The estimation of dust emissions from hauling has also accounted for the distance travelled per trip, which differs for Horse and Heyford Pits;
- Wind blown dust will take place continuously from unvegetated, exposed surfaces. As the overburden dumps will be progressively rehabilitated, the surface area mined in each 5-year operational window is assumed to represent the exposed surface area from the pits. Wind blown dust from the stockpiles is based on the surface area of each stockpile;
- Equipment at the CHPP handles the coal from Caval Ridge and from the Southern ROM on separate conveyors until the coal is stacked and blended on the raw coal stockpiles;
- Equipment at the Southern ROM comprises dozers for recovering the coal from the ROM; and
- Equipment at the CHPP for handling coal from the Southern ROM comprises only transfer points.

The equipment numbers used in the assessment and the allocation to each pit, for modelling of the typical operations, are presented in Table 3-4. Emissions from all of these sources (excluding graders and dozers) are dependent upon ROM coal and overburden production figures. The modelling has assumed the number of dozers and graders is as presented in Table 3-4, for all three years modelled.

Table 3-4 Equipment Allocated to each Mining Activity for Typical Operations

Activity	Horse Pit (Northern section)	Horse Pit (Southern section)	Heyford Pit	Southern ROM
Pre-strip Truck and Shovel and Reject dumping	1 Shovel 1 Grader 2 Dozers 1 Drill Rig Truck Dumping Reject Dumping	1 Excavator 1 Grader 2 Dozers[+] 1 Drill Rig Truck Dumping Reject Dumping	1 Excavator 1 Dozer[*] 1 Drill Rig Truck Dumping	Not applicable
Dragline	1 Dragline 1 Dozer 1 Drill Rig	1 Dragline 1 Dozer 1 Drill Rig	1 Dragline 1 Dozer 1 Drill Rig	Not applicable
Coaling equipment	1 Excavator 1 Dozer	1 Excavator 1 Dozer	1 Excavator 1 Dozer Coal Drill	Not applicable
Blasting	Based on tonnes material moved by dragline, prestrip and dozer stripping			
Coal Hauling	Cat 793	Cat 793	Cat 793	Not applicable
Reject Hauling	Cat 789	Cat 789	Not applicable	Not applicable
Overburden hauling	Cat 797, Cat 793	Cat 797, Cat 793	Cat 797, Cat 793	Not applicable
Wind blown dust	Based on exposed area			
ROM coal receival at CHPP	2 Dozers Truck unloading 4 Sizer transfer points			2 Transfer points
ROM coal sizing and	1 Stacker			

Activity	Horse Pit (Northern section)	Horse Pit (Southern section)	Heyford Pit	Southern ROM
stockpiling	1 Reclaimer 2 Transfer points Wind erosion on stockpiles			
Southern ROM loading and conveying	Not applicable	Not applicable	Not applicable	Wheeled dozer Truck unloading 1 Dozer 1 Transfer point Wind erosion on stockpiles
Product coal handling and train loadout	4 Transfer points 1 Stacker 1 Reclaimer Wind erosion on stockpiles			

+ 1 dozer allocated to southern section of Horse Pit for Year 2 and Year 20

* 2 dozers allocated to Heyford Pit for Year 2 and Year 20

Particle Size Distribution

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

Dust from overburden and coal handling operations is generated using mechanical means and thus the majority of dust emitted from coal mines consists of larger-sized particles (i.e. greater than $PM_{2.5}$) when compared with particulate matter generated during combustion processes which contains a higher percentage of particles in the range of $PM_{2.5}$ to ultrafine particles. Dust from roads can be finer than that generated by material handling due to the repeated pulverising of road materials into smaller fragments and the resultant creation of fine particles which can easily become airborne.

The proportion of dust that is released from the site as either TSP or PM_{10} has been represented in the emission factors used to generate the emission data. These emission factors indicate that PM_{10} emission rates are typically less than 50% of the TSP emission rates (Table 3-6).

Studies conducted by the Midwest Research Institute[9] into a wide-range of dust generating activities for the purposes of developing emission factors that are utilised by the US EPA, have resulted in proposed $PM_{2.5}$ to PM_{10} ratios as outlined in Table 3-5.

[9] 9 C. Cowherd & D. Ono (2005) *Proposed Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors*. http://www.epa.gov/ttn/chief/conference/ei15/session14/cowherd_pres.pdf

Table 3-5 Midwest Research Institute's Proposed $PM_{2.5}$ to PM_{10} Ratios

Source Category	$PM_{2.5}/PM_{10}$ Ratio
Paved Roads	0.15
Unpaved Roads	0.1
Construction & Demolition	0.1
Aggregate Handling & Storage Piles	0.1 (traffic), 0.15 (transfer)
Industrial Wind Erosion	0.15
Agricultural Tilling	0.2
Open Area Wind Erosion	0.15

In the absence of additional information, a conservative assumption that 20% of the dust emitted from the Project site for all dust sources consists of particles with a diameter less than 2.5 microns, has been applied in this assessment.

Emission Factors

The emission factors that were used in the emission estimations for each site operation are provided in Table 3-6. These factors were then multiplied by the appropriate site activity (such as the tonnes of overburden moved by excavator) to generate the emission rates for each site operation for both TSP and PM_{10} and for each scenario modelled. The emission factors presented in the table do not include any dust control measures to reduce dust emissions from the site. These are addressed in Section 3.4.2.

Table 3-6 Emission Factors used in Dispersion Modelling (prior to control measures)

Activity	Working Material	TSP Emission Factor	PM_{10} Emission Factor	Units	PM_{10}/TSP Ratio
Dragline	Overburden	0.16	0.02	kg/bcm	0.13
Excavator, Shovel or Front End Loader	Overburden	0.0017	0.0008	kg/t	0.47
Excavator, Shovel or Front End Loader	Coal	0.014	0.007	kg/t	0.5
Bulldozer	Coal	13.1	3.8	kg/h	0.29
Bulldozer	Overburden	28.7	7.8	kg/h	0.27
Trucks Dumping	Overburden	0.012	0.004	kg/t	0.33
Trucks Dumping	Coal	0.01	0.004	kg/t	0.4
Drilling	-	0.6	0.3	kg/hole	0.5
Blasting	Overburden	220	114	kg/blast	0.52
Wheel generated dust from unpaved roads	Overburden Hauling	5.5	1.3	kg/VKT	0.24
	Coal Hauling	5.8	1.4	kg/VKT	0.24
	Reject Hauling	4.6	1.1	kg/VKT	0.24
Graders	Overburden	0.190	0.085	kg/VKT	0.45
Loading Stockpiles	Coal	0.004	0.0017	kg/t	0.43
Unloading from Stockpiles	Coal	0.03	0.013	kg/t	0.43
Loading to Trains	Coal	0.0004	0.00017	kg/t	0.43
Miscellaneous Transfer	Coal	0.00032	0.00015	kg/t	0.47

Activity	Working Material	TSP Emission Factor	PM_{10} Emission Factor	Units	PM_{10}/TSP Ratio
Points					
Wind Erosion	Coal	0.4	0.2	kg/ha/h	0.5

Production Data

Production data were provided by BMA from the mine production planning software for Year 1 (2012) to Year 30 (2041) (see spreadsheet "080804 EIS_Production data by Pit.xls"). This provided detailed data for Caval Ridge on the following items for each year of operation and for each pit:

- Tonnes of ROM and Product coal moved;
- Volume of overburden removed by dragline, dozer and truck and shovel;
- Area of disturbed land;
- Volume of coal and overburden material blasted;
- Total metres of coal and overburden material drilled; and
- Tonnes of reject material from the CHPP.

The amount of ROM and Product coal and amount of reject material per year from the Southern ROM were also provided in the same spreadsheet, and have been used for dust emission calculations from the CHPP. The tonnes of material moved for each year modelled are presented in Section 3.4.3 through Section 3.4.5.

Comparison to Similar Operations

The use of site-specific emission factors developed for other mine sites cannot easily be compared to other coal mines or similar mining operations. This is due to a range of factors including:

- the types of equipment used to remove overburden and coal;
- the tonnes of ROM coal and overburden material handled;
- the depth of mining operations for overburden and coal;
- the method of managing overburden stockpiles;
- the inherent moisture of the coal and overburden; and
- the configuration of haul roads, dumps and CHPP locations in relation to the pits.

The emissions in this assessment have been based on industry-standard emission estimation methods, with emission factors derived from the NPI and AP-42 emission estimation handbooks. Likewise, industry-standard practices for dust control measures have been incorporated into the project design and air quality assessment.

3.4.2 Dust Reduction Measures

Dust Control Measures

Dust control measures that will be implemented on site have been identified by BMA. These consist of a mixture of engineering controls (such as enclosure of conveyors) and control measures (such as watering of haul roads and stockpiles), as documented in Table 3-7. The descriptions of control measures to be used for the Project have been matched to estimates of the control efficiency, as described in the NPI manual, for inclusion in modelling.

Table 3-7 Control Measures to be Implemented for the Project

Site Activity	Control Measures to be Applied	Control Factor used in Modelling
Pre-strip, Pit Operations, Hauling		
Haul Roads (coal and overburden truck movements)	Haul road watering	75% (Level 2 watering, more than 2 litres/m²/hour of water applied)
Truck and shovel excavation	-	Assumed no controls
Dragline	-	Assumed no controls
Dozers, excavators and shovels	-	Assumed no controls
CHPP		
ROM Stockpiles	Minimise double handling	No applicable control factor
	Water sprays and water cannons used on dumping sources, operated on timers	50%
Conveyors	Curved roof conveyors, no sides	Assumed no emissions due to enclosure
	No transfer points on overland conveyor	
	Belt washing and belt scrapers used	
Transfer Points	Enclosed	70%
	Fogging system on all conveyor transfer points	
Sizing stations	All sizing stations are fully enclosed with fogging system on discharge chute	Assumed no emissions due to enclosure
Raw coal stockpile – stackers and reclaimers	Control of drop height to control impact energy on stockpiles	50% for water sprays
	Sprays on stacker/reclaimer	
Raw coal surge bins	Fully enclosed with a vent system	Assumed no emissions due to enclosure
	Fogging system on feeders to conveyors	
CHPP plant feed conveyor	None identified	Assumed no controls
CHPP product coal conveyors	High moisture content product (~11%)	50%
	No spray controls to be installed due to high moisture content of washed coal	Assumed no emissions due to high moisture content
Product stacker and reclaimer	Control of drop height to control impact energy on stockpiles	50% for high moisture content
	No spray controls to be installed due to high moisture content of coal	
Product stockpile	No controls to be installed	Assumed no controls
Train Load Out	Spray bars on train load out to include chemical reagent dosing system	90%

A control factor of 90% means that 90% of the dust that would be released for the uncontrolled source is prevented from being released, hence only 10% of the possible amount of dust generated is released. The control measures are applied to each relevant site operation after the uncontrolled emission rate has been calculated.

The water requirements for the project have been addressed in the water balance for the mine. This has included an allocation of water to be used for the proposed dust suppression measures.

Modelling of normal operations has assumed that the required water is available for dust suppression. The potential impacts if watering for dust control on the haul roads fails has been assessed in the report as the 'upset scenario', which is detailed in Section 3.4.6.

Pit Retention Factor

Mining activities that take place in an open cut pit do not have the same magnitude of air emissions as the equivalent activity would if conducted at surface level. This is due to the natural retention of dust within the pit, particularly the larger particles which tend to be deposited in the pit close to the dust source due to their larger size and mass. The pit retention factor is used in modelling the dust emissions from mines to represent this natural tendency of larger dust particles to remain within the pit, and thus not become a nuisance to health at residential locations.

The pit retention factor that is recommended for use in the NPI Emission Estimation Technique Manual for Mining is a factor of 50% for TSP and 5% for PM_{10}. This factor is the percentage of particles that are initially emitted by dust-generating activities within the open cut pit but remain in the pit and therefore do not contribute to off-site dust impacts.

The recommended pit retention factor has been applied to sources that are at least 50 m below the natural surface level of the pit, such as coal excavation, draglines and dozers in the pit (with the coal or dragline operations). Sources that are close to or above the natural surface level do not have the pit retention factor applied to their emission rates, such as the CHPP, haul roads, truck and shovel operations, dozers associated with the truck and shovel or overburden stockpiles and activities on the box cut disposal area.

3.4.3 Emissions During Construction

The construction of the Project for the purposes of air quality modelling encompasses the creation of the initial box cut and earthworks associated with construction of the CHPP facilities. The dust emissions from the box cut operations have been estimated for Year 1 of operation, using the emission factors and estimates of control factors as detailed above. Production data from Horse Pit, Heyford Pit and the ROM coal imported from the Southern ROM to the CHPP during construction activities in Year 1 are presented in Table 3-8. Dragline operations in Year 1 are only conducted at Heyford Pit at a depth well below surface level. This was previously an operating pit so no further excavation of the box cut area is required.

The total distance travelled by coal, reject and overburden haul trucks for this scenario are also presented in the table. The distance in vehicle kilometres travelled (vkt) has been estimated from the number of truck movements required to move the amounts of material listed in the table, as well as the length of haul roads and ramps as estimated from site plans.

Due to the scale of other construction activities required on site, such as earthworks for the construction of the CHPP, construction of the site buildings and facilities and construction of haul roads, and the proximity of these activities in relation to the sensitive receptor locations, impacts of emissions of dust from these types of construction activities have not been included in the air quality assessment. It is also noted that these activities will be completed prior to commencement of mining. The management of dust impacts from these activities is discussed in the Environmental Management Plan.

Table 3-8 Production Data for Year 1 of Operations

Project Activity	Horse Pit	Heyford Pit	Southern ROM	Project Total
ROM coal (tonnes)	2,885,924	4,139,164	3,280,411	10,305,500
Product coal (tonnes)	1,800,000	2,200,000	1,767,982	5,767,982
Reject coal (tonnes)	1,429,788	1,747,518	1,512,429	4,689,735
Volume overburden by dragline (bcm)	0	11,383,686	n/a	11,383,686
Volume overburden by T+S (bcm)	35,207,677	16,838,223	n/a	52,045,900
Area disturbed (ha)	140	82	n/a	222
Distance travelled by coal trucks per year (vkt)	217,062	194,999	n/a	412,061
Distance travelled by reject trucks per year (vkt)	391,926	0	n/a	391,926
Distance travelled by overburden trucks per year (vkt)	776,303	290,788	n/a	1,067,091
Area blasted per year (ha)	231	178	n/a	409

The emission rates for construction activities in Year 1 are presented in Table 3-9. The higher dust emissions from Horse Pit reflect the large amount of overburden material moved by truck and shovel operations in Year 1, the conservative assumption that the coaling equipment is located mostly in Horse Pit and the larger disturbed area for Horse Pit.

Table 3-9 Emission Rates from Coal Mining Sources for Construction in Year 1

Project Operation	Emission Rates (kg/hr)					
	TSP			PM_{10}		
	Horse Pit	Heyford Pit	Southern ROM	Horse Pit	Heyford Pit	Southern ROM
Pre-strip Truck and Shovel and Reject dumping	228.5	75.3	-	73.8	25.3	-
Dragline	0.0	120.2	-	0.0	32.3	-
Coaling equipment	15.5	10.2	-	9.3	6.9	-
Blasting	139.4	107.2	-	72.5	55.7	-
Coal Hauling	88.2	33.5	-	22.4	8.8	-
Reject Hauling	51.0	-	-	12.5	-	-
Overburden hauling	122.5	46.5	-	30.3	11.6	-
Wind blown dust	56.0	32.8	-	28.0	16.4	-
ROM coal receival at CHPP	30.6		0.1	9.4		0.03
ROM coal sizing and	24.4			10.9		

Project Operation	Emission Rates (kg/hr)					
	TSP			PM_{10}		
	Horse Pit	Heyford Pit	Southern ROM	Horse Pit	Heyford Pit	Southern ROM
stockpiling						
Southern ROM loading and conveying	-	-	32.1	-	-	10.2
Product coal handling and train loadout	21.2			9.8		
Total from each pit	**726.3**	**461.9**	**46.7**	**258.4**	**170.8**	**16.8**

3.4.4 Emissions During Operation

The net emissions from each site operation, with the relevant dust control measures and pit retention factors applied, have been calculated for each scenario modelled.

To represent the changing coal production, location of mining and amount of overburden moved per year, two scenarios have been modelled for operation of the Project. Year 2 is the first year of full coal production. Year 20 has been selected as representative of mining operations on the eastern side of the lease, and involving higher amounts of overburden removal due to the deeper coal seam.

The emission rates that were derived from each operation on the mine site have been grouped according to the type of operation and according to the location of the dust-generating activity. Operations for pre-strip truck and shovel, coaling equipment and blasting have all been located in the corresponding pit for air quality modelling. Emissions from hauling of coal, reject and overburden materials were all based on the total distance travelled by the truck fleet, accounting for the locations of the ramps and the tonnes of material moved for each pit. These sources were located along the haul route from each pit to the CHPP.

Year 2

The dust emissions from Year 2 of operations have been estimated using the emission factors and estimates of control factors as detailed above. Production data from Horse Pit, Heyford Pit and the ROM coal imported from the Southern ROM to the CHPP for Year 2 of operations are presented in Table 3-10. The total distance travelled by coal, reject and overburden haul trucks for this scenario are also presented in the table. The distance in vehicle kilometres travelled (vkt) has been estimated from the number of truck movements required to move the amounts of material listed in the table, as well as the length of haul roads and ramps. Dragline operations are scheduled to commence in Horse Pit for Year 2 once the box cut area has been established. The draglines operate in the lower sections of the pit, just above the coal seam.

Table 3-10 Production Data for Year 2 of Operations

Project Activity	Horse Pit	Heyford Pit	Southern ROM	Project total
ROM coal (tonnes)	4,139,564	5,213,598	5,165,546	14,518,707
Product coal (tonnes)	2,500,000	3,000,000	2,766,699	8,266,699
Reject coal (tonnes)	1,875,906	2,251,087	2,398,847	6,525,840
Volume overburden by dragline (bcm)	20,033,975	12,748,201	n/a	32,782,176
Volume overburden by T+S (bcm)	8,821,356	13,915,838	n/a	22,737,194
Area disturbed (ha)	96	21	n/a	116
Distance travelled by coal trucks per year (vkt)	311,353	245,616	n/a	556,969
Distance travelled by reject trucks per year (vkt)	545,371	0	n/a	545,371
Distance travelled by overburden trucks per year (vkt)	123,245	222,726	n/a	345,971
Area blasted per year (ha)	120	118	n/a	238

The emission rates for Year 2 of operations are presented in Table 3-11. The higher dust emissions from Horse Pit reflect the large amount of overburden material moved by dragline operations in Year 2, the placement of reject material into Horse Pit, the conservative assumption that the coaling equipment is located mostly in Horse Pit and the larger disturbed area for Horse Pit.

Table 3-11 Emission Rates from Coal Mining Sources for Year 2 of Operations

Project Operation	Emission Rates (kg/hr)					
	TSP			PM_{10}		
	Horse Pit	Heyford Pit	Southern ROM	Horse Pit	Heyford Pit	Southern ROM
Pre-strip Truck and Shovel and Reject dumping	108.3	92.9	-	31.7	28.9	-
Dragline	215.1	132.8	-	58.7	35.2	-
Coaling equipment	16.5	11.1	-	10.2	7.8	-
Blasting	72.3	70.9	-	37.6	36.9	-
Coal Hauling	123.9	41.9	-	31.1	10.9	-
Reject Hauling	71.0	-	-	17.4	-	-
Overburden hauling	20.3	35.8	-	5.2	9.0	-
Wind blown dust	94.4	41.2	-	47.2	20.6	-
ROM coal receival at CHPP	32.0		0.1	10.0		0.1
ROM coal sizing and stockpiling	32.7			14.4		
Southern ROM loading and conveying	-	-	34.3	-	-	11.1

Product coal handling and train loadout	25.9			11.9		
Total from each pit	**752.6**	**465.7**	**55.3**	**251.1**	**164.3**	**20.5**

Year 20

The dust emissions from Year 20 of operations have been estimated using the emission factors and estimates of control factors as detailed above. Production data from Horse Pit, Heyford Pit and the ROM coal imported from the Southern ROM to the CHPP for Year 20 of operations are presented in Table 3-12. The total distance travelled by coal, reject and overburden haul trucks for this scenario are also presented in the table. The distance in vehicle kilometres travelled (vkt) has been estimated from the number of truck movements required to move the amounts of material listed in the table, as well as the length of haul roads and ramps.

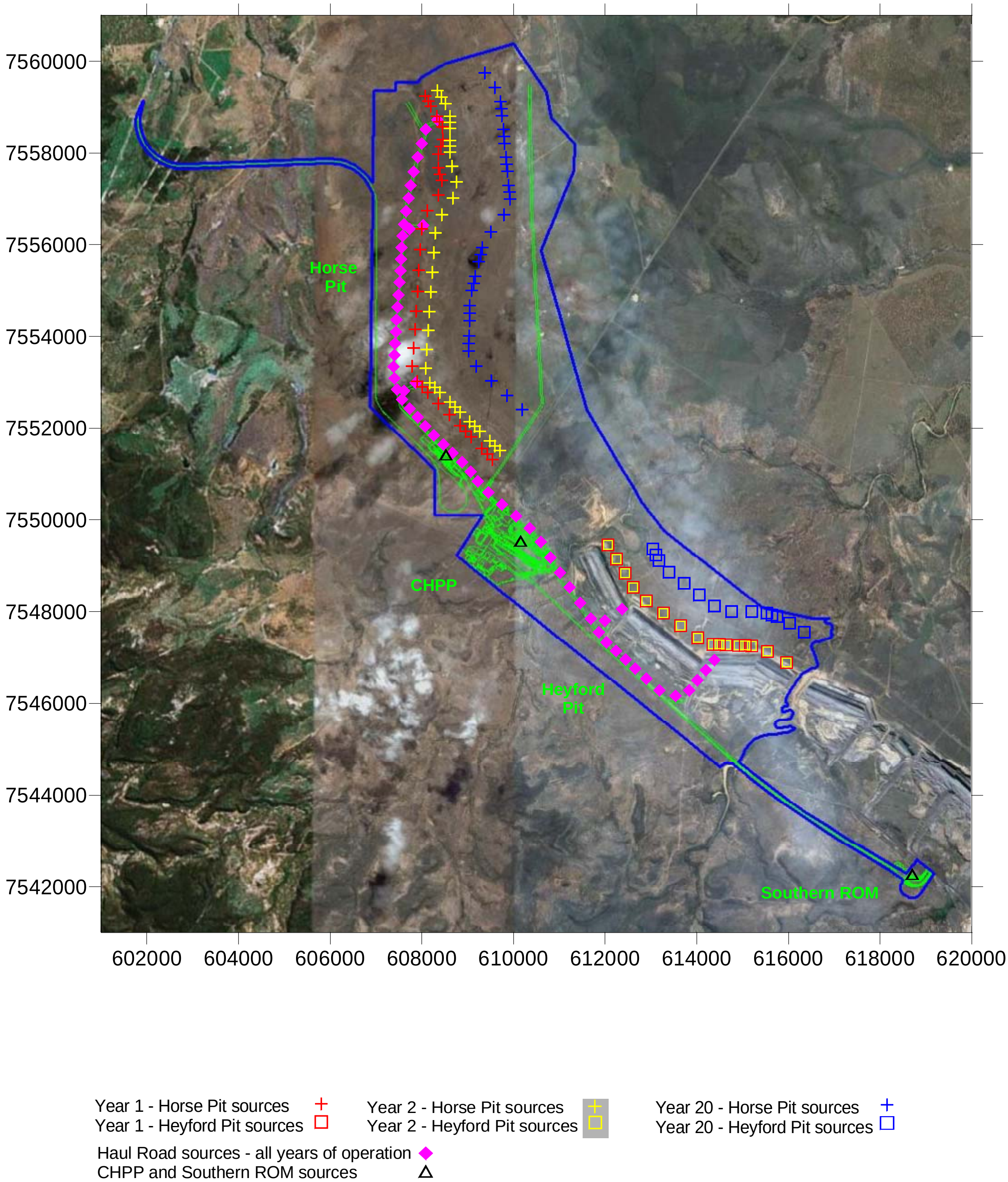
The emission rates for Year 20 of operations are presented in Table 3-13. The higher dust emissions from Horse Pit reflect the large amount of overburden material moved by dragline operations in Year 20, the placement of reject material into Horse Pit, the conservative assumption that the coaling equipment is located mostly in Horse Pit and the larger disturbed area for Horse Pit.

Table 3-12 Production Data for Year 20 of Operations

Project Activity	Horse Pit	Heyford Pit	Southern ROM	Project Total
ROM coal (tonnes)	4,202,265	5,492,137	6,243,261	15,937,663
Product coal (tonnes)	2,500,000	3,000,000	3,175,767	8,675,767
Reject coal (tonnes)	2,027,148	2,432,578	3,067,494	7,527,219
Volume overburden by dragline (bcm)	26,427,153	11,400,040	n/a	37,827,192
Volume overburden by T+S (bcm)	12,089,456	21,034,310	n/a	33,123,766
Area disturbed (ha)	51	16	n/a	67
Distance travelled by coal trucks per year (vkt)	316,069	258,739	n/a	574,807
Distance travelled by reject trucks per year (vkt)	629,057	0	n/a	629,057
Distance travelled by overburden trucks per year (vkt)	280,755	410,142	n/a	690,898
Area blasted per year (ha)	197	213	n/a	410

Table 3-13 Emission Rates from Coal Mining Sources for Year 20 of Operations

Project operation	Emission rates (kg/hr)					
	TSP			PM_{10}		
	Horse Pit	Heyford Pit	Southern ROM	Horse Pit	Heyford Pit	Southern ROM
Pre-strip Truck and Shovel and Reject dumping	132.9	130.3	-	40.9	43.0	-
Dragline	274.5	120.3	-	72.5	32.3	-
Coaling equipment	16.5	11.4	-	10.3	8.0	-
Blasting	118.8	128.4	-	61.8	66.8	-
Coal Hauling	135.5	44.1	-	34.0	11.4	-
Reject Hauling	81.8	-	-	20.1	-	-
Overburden hauling	44.9	65.2	-	11.2	16.2	-
Wind blown dust	90.4	36.0	-	45.2	18.0	-
ROM coal receival at CHPP	32.2		0.1	10.1		0.06
ROM coal sizing and stockpiling	35.5			15.6		
Southern ROM loading and conveying	-	-	35.6	-	-	11.7
Product coal handling and train loadout	26.7			12.2		
Total from each pit	**925.8**	**575.4**	**60.1**	**307.8**	**211.0**	**22.7**



Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT		Title: **LOCATION OF DUST SOURCES USED FOR AIR QUALITY MODELLING FOR ALL YEARS**
URS	Drawn: AB	Approved: CB	Date: 17-02-2009
	Job No: **4262 6158** /6161	File: 42626158-g-166.srf	Figure: **3-2** Rev:A A4

3.4.5 Worst-case Emissions

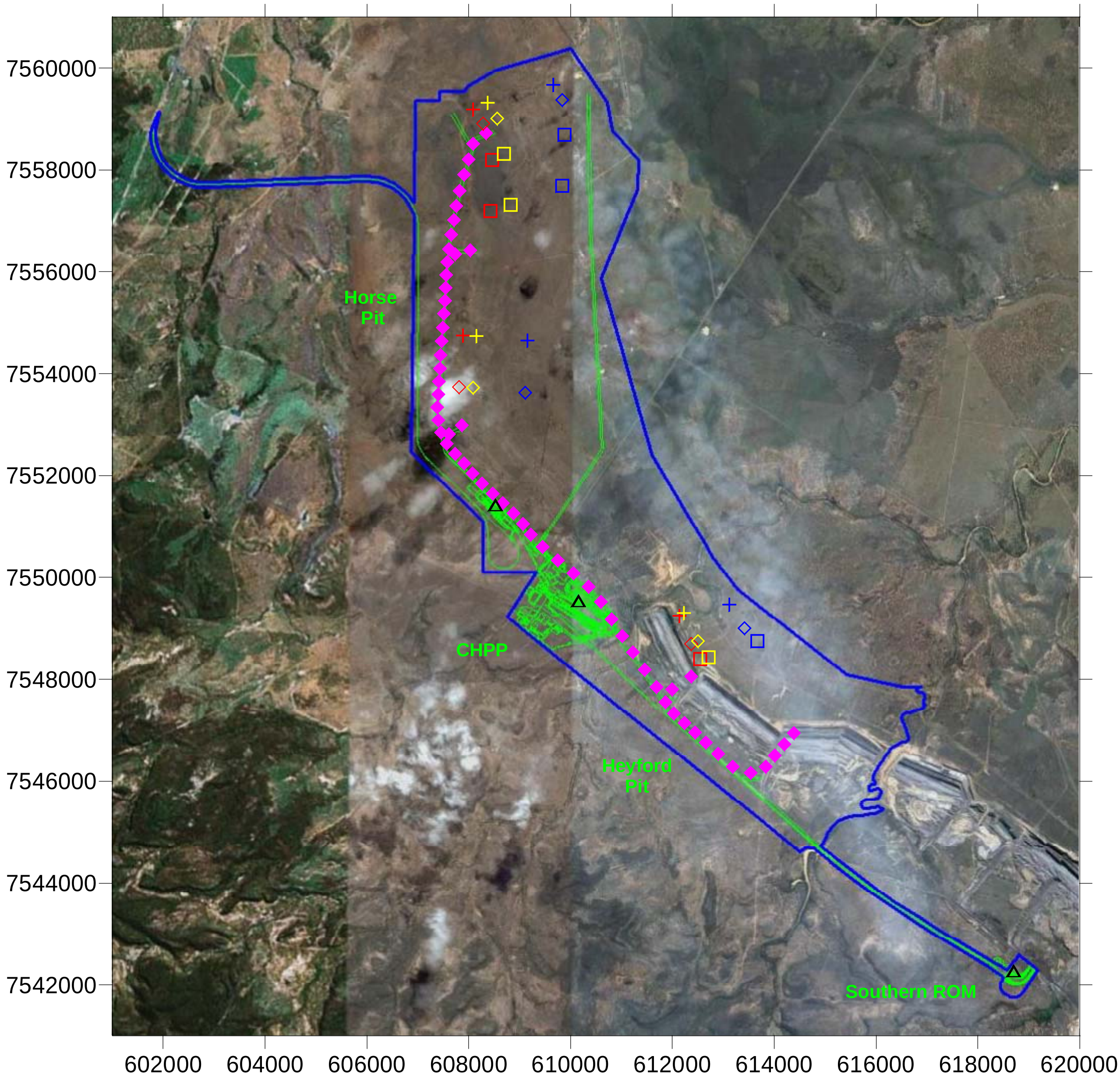
Worst-case emissions have been modelled for the Project by accounting for the possible grouping of the in-pit sources located at either the northern or southern end of the pit areas in Horse and Heyford Pits. These accounted for the simultaneous operation of the dragline, truck and shovel pre-strip fleet, blasting, coaling and reject dumping in near proximity to one another. The locations of sources for these two worst-case scenarios (northern case and southern case) are shown in Table 3-14 and Table 3-15 respectively. BMA has advised that equipment operating in the pits will maintain separation distances from other equipment of approximately 1 km (for dragline and truck and shovel operations) or approximately 300 m (for coaling equipment) to avoid competing demands for access to roadways and ramps, and for safety reasons.

The production data for each pit were used to derive emission rates for these pit activities, with the exception of the shovel and excavator which were assumed to operate at their peak production capacities (2,600 m³/hr and 770 m³/hr respectively). The equipment allocated to each pit for the worst-case operating scenarios is presented in Table 3-14. Other equipment that operates on site, such as the coal and overburden hauling and the CHPP, was assumed to operate at the normal capacity.

Table 3-14 Equipment Allocated to Each Pit for Worst-case Operating Scenarios

Pit	Operation	Northern scenario	Southern scenario
Horse Pit	Pre-strip Truck and Shovel and Reject Dumping	1 shovel with dozers 1 excavator with dozers 1 dozer on reject dump Truck dumping of overburden	1 excavator with dozers 1 dozer on reject dump Truck dumping of overburden
	Dragline	2 draglines with dozer and drilling	2 draglines with dozer and drilling
	Coaling equipment	2 coal excavators with dozer	1 coal excavator with dozer
Heyford Pit	Pre-strip Truck and Shovel and Reject Dumping	1 excavator with dozers Truck dumping of overburden	1 shovel with dozers 1 excavator with dozers Truck dumping of overburden
	Dragline	1 dragline with dozer and drilling	1 dragline with dozer and drilling
	Coaling equipment	1 coal excavator with dozer and coal drilling	2 coal excavators with dozer and coal drilling

For each of the modelled years (Years 1, 2 and 20), this representation of the pit sources has been performed twice, a run with each emissions grouped at the northern end of each region, and a second run with each emissions grouped at the southern end of each region. The highest 24 hour average results of this sensitivity analysis from the north or south scenario are presented in the assessment as the worst-case impacts.

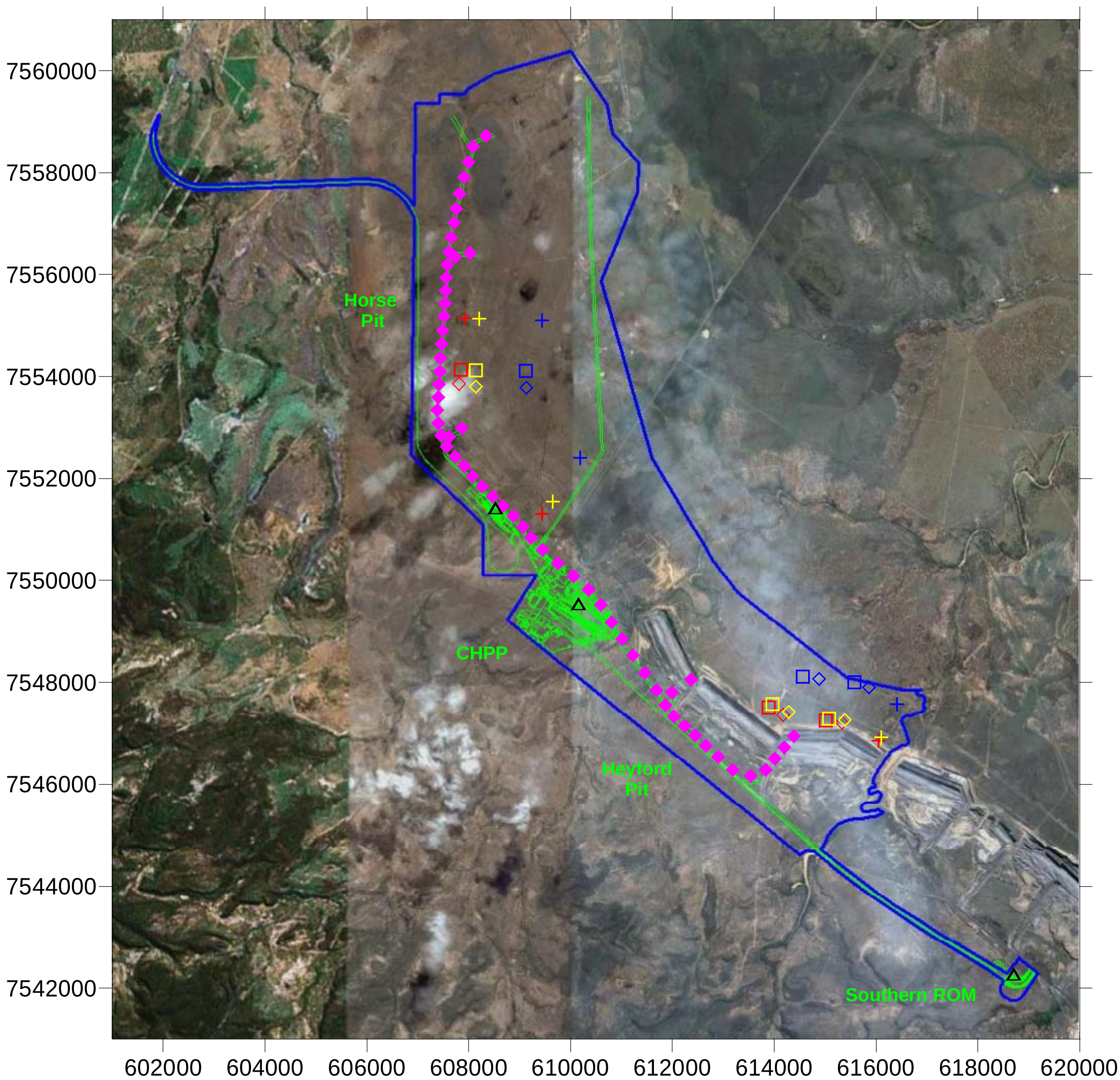


Year 1 - Dragline sources
Year 1 - Coaling sources
Year 1 - T&S sources
Year 2 - Dragline sources
Year 2 - Coaling sources
Year 2 - T&S sources
Year 20 - Dragline sources
Year 20 - Coaling sources
Year 20 - T&S sources
Haul Road sources - all years of operation
CHPP and Southern ROM sources

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	Title: LOCATION OF DUST SOURCES USED FOR AIR QUALITY MODELLING FOR WORST-CASE NORTHERN SCENARIO
URS	Drawn: AB / Approved: CB / Date: 17-02-2009	Figure: 3-3 / Rev:A
	Job No: **4262 6158** /6161 / File: 42626158-g-167.srf	A4



Year 1 - Dragline sources
Year 1 - Coaling sources
Year 1 - T&S sources
Year 2 - Dragline sources
Year 2 - Coaling sources
Year 2 - T&S sources
Year 20 - Dragline sources
Year 20 - Coaling sources
Year 20 - T&S sources
Haul Road sources - all years of operation
CHPP and Southern ROM sources

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT			Title: LOCATION OF DUST SOURCES USED FOR AIR QUALITY MODELLING FOR WORST-CASE SOUTHERN SCENARIO	
	Drawn: AB	Approved: CB	Date: 17-02-2009	Figure: 3-4	Rev:A
	Job No: 4262 6158 /6161	File: 42626158-g-168.srf			A4

3.4.6 Emissions During Upset Conditions

Upset conditions in relation to air quality impacts could arise due to a failure of dust control measures, resulting in an increase the amount of dust released from the site. A likely cause of upset conditions would be inadequate or non-existent dust control on the haul roads, which are an important source of dust for off-site impacts.

The emissions for upset conditions have been estimated by assuming no controls on wheel-generated dust from haul roads. The predicted impacts for the maximum 24-hour average concentration for this upset scenario are presented in the assessment. As BMA is committed to managing the site to minimise dust impacts to the greatest extent possible, this scenario has been assumed to last for only a short time and hence the annual average concentrations of dust have not been estimated for the upset scenario.

Emissions that have been estimated for hauling operations for this scenario are presented in Table 3-15 for coal, reject and overburden hauling. These have been combined with emissions estimated for typical operations for all other pit and CHPP activities that remain unchanged for this scenario, with the revised total emissions from each pit operation presented in the table.

Table 3-15 Emission Rates for Operation Under Upset Conditions for Haul Roads

Project Operation		Emission Rates (kg/hr)			
		TSP		PM_{10}	
		Horse Pit	Heyford Pit	Horse Pit	Heyford Pit
Year 1	Coal Hauling	352.7	134.0	89.4	35.2
	Reject Hauling	204.0	-	50.1	-
	Overburden Hauling	490.1	186.0	121.3	46.5
	Total under upset conditions	1511.4	701.9	454.1	232.1
Year 2	Coal Hauling	495.5	167.8	124.6	43.5
	Reject Hauling	283.8	-	69.8	-
	Overburden Hauling	81.0	143.3	20.7	36.0
	Total under upset conditions	1397.8	699.1	412.3	223.9
Year 20	Coal Hauling	542.2	176.5	136.0	45.6
	Reject Hauling	327.4	-	80.5	-
	Overburden Hauling	179.7	260.7	44.9	64.9
	Total under upset conditions	1712.7	903.4	503.9	293.8

3.5 Modelling Methodology

The Calpuff dispersion modelling system was used for dispersion modelling of all dust emissions from the Project, as this model is approved for use in Queensland and is a guideline model in the USA where it was developed. The Calpuff model uses three-dimensional wind fields generated in Calmet, which were supplemented with data generated using the CSIRO model TAPM. The Calpuff model is appropriate for use in the assessment of dust impacts from coal mines as it accounts for pollutant recirculation, convective conditions, terrain features and temperature inversions. Due to the inland location of the site, specific treatment of sea breeze conditions is not required.

The methodology for meteorological modelling using TAPM and Calmet and dispersion using Calpuff are described below. The Calpuff model was used to predict the ground-level concentrations of TSP and PM_{10}, and the deposition of TSP using appropriate averaging times. Estimated background levels of TSP and PM_{10} concentration and dust deposition, as discussed in Section 2.3, have been added to the modelled impacts to determine the cumulative impact from Caval Ridge mine with existing land uses in the vicinity of the Project.

3.5.1 Meteorological Modelling Methodology

Local meteorological measurements at the Bureau of Meteorology station located at the Moranbah Water Treatment Plant are insufficient to provide data for detailed dispersion modelling. Hourly records of wind speed and direction, temperature, mixing height and stability class are not recorded. To overcome these limitations, the three-dimensional prognostic meteorological model TAPM (The Air Pollution Model, developed by the CSIRO[10]) was used to generate wind data for the site location. TAPM uses detailed synoptic analysis of all surface and upper air data collected in Australia to determine the wind flows over a chosen model domain and time period. It contains databases on the vegetation types, land use, soil moisture content and terrain elevation (from 9-second DEM data) that are used to specify the surface parameters for the selected model domain.

TAPM was set up for the region around the Caval Ridge mine to simulate windflows around the location to a 1 km resolution. The model parameters specified for the run were as follows:

- Grid centred on latitude 22°7', longitude 148°4', with local coordinates 610,015 m E, 7553,875 m N (UTM Zone 55);
- Nested grids of 30 by 30 grid points, with grid intervals of 30 km, 10 km, 3 km and 1 km;
- The period modelled was 1 January 2007 to 31 December 2007.

The data files were used as direct inputs to the Calmet meteorological model[11] by extracting the modelled data at the location of the CHPP for the surface and upper air data files. In addition, a data file (CSUMM format) containing all the three-dimensional upper air wind speed and direction data from each level of the TAPM results was used as an "initial guess" field in Calmet, to fully capture the influence of regional topographical features, such as hills and valleys, which are outside the detailed modelling domain.

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[10] Hurley, P. J. (2005), The Air Pollution Model (TAPM) Version 3, Part 1: Technical Description, CSIRO Atmospheric Research Technical Paper 71.

[11] TRC Environmental Corporation, Calpuff Version 6 Users' Instructions (Draft), Lowell, Massachusetts, USA, May 2006.

The Calmet model domain was 30 km by 30 km. This is of sufficient size to capture the mining activities as well as the residential areas of Moranbah and individual homesteads that may be affected by the proposed mining operations. Since no appropriate surface meteorological observation data were available within the model domain, synthetic data generated by TAPM was used to initialise the model. The Calmet model features enhanced treatment of terrain effects around the site and allows the wind fields to be influenced by the differential heating of the land surface depending on the angle of the sun. Its non steady-state formulation also allows the windfields to travel around or over obstacles such hills, depending on the strength of the wind, and to recirculate pollutants within the model domain as the prevailing wind directions change through the day. Calmet calculates parameters such as mixing height and stability class that are used in the model to determine the dispersion conditions for every hour of the year.

The resultant three-dimensional windfields from Calmet were used as inputs to the dispersion model Calpuff. The model domain is the boundary of the region shown on Figure 3-1, which also shows sensitive receptor locations near the Project.

The winds for the area are characterised by wind speeds of 2 to 5 m/s from the east-south-easterly direction. There is very infrequent occurrence of winds from the west or south at the site location.

3.5.2 Dispersion Modelling Methodology

Model Selection

The model domain was 30 km by 30 km, with the dispersion results calculated at a resolution of 500 m. The dispersion parameters specified in the model include the use of dispersion coefficients based on turbulence data computed from the modelled micrometeorology and partial plume path adjustment for terrain correction of plume impacts.

Pollutants Modelled

The pollutants modelled from the operation of the Caval Ridge Coal Mine were TSP, PM_{10} and included dust deposition. Emission rates for each dust source on site were derived using the methodology described above. The emission sources that were identified from the data provided by BMA were modelled for average and peak 24 hour emissions for the year, as detailed in Section 3.4.

Model results for PM_{10} will be used to predict the impact of emissions of $PM_{2.5}$ from Project-related dust generating activities.

Source Types and Locations

The selection of source type to represent an air emission source is matched by the nature of the dust-generating activities and how the dust is released. Possible source types in Calpuff are point, area, volume and line sources. Volume sources have been used for dispersion modelling of all sources of dust from the site to represent the nature of activities conducted on open-cut mines. The equipment that is used for open-cut mining operations is some of the largest equipment available. Activities such as excavating of coal or dropping of overburden from a dragline bucket result in the instantaneous creation of a cloud of dust, which is clearly visible from the edge of an operating open-cut pit. Likewise, the plume of dust that is generated by a truck moving on unpaved roads is mixed in the wake of the vehicle to form a visible dust cloud that rises above the vehicle height. The volume source is the most representative of the nature of these activities, as it accounts for the dispersion of an amount of dust that is well mixed in the air immediately at the source. For this reason, volume sources have been used throughout the assessment.

The sensitive receptor locations at Caval Ridge are at some distance from the mining activities (at least 650 m from the mine boundary and over 1,100 m from disturbed areas. This separation of the sources and receptors lessens the influence of the initial source structure (i.e. whether modelled as volume, area or point source) and results over 1 km from the source should be relatively independent of source selection for near-surface sources such as those in coal mines.

Source emission parameters, such as the height of release and the initial spread of the plume from each release point, were estimated from data provided by BMA on the height of sources and the source types. These data have been used to derive the source height and initial spread of the plume, used in the dispersion modelling setup, as noted in Table 3-16.

Table 3-16 Source Height and Initial Horizontal and Vertical Spread of Plumes as used in Dispersion Modelling

Source Type	Source Height Above Ground Level (m)	Initial Horizontal Spread (m)	Initial Vertical Spread (m)
Overburden hauling	10	100	20
Coal and reject hauling	10	100	20
Moving pit sources	15	125	30
Blasting	50	50	25
CHPP (including stockpiles)	10	40	20
Wind blown dust	20	125	30

The locations of each source were derived from the project mine plan that was developed for the Project. Haul road locations do not change throughout operation of the project, however the progression of the mine generally moves eastward.

Haul roads were modelled as volume sources that were spread out along the haul routes at approximately 500 m intervals. The emissions for each road section were determined from the number of vehicle movements on the section and the distance travelled for the return journey.

Sources that are located in the pit, including draglines, truck and shovel, coaling equipment and blasting, were modelled as volume sources. For modelling of typical operations and operations during upset conditions from the Project, the source locations were spread out along the pit length at 500 m intervals, with emission rates corresponding to the appropriate pit activities. For the worst-case 24 hour scenario, the pit activities were modelled as though they are clustered to either the north or the south of the pit, as detailed in Section 0.

Activities at the CHPP, such as ROM coal dumping and stockpile movements were modelled as volume sources located at the centre of each dust-generating activity. Coal handling activities at the Southern ROM were modelled as a single volume source.

Particulate Sizes

An assumed mean particle diameter of 10 µm and standard deviation of 2 µm was used for TSP, and a mean particle diameter of 5 µm and standard deviation of 1 µm was used for modelling of PM_{10}. Estimates of dust deposition at residential locations were based on the deposition of TSP.

As noted in the previous section, model results for PM_{10} were used to assess the potential impact of emissions of $PM_{2.5}$ associated with dust-generating activities from the Project site.

Receptor Locations Modelled

Sensitive receptor locations were included in the Calpuff modelling for the prediction of air quality impacts at residential locations. As noted in Section 3.1, for ease of analysis and presentation, receptors were combined into groups based on location as indicated in Table 3-1.

Averaging Time and Percentiles For Compliance

The modelling results have been analysed for the same averaging periods as the relevant Project air quality goals.

Schedule 1 of the EPP(Air) 2008 indicates an allowance of 5 exceedences of the air quality objective of 50 $\mu g/m^3$ for the 24-hour average concentration of PM_{10}. Thus for this assessment, the 5^{th} highest 24-hour average ground level concentration of PM_{10} at each receptor location will be presented.

The maximum 24-hour average ground-level concentration of $PM_{2.5}$ will be presented.

3.5.3 Limitations of Dispersion Modelling

General Limitations

Modelling of complex physical systems is based on the use of numerical techniques to solve a set of governing equations. In general, the more complicated the system that is modelled, the more parameterisations (or approximations) that are required in order to solve these equations; particularly in relation to the representation of sub-grid scale processes. Thus, there are inherently a number of 'tuneable' parameters that are required as input into the models. Model developers often suggest default values for these parameters which may be based on observational data, laboratory experiments or professional experience. Depending on the scale of the project, assessing the sensitivity of model results to input data and/or the value of tuneable parameters can be prohibitive, either in terms of computational requirements, timeframes for completion of the assessment, and/or budget constraints.

Model validation is a critical component to both model development and application. Rarely however does a suitable data set exist with which to conduct a detailed, statistically meaningful model validation study. The Calpuff dispersion model has been developed to estimate the impact of emissions from a range of source types including: point sources (tall and short stacks), buoyant line sources (aluminium smelters), buoyant area sources (i.e. forest fires), area sources, and volume sources. Model validation exercises have tended to focus on the impacts of emissions from point sources (i.e. stacks). Non-buoyant line sources such as haul roads are not explicitly included as a source type in Calpuff. Instead these types of sources are typically represented as a series of volume sources whose separation distance is taken as a function of the minimum distance to the nearest receptor following the simulated line source methodology used in regulatory approved dispersion model Ausplume developed by the Victorian EPA. Model validation of low level emissions of pollutants (such as dust generated by large-scale mining activities) is additionally complicated by the near-surface release of emissions, the non-stationality of emission sources, and the variability in the locale of activities (such as blasting events).

In general, models have difficulty in accurately dealing with light wind speeds (ie less than 1 m/s) due to the dominance of physical processes other than advection and or turbulent diffusion under such conditions. The inability to accurately predict the minimum mixing height is another limiting factor of dispersion modelling and is particularly important when dealing with low level, non-buoyant (or low-buoyancy) emission sources such as those present on a coal mine.

Another challenge facing the dispersion modeller is the uncertainty in relation to the preciseness and representativeness of input data combined with limited observational data which are key factors contributing to the lack of comprehensive model validation studies for the majority of air quality assessments.

Assessment Methodology Limitations

The modelling methodology outlined in this section was developed during mid 2008. At this time, the EPP(Air) Policy 1997 was in affect. There are a number of changes between the EPP(Air) Policy, 2008 which is currently enacted and the 1997 version of the policy. Of particular relevance to this assessment is the change from a 24-hour average PM10 criteria of 150 µg/m3 (EPP(Air) 1997) to a 24-hour average PM10 objective of 50 µg/m3 (EPP(Air) 2008). With background levels of PM10 estimated at 20 µg/m3 the reduction in the criteria has a significant influence on the modelling methodology requirements that is adopted: ie away from one of conservatism towards one of increased accuracy. Examples of possible areas of refinement include (but are not limited to):

- Wind speed dependent wind erosion emission factors.
- Use of the technical option in Calpuff that allows puff-splitting.
- Development of site-specific emission factors in addition to what has been developed for this assessment based on the recommendations of the NPI EETM and the US EPA AP 42.
- Validation of model default parameters.
- Refining the application of Project information.

Refinement of the methodology adopted in this assessment is currently under review.

Project-Specific Limitations

This assessment relies on the completeness, accuracy and/or representativeness of a number of input data sets including:

- Project information;
- Client and regulatory supplied meteorological data;
- NPI emission factors; and
- Non site-specific default parameters used in the development of the emission factors.

Other limitations of the assessment include (but may not be limited to):

- The accuracy of the characterisation of the background environment; and
- The sensitivity of the dispersion modelling results to tuneable model input parameters.

Further discussion of the model sensitivity is included in Appendix A.

This report was prepared between November 2007 and February 2009 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of BMA Coal and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal .

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false

Results from the dispersion modelling have been analysed at discrete receptor locations near the Project site. Additionally, contour plots showing the predicted impacts across the modelling domain are presented.

4.1 Interpretation of Results

When reviewing output from dispersion models it is important to interpret the results presented in the context of the limitations outlined in Section 3.5.3. In particular, those associated with validating the relevance and applicability of both the model input data sets and model output which may have a significant impact on the accuracy of the results presented.

Additionally, consideration should be given to the discussions presented in Section 3.3 relating to the challenges when defining and representing the background environment. The spatial and temporal variability of dust sources that are not explicitly modelled raises questions in relation to the applicability of a single ‘background’ concentration value across the entire study region.

Recent changes to the EPP(Air) Policy have seen a significant change to the stated objective for the 24-hour average concentration of PM_{10} from 150 µg/m^3 listed in the 1998 version of the EPP(Air) Policy to 50 µg/m^3 in the current policy. The inclusion of air quality objectives $PM_{2.5}$ is also a significant change to the EPP(Air) Policy. To date however, there has been no guidance document issued by the Queensland EPA in relation to how the Policy is to be implemented with regards to the interpretation of results from dispersion modelling.

Dispersion modelling is undoubtedly a very useful tool for the identification of potential air quality issues within the study region. However, the confirmation of a model-predicted impact (either adverse or beneficial) can only be definitively assessed by the detailed analysis of observational data. Changes to the EPP(Air) will undoubtedly put more emphasis on the implementation of comprehensive baseline and operational monitoring programs.

Based on these comments it is plausible that the representativeness of reported model results may vary depending on both the averaging period and/or the source type and will undoubtedly be guided by comparison of model results with observational data.

Section 4 Dispersion Modelling Results

Other minor comments noted include:

- Software graphics packages such as SURFER which has been used in this assessment to develop the regional contour plots involve the interpolation of results onto the contour grid and will therefore be associated with some degree of spatial uncertainty. Results presented in tabular form are extracted directly from model output and are thus a better representation of predicted impacts at receptor locations.
- It is noted that the presentation of results within the tables are reported to one decimal place (which is typical for air quality assessments). However, this suggests a level of accuracy of model predictions which is not realisable, nor verifiable. Reporting (for example) a concentration of 23.4 µg/m^3 implies an accuracy of ±0.05 µg/m^3. Quantifying the uncertainty in the results presented is in general, not undertaken for the reasons discussed in Section 3.5.3.

Results presented in the following sections include both the Project-related incremental contribution to ground-level concentrations of dust at receptor locations as well as cumulative impacts that incorporate the estimates of background levels of dust.

4.2 Construction Impacts in Year 1

Predicted air quality impacts due to construction of the initial box cut and operation of mining activities in Heyford pit for Year 1 are presented in Table 4-1 for TSP, PM_{10}, $PM_{2.5}$ and dust deposition. Predicted exceedences of the relevant Project goals are highlighted in bold font.

Results suggest that impacts around the Caval Ridge Mine site will not exceed the EPP (Air) objectives for $PM_{2.5}$, TSP or the Qld EPA guideline for dust deposition during construction.

Results for the 5th highest 24-hour average ground-level concentration of PM_{10} highlights the potential for PM_{10} levels to exceed the EPP(Air) objective of 50 µg/m^3 at some locations within the study region. A detailed investigation into modelled worst-case meteorological conditions presented in Appendix A highlights the strong dependence of the model results on the model default value of the mixing height which plays a key role in the calculation of night time impacts.

The areal extent of the region that is predicted to exceed the relevant Project goals are illustrated in Figure 4-1 through Figure 4-5 for operations in Year 1.

The most affected areas are predicted to be associated with locations in Southern Moranbah, homesteads to the west of the site and residences north of the mine.

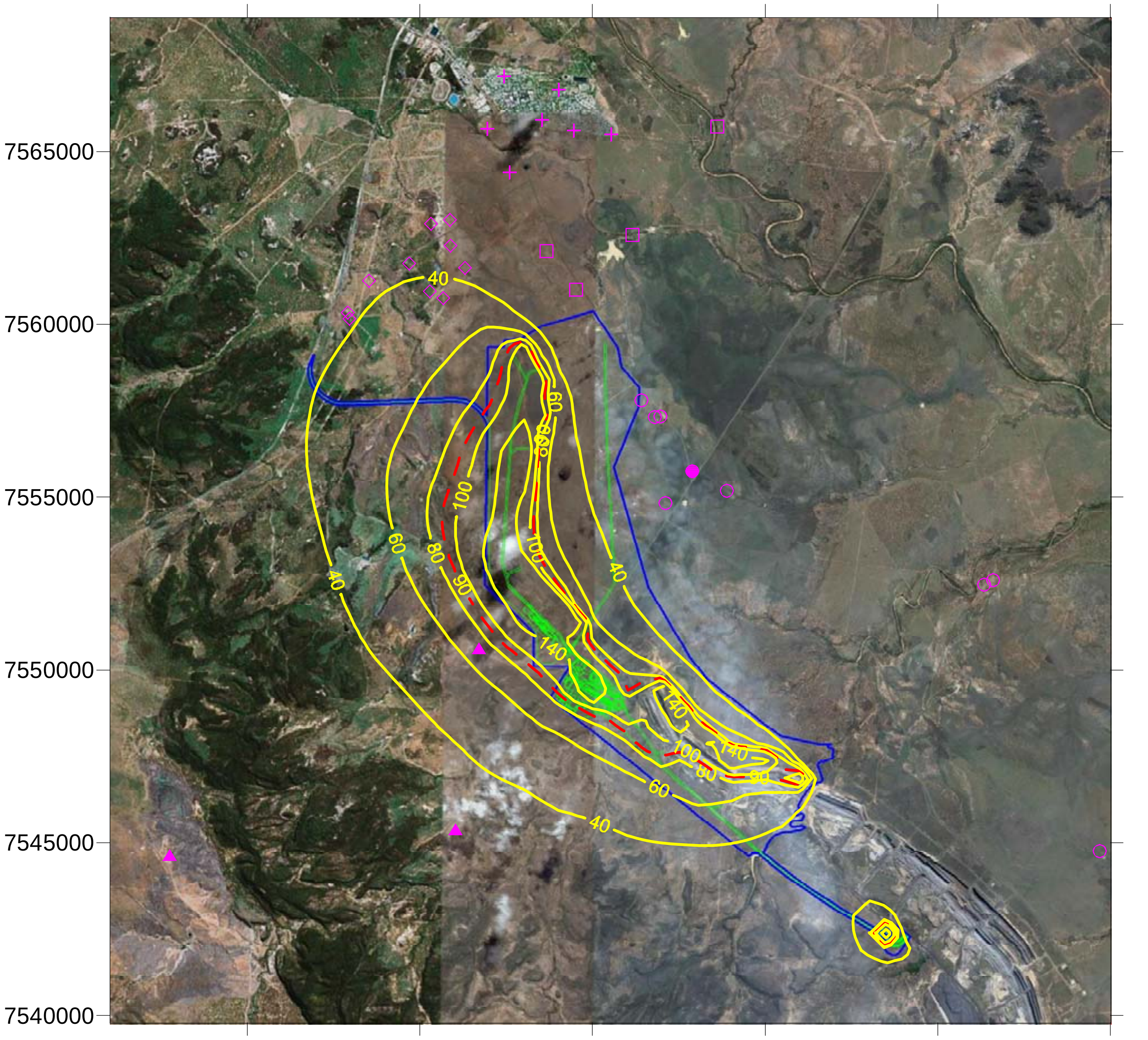
Results of the dispersion modelling have been used to aid in the development of a local air quality monitoring program that is outlined in Appendix C. Information obtained during monitoring will be used to assess the effectiveness of current operational practices and the need for additional dust mitigation measures as outlined in Section 5 and detailed in the Environmental Management Plan.

Table 4-1 Predicted Impacts at Residential Locations for Year 1 for Typical Operations

Pollutant	TSP		PM_{10}		$PM_{2.5}$		$PM_{2.5}$		Dust Deposition	
Averaging period	**Annual**		**24-hour+**		**24-hour++**		**Annual**		**Monthly**	
Units	**µg/m³**		**µg/m³**		**µg/m³**		**µg/m³**		**g/m²/month**	
Sensitive Receptor Group	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**
Moranbah	3.8	35.2	52.5	**71.3**	7.3	10.2	0.5	2.1	0.5	2.0
Southern Moranbah	26.5	57.9	77.8	**96.6**	13.7	16.6	2.9	4.5	1.4	2.9
Homesteads N of site	7.2	38.6	52.9	**71.7**	11.2	14.1	0.8	2.4	0.8	2.3
Homesteads E of site	7.3	38.7	34.7	**53.5**	4.9	7.8	0.9	2.5	0.7	2.2
Homesteads W of site	50.6	82.0	78.0	**96.8**	14.9	17.8	5.3	6.9	2.2	3.7
Commercial premises	5.1	36.5	25.7	44.5	3.4	6.3	0.6	2.2	0.6	2.1
Background	**31.4**		**18.8**		**2.9**		**1.6**		**1.5**	
EPP(Air) Objective	**90**		**50**		**25**		**8**		**4**	

+ Results for the 5th highest 24-hour average concentration have been reported.

++ Results for the maximum 24-hour average concentration have been reported.



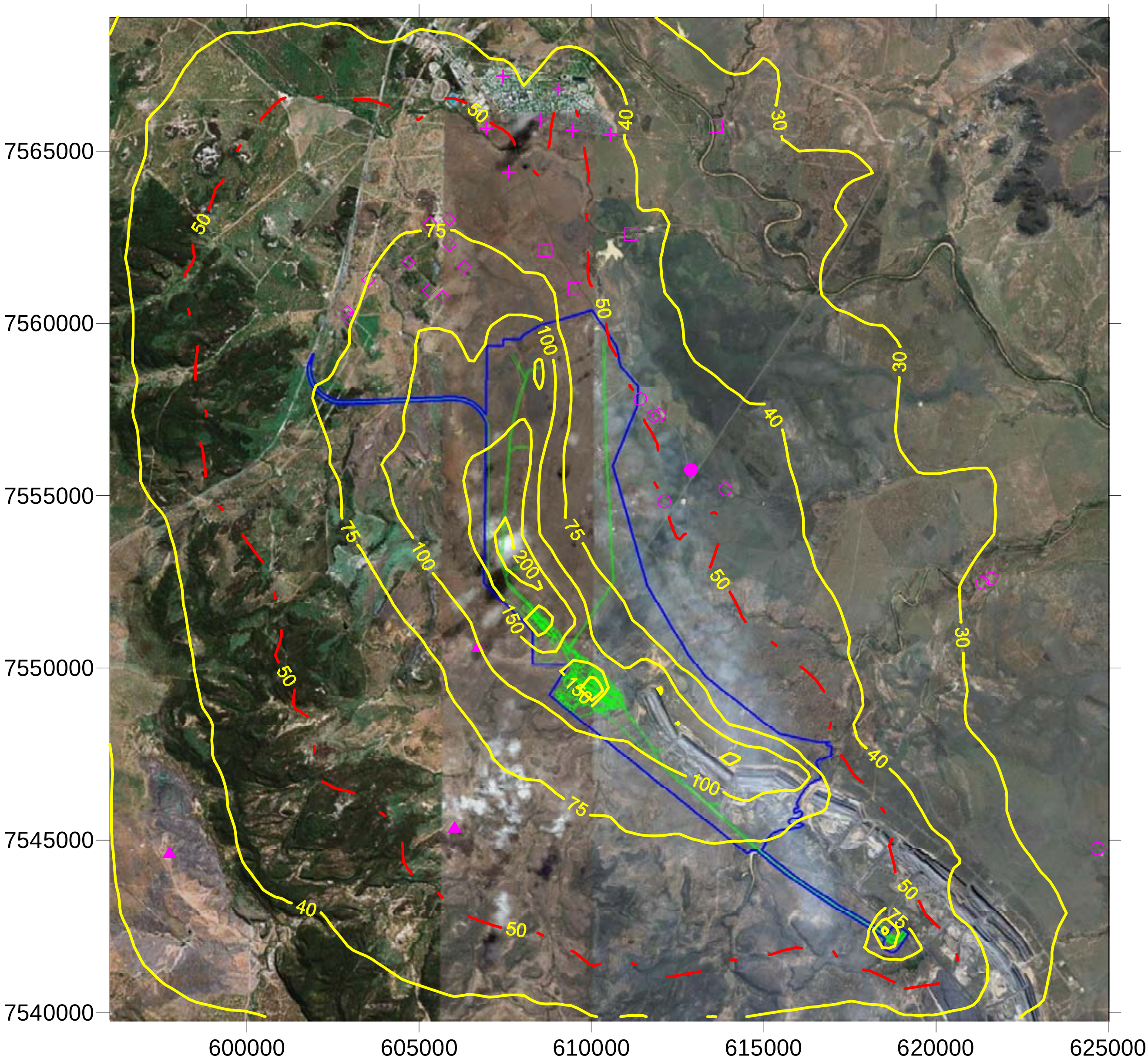
EPP (Air) Guideline: 90 µg/m³

Moranbah
Southern Moranbah
Homesteads North of site
Homesteads East of site
Homesteads West of site
Commercial premises

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	Title: ANNUAL AVERAGE CONCENTRATION OF TSP (µg/m³) FOR YEAR 1 WITH BACKGROUND
Drawn: DH	Approved: CB	Date: 17-02-2009
Job No: **4262 6158** /6161	File: 42626158-g-171b.srf	Figure: **4-1** Rev:B A4



EPP (Air) Objective: 50 µg/m³

Moranbah
Southern Moranbah
Homesteads North of site
Homesteads East of site
Homesteads West of site
Commercial premises

Source: Google 2008

Datum: AGD84, AMG Zone 55

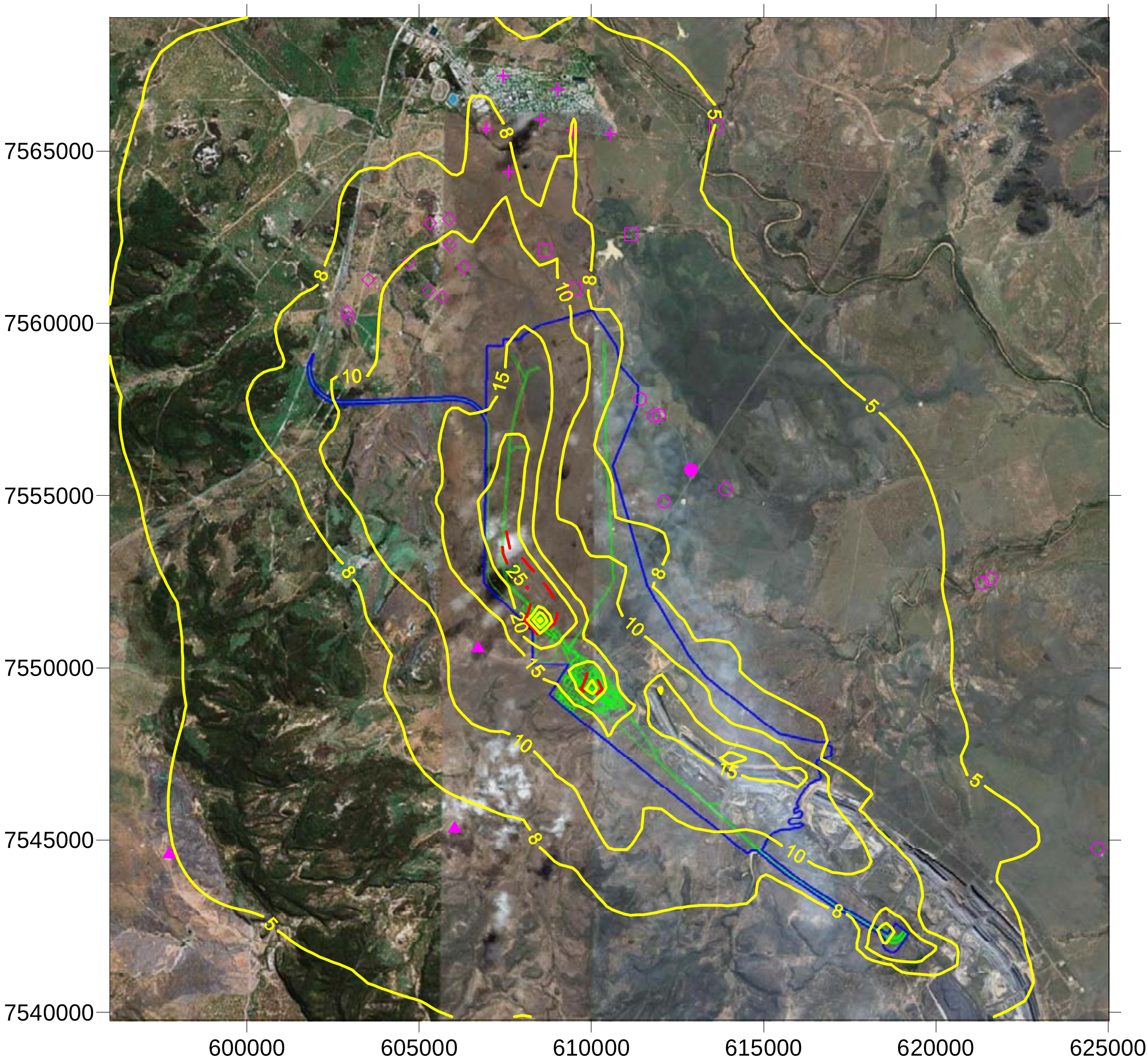
Client: BMA BHP Billiton Mitsubishi Alliance

URS

Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT

Title: FIFTH HIGHEST 24 HOUR AVERAGE CONCENTRATION OF PM_{10} (µg/m³) FOR YEAR 1 WITH BACKGROUND

Drawn: DH	Approved: CB	Date: 17-02-2009	Figure: 4-2	Rev:B
Job No: 4262 6158 /6161	File: 42626158-g-172b.srf			A4



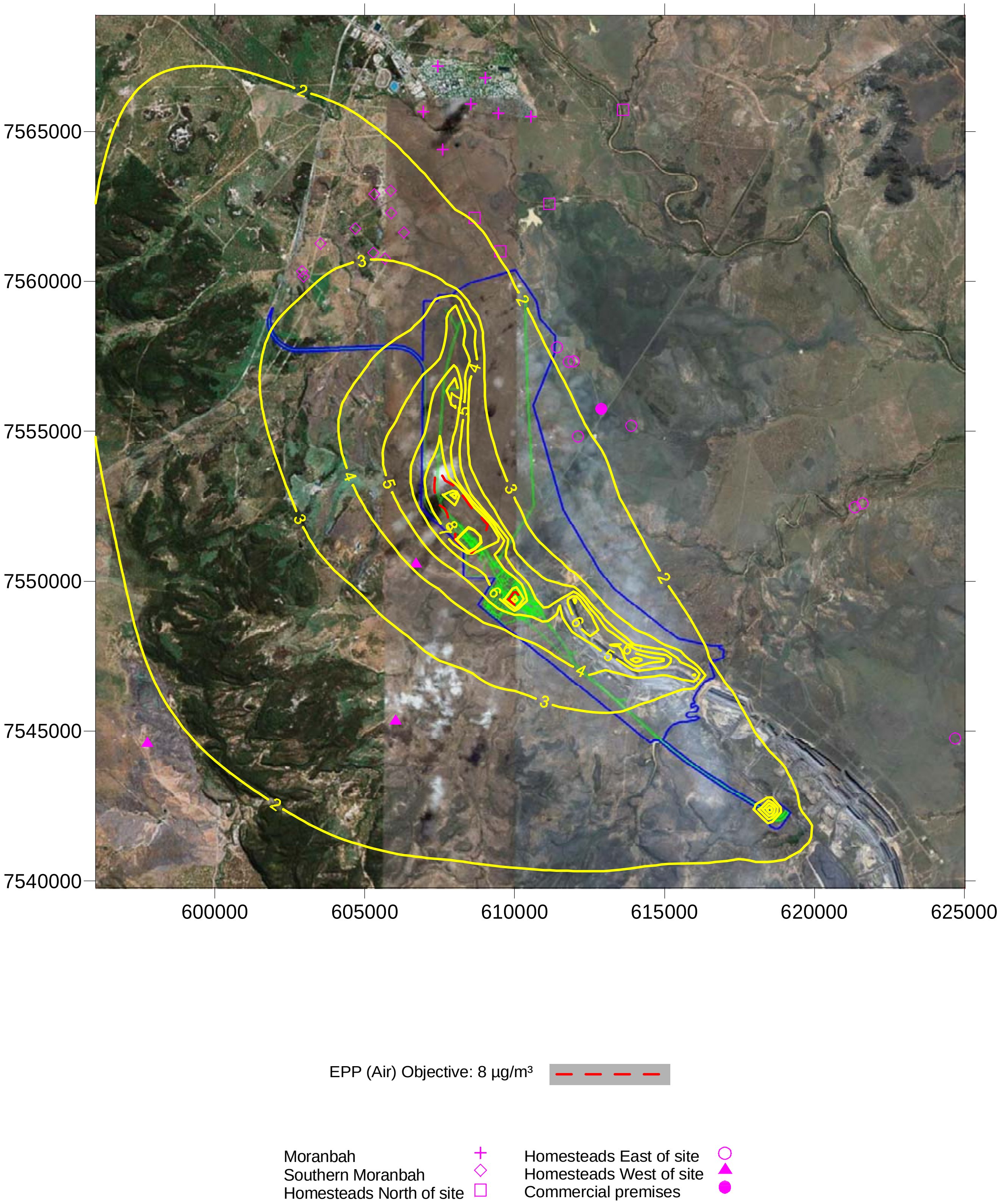
EPP (Air) Objective: 25 µg/m³

Moranbah +
Southern Moranbah ◇
Homesteads North of site □
Homesteads East of site ○
Homesteads West of site ▲
Commercial premises ●

Source: Google 2008

Datum: AGD84, AMG Zone 55

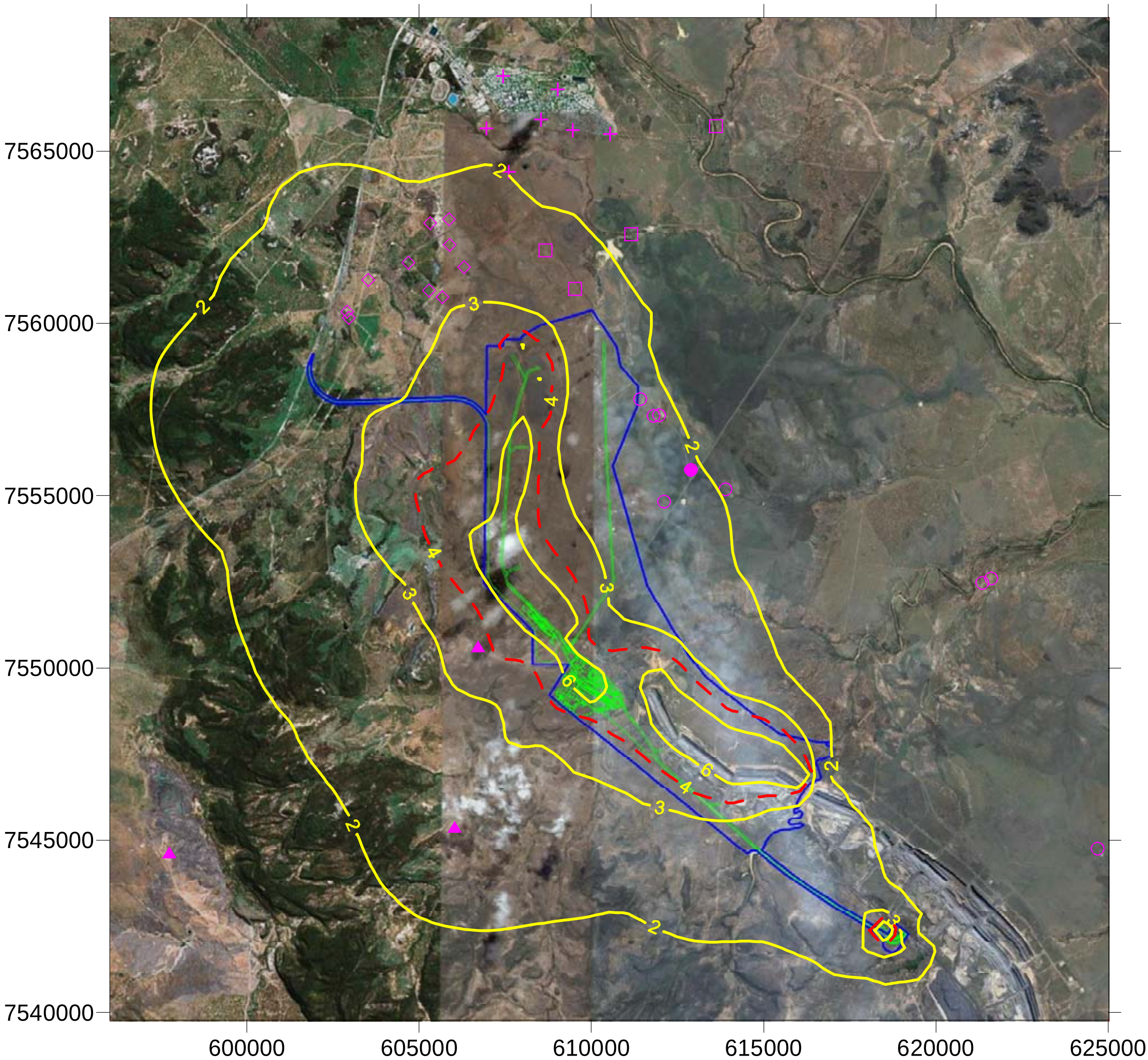
Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT		Title: MAXIMUM 24 HOUR AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 1 WITH BACKGROUND
	Drawn: DH	Approved: CB	Date: 17-02-2009
	Job No: 4262 6158 /6161	File: 42626158-g-173b.srf	Figure: 4-3 — Rev:B — A4



Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT			Title: ANNUAL AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 1 WITH BACKGROUND	
	Drawn: DH	Approved: CB	Date: 17-02-2009	Figure: 4-4	Rev:B
	Job No: 4262 6158 /6161	File: 42626158-g-174b.srf			A4



EPP (Air) Guideline: 4 g/m²/month

Moranbah
Southern Moranbah
Homesteads North of site
Homesteads East of site
Homesteads West of site
Commercial premises

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT			Title: **MAXIMUM MONTHLY DEPOSITION OF TSP (g/m²/month) FOR YEAR 1 WITH BACKGROUND**	
URS	Drawn: DH	Approved: CB	Date: 17-02-2009	Figure: **4-5**	Rev:B
	Job No: **4262 6158** /6161	File: 42626158-g-175b.srf			A4

4.3 Operational Impacts in Year 2

Predicted air quality impacts due to operation of the Caval Ridge mine for Year 2 are presented in Table 4-2. Ground-level concentrations that are predicted to exceed the relevant Project goal are highlighted in bold font.

Results suggest that impacts around the Caval Ridge Mine site will not exceed the EPP (Air) objectives for $PM_{2.5}$, TSP or the Qld EPA guideline for dust deposition under typical operating conditions.

As was the case for the Year 1 scenario, results for the 5th highest 24-hour average ground-level concentration of PM_{10} highlights the potential for PM_{10} levels to exceed the EPP(Air) objective of 50 µg/m^3 at some locations within the study region. A detailed investigation into modelled worst-case meteorological conditions presented in Appendix A highlights the strong dependence of the model results on the model default value of the mixing height which plays a key role in the calculation of night time impacts.

The areal extent of the region predicted to exceed the relevant Project goals are illustrated in Figure 4-6 through Figure 4-10 for operations in Year 2.

The most affected areas are residences in Southern Moranbah, homesteads to the west and residential locations to the north of the mine.

Results of the dispersion modelling have been used to aid in the development of a local air quality monitoring program that is outlined in Appendix C. Information obtained during monitoring will be used to assess the effectiveness of current operational practices and the need for additional dust mitigation measures as outlined in Section 5 and detailed in the Environmental Management Plan.

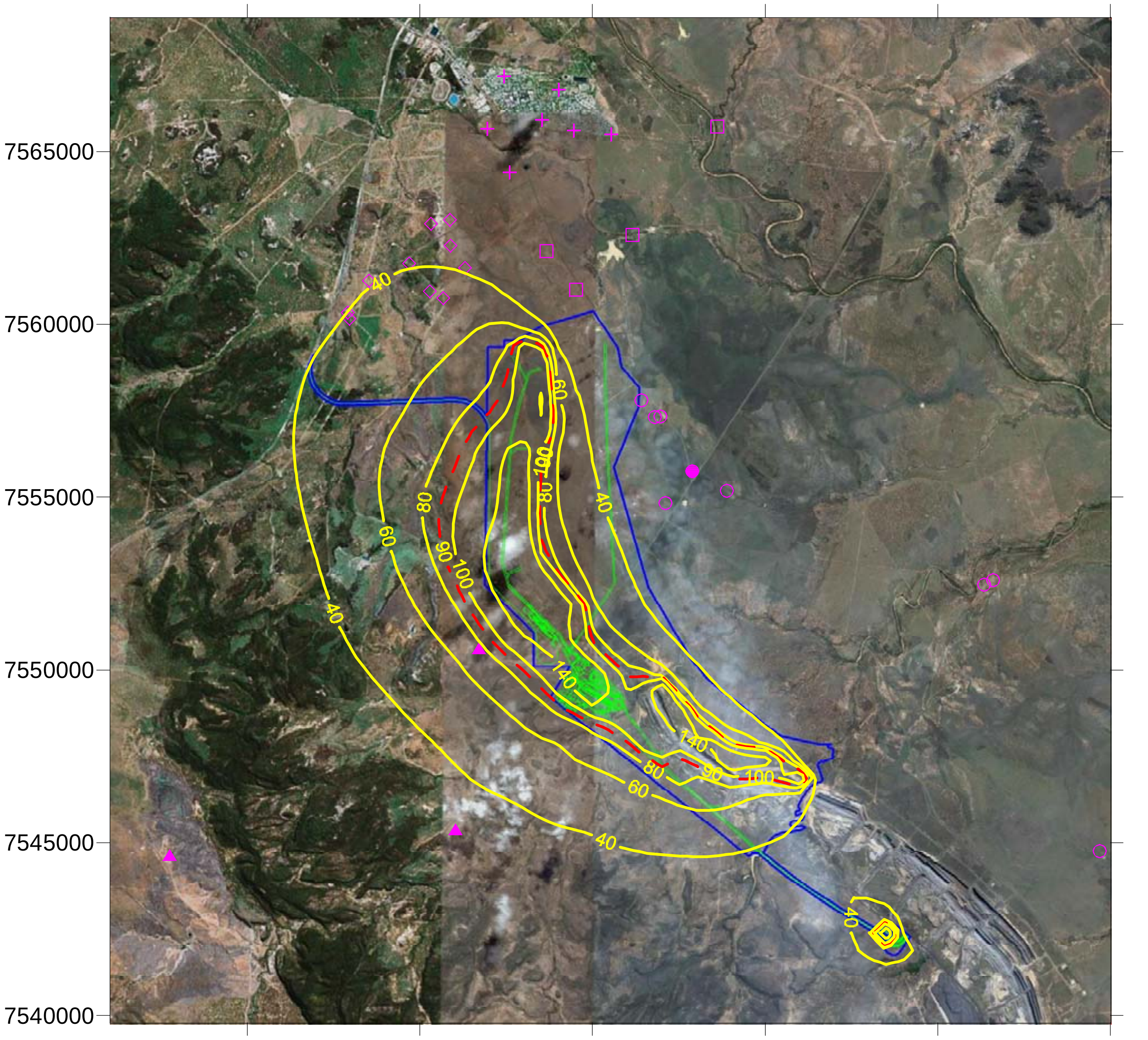
Dispersion Modelling Results

Table 4-2 Predicted Impacts at Residential Locations for Year 2 for Typical Operations

Pollutant	TSP		PM_{10}		$PM_{2.5}$		$PM_{2.5}$		Dust Deposition	
Averaging period	**Annual**		**24-hour+**		**24-hour++**		**Annual**		**Monthly**	
Units	**µg/m^3**		**µg/m^3**		**µg/m^3**		**µg/m^3**		**g/m^2/month**	
Sensitive Receptor Group	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**
Moranbah	4.4	35.8	35.6	**54.4**	8.9	11.8	0.6	2.2	0.5	2.0
Southern Moranbah	28.8	60.2	83.7	**102.5**	14.7	17.6	3.1	4.7	1.5	3.0
Homesteads N of site	8.3	39.7	46.3	**65.1**	11.2	14.1	0.9	2.5	0.9	2.4
Homesteads E of site	8.6	40.0	38.4	**57.2**	6.0	8.9	1.0	2.6	0.8	2.3
Homesteads W of site	56.4	87.8	89.5	**108.3**	16.1	19.0	5.8	7.4	2.4	3.9
Commercial premises	6.0	37.4	28.2	47.0	4.5	7.4	0.7	2.3	0.6	2.1
Background	**31.4**		**18.8**		**2.9**		**1.6**		**1.5**	
EPP(Air) Objective	**90**		**50**		**25**		**8**		**4**	

+ Results for the 5th highest 24-hour average concentration have been reported.

++ Results for the maximum 24-hour average concentration have been reported.



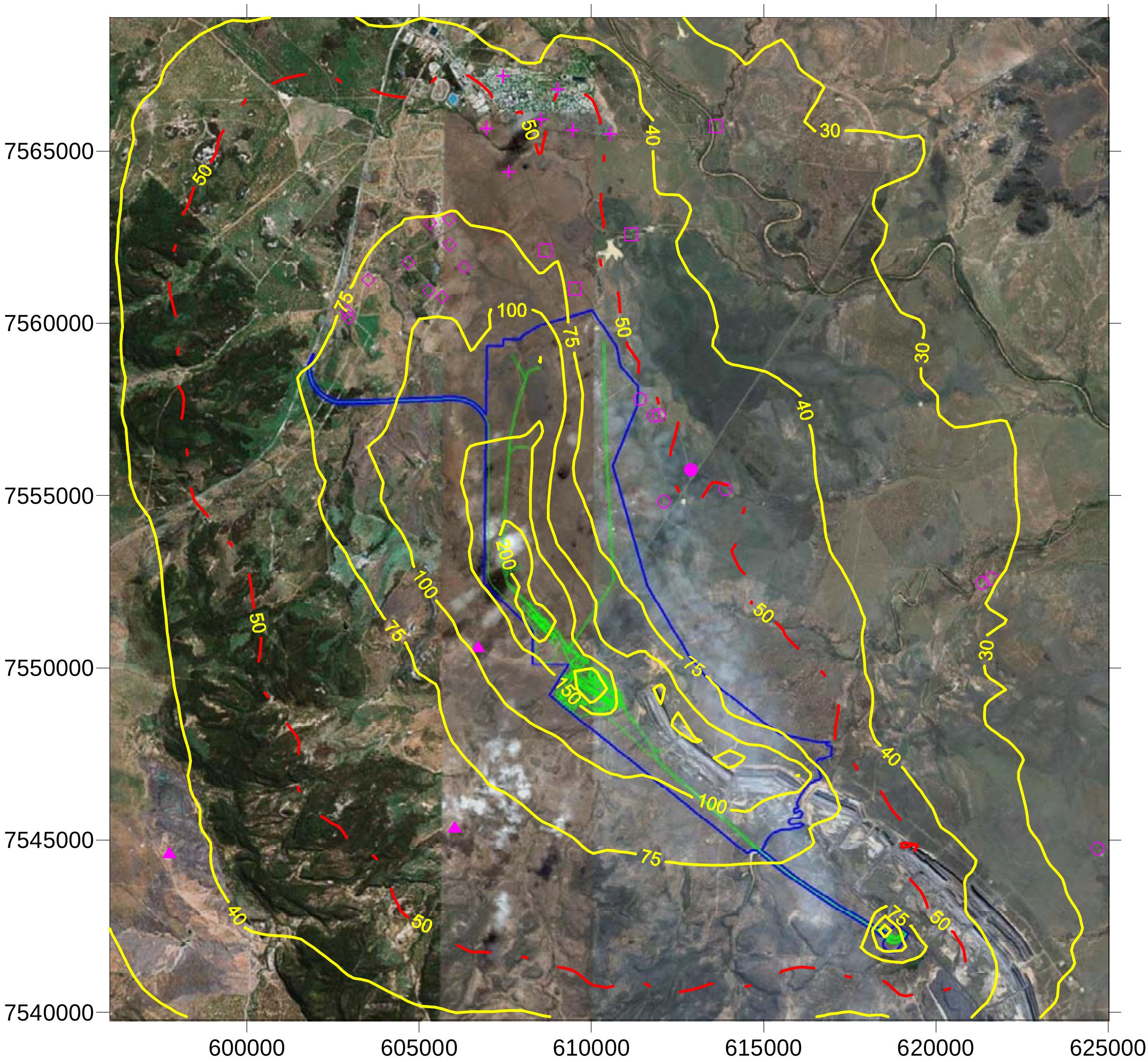
EPP (Air) Guideline: 90 µg/m³

Moranbah
Southern Moranbah
Homesteads North of site
Homesteads East of site
Homesteads West of site
Commercial premises

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT		Title: ANNUAL AVERAGE CONCENTRATION OF TSP (µg/m³) FOR YEAR 2 WITH BACKGROUND
	Drawn: DH	Approved: CB	Date: 17-02-2009
	Job No: **4262 6158** /6161	File: 42626158-g-176b.srf	Figure: 4-6 — Rev:B — A4



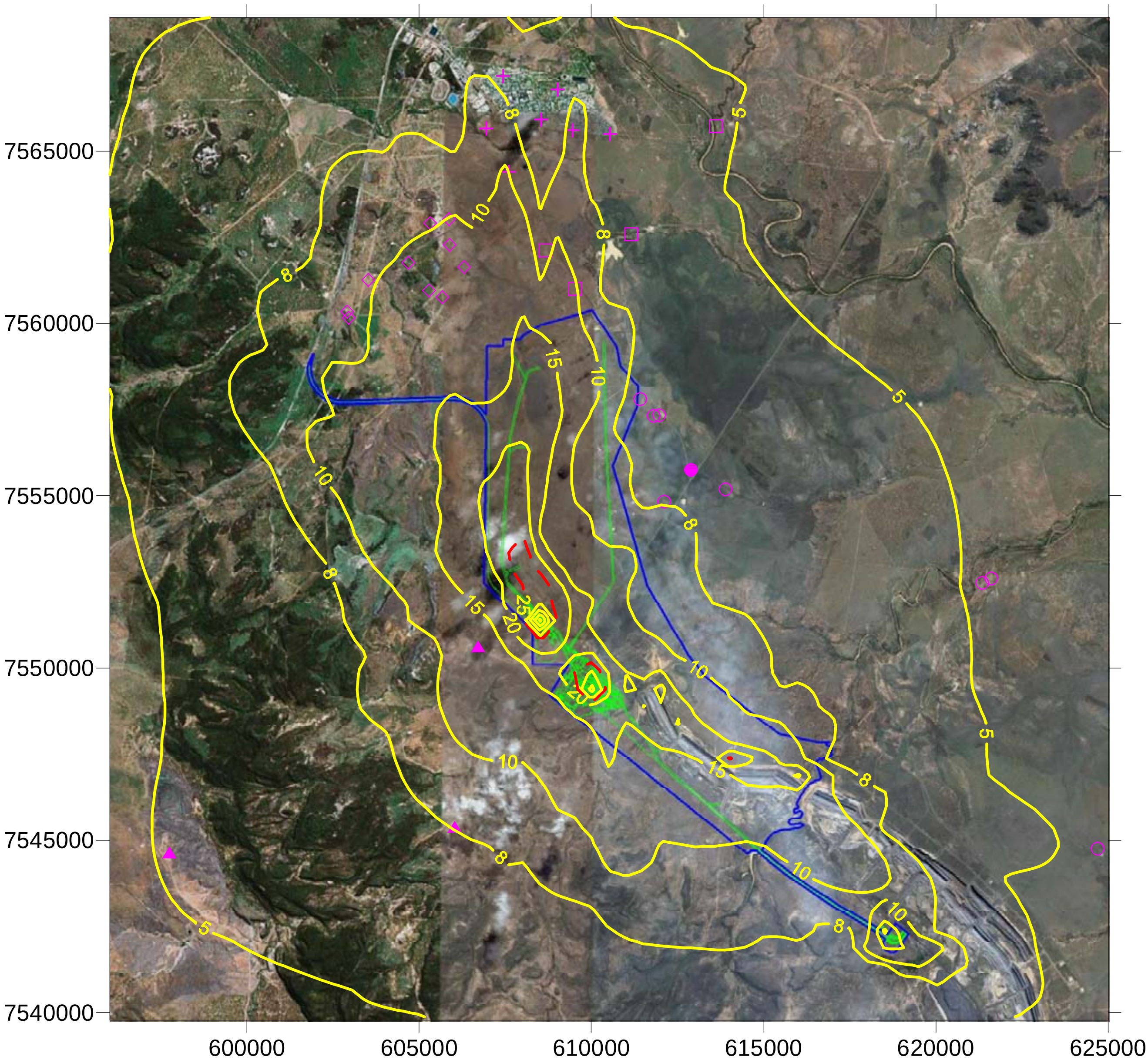
EPP (Air) Objective: 50 µg/m³

Moranbah +
Southern Moranbah ◇
Homesteads North of site □
Homesteads East of site ○
Homesteads West of site ▲
Commercial premises ●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT			Title: FIFTH HIGHEST 24 HOUR AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 2 WITH BACKGROUND	
	Drawn: DH	Approved: CB	Date: 17-02-2009	Figure: 4-7	Rev:B
	Job No: **4262 6158** /6161	File: 42626158-g-177b.srf			A4



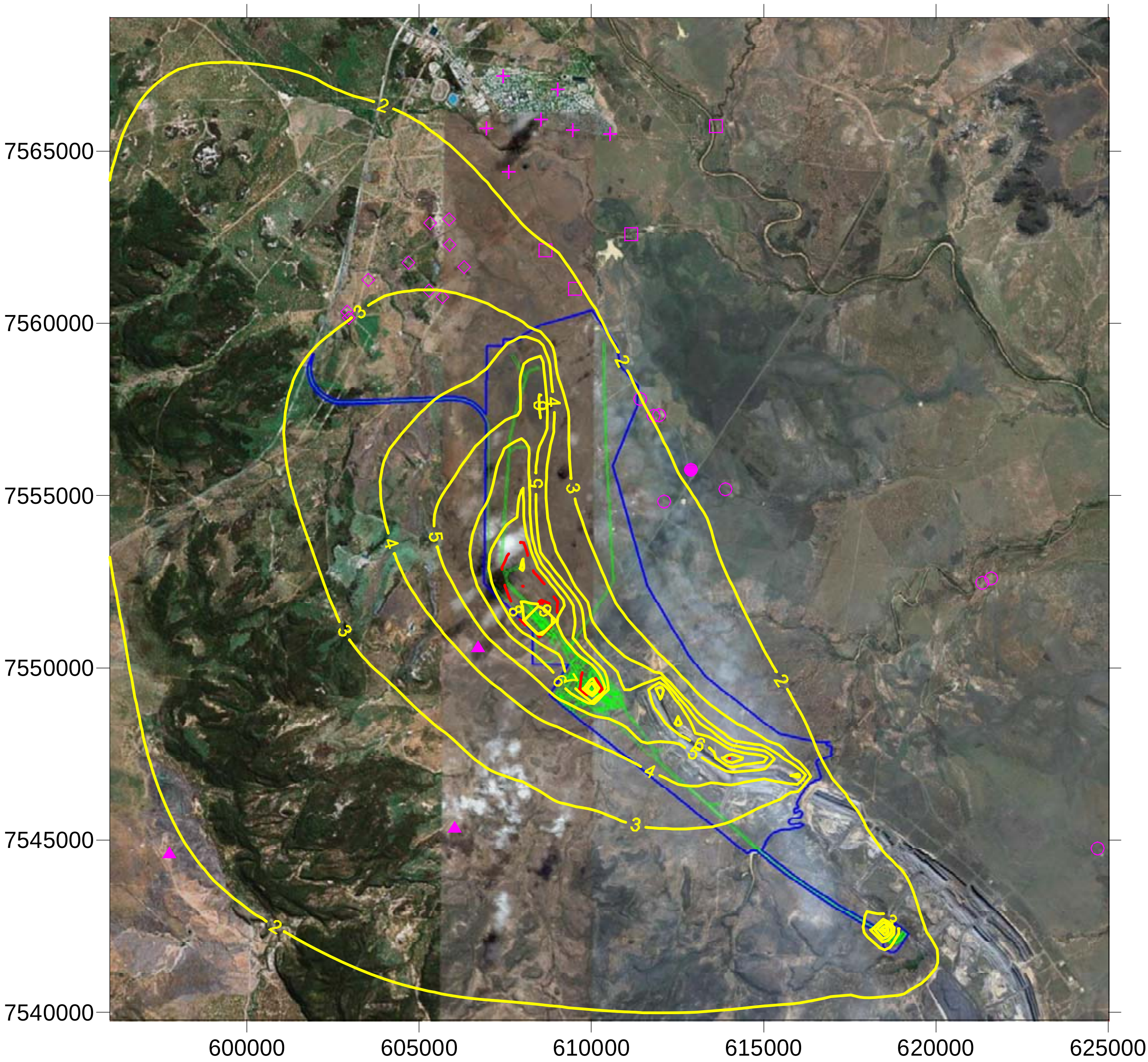
EPP (Air) Objective: 50 µg/m³

Moranbah	+	Homesteads East of site	○
Southern Moranbah	◇	Homesteads West of site	▲
Homesteads North of site	□	Commercial premises	●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT		Title: MAXIMUM 24 HOUR AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 2 WITH BACKGROUND
	Drawn: DH	Approved: CB	Date: 17-02-2009
	Job No: **4262 6158** /6161	File: 42626158-g-178b.srf	Figure: **4-8** Rev:B A4



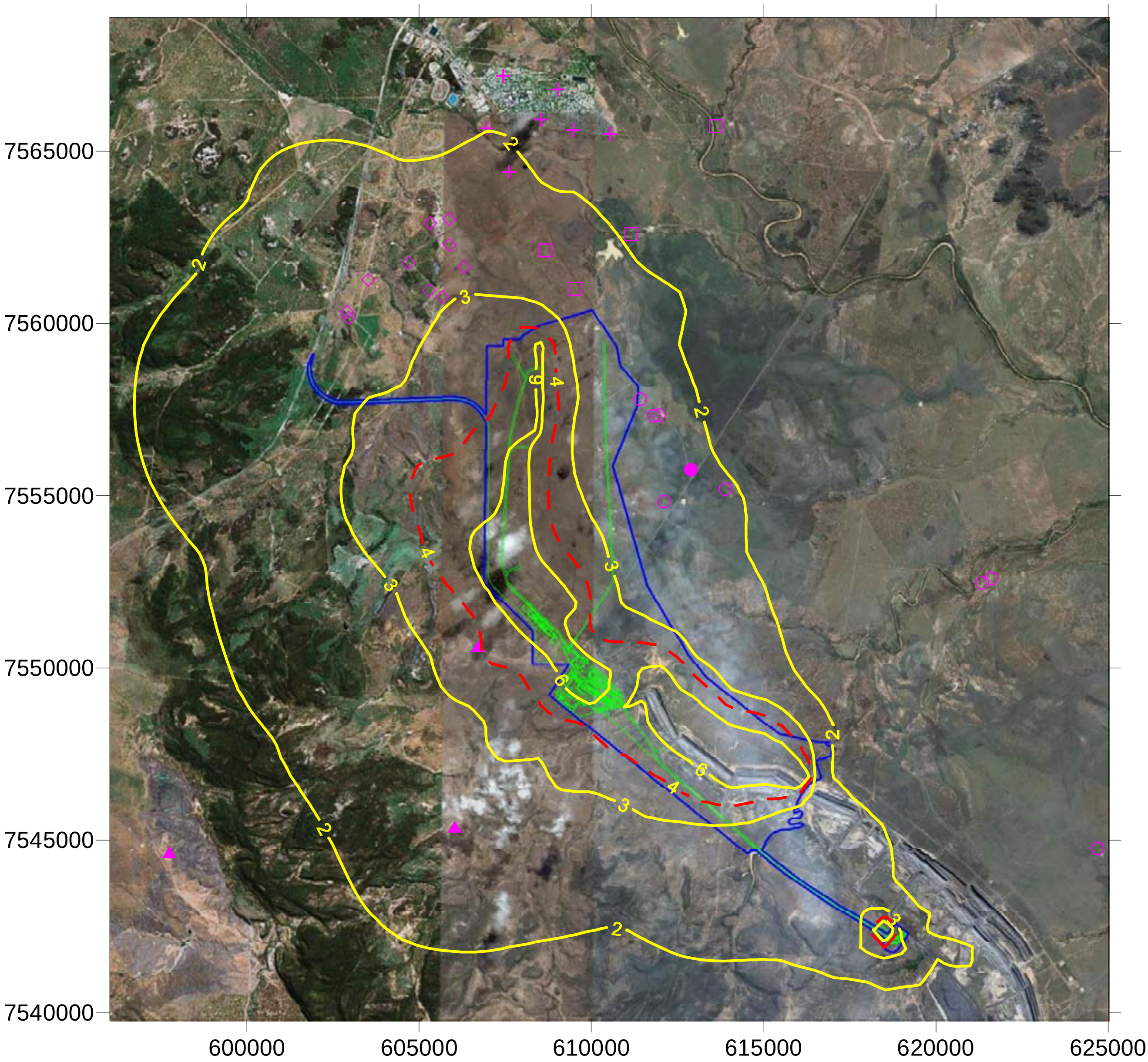
EPP (Air) Objective: 8 µg/m³

Moranbah	+	Homesteads East of site	○
Southern Moranbah	◇	Homesteads West of site	▲
Homesteads North of site	□	Commercial premises	●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance; URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	Title: ANNUAL AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 2 WITH BACKGROUND
	Drawn: DH; Approved: CB; Date: 17-02-2009	Figure: 4-9; Rev:B
	Job No: 4262 6158 /6161; File: 42626158-g-179b.srf	A4



EPP (Air) Guideline: 4 g/m²/month

Moranbah +
Southern Moranbah ◇
Homesteads North of site □
Homesteads East of site ○
Homesteads West of site ▲
Commercial premises ●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	Title: **MAXIMUM MONTHLY DEPOSITION OF TSP (g/m²/month) FOR YEAR 2 WITH BACKGROUND**
URS	Drawn: DH; Approved: CB; Date: 17-02-2009	Figure: **4-10**
	Job No: **4262 6158** /6161; File: 42626158-g-180b.srf	Rev: B; A4

4.4 Operational Impacts in Year 20

Predicted air quality impacts due to operation of the Caval Ridge mine for Year 20 are presented in Table 4-3. Ground-level concentrations that are predicted to exceed the relevant Project goal is highlighted in bold font.

These results indicate that predicted impacts around the Caval Ridge mine do not exceed the EPP (Air) objectives for $PM_{2.5}$ and TSP or the Qld EPA guideline for dust deposition under typical operating conditions.

As was the case for the Year 1 and Year 2 scenarios, results for the 5^{th} highest 24-hour average ground-level concentration of PM_{10} highlights the potential for PM_{10} levels to exceed the EPP(Air) objective of 50 µg/m³ at some locations within the study region. A detailed investigation into modelled worst-case meteorological conditions presented in Appendix A highlights the strong dependence of the model results on the model default value of the mixing height which plays a key role in the calculation of night time impacts.

The areal extent of the region that is predicted to exceed the relevant Project goals are illustrated in Figure 4-11 through Figure 4-15 for operations in Year 20.

The most affected areas are predicted to be the residences north of the mine, locations in Southern Moranbah, homesteads to the east of the mine and the homesteads to the west of the site.

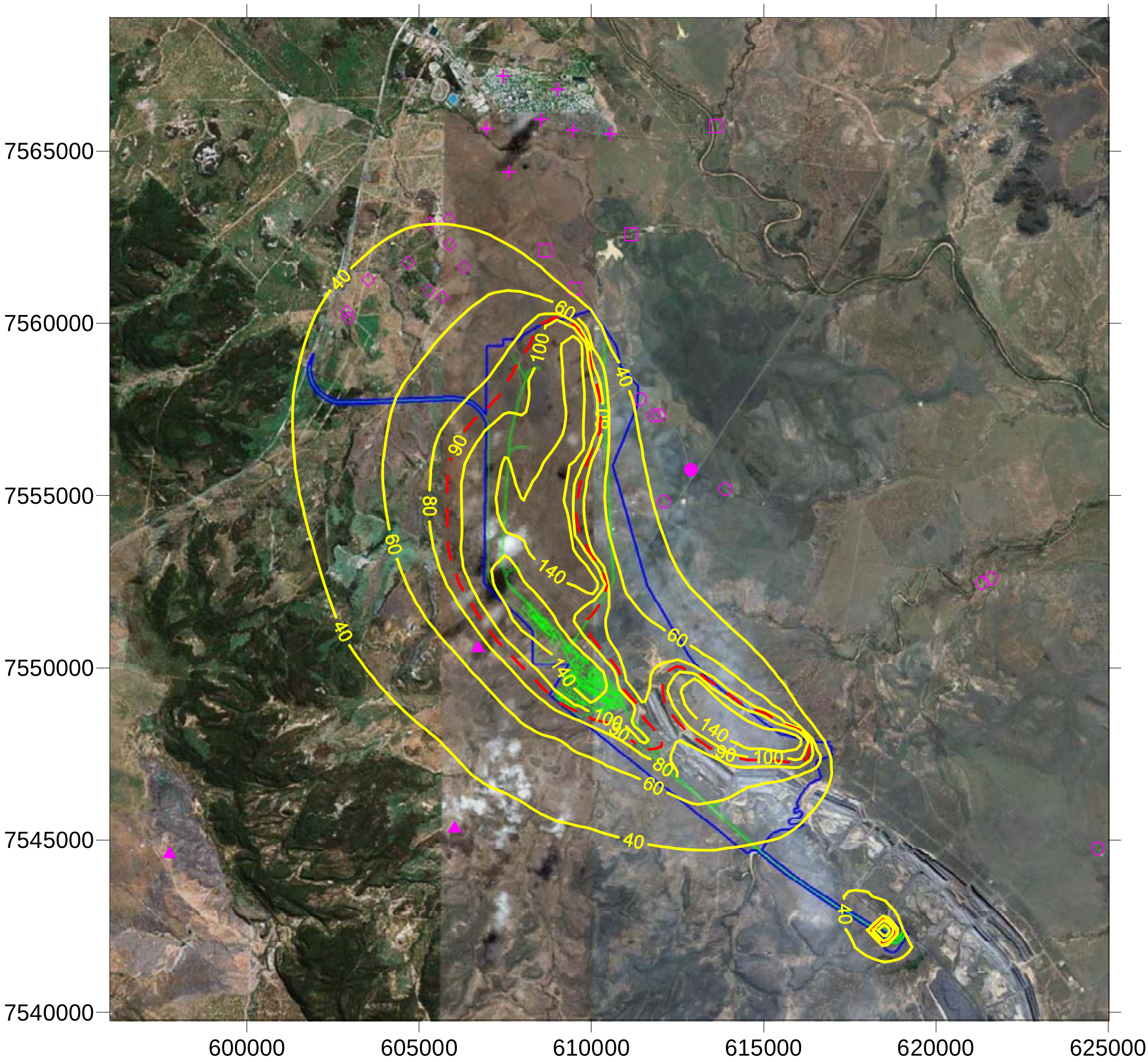
Results of the dispersion modelling have been used to aid in the development of a local air quality monitoring program that is outlined in Appendix C. Information obtained during monitoring will be used to assess the effectiveness of current operational practices and the need for additional dust mitigation measures as outlined in Section 5 and detailed in the Environmental Management Plan.

Table 4-3 Predicted Impacts at Residential Locations for Year 20 for Typical Operations

Pollutant	TSP		PM_{10}		$PM_{2.5}$		$PM_{2.5}$		Dust Deposition	
Averaging period	**Annual**		**24-hour+**		**24-hour++**		**Annual**		**Monthly**	
Units	**µg/m³**		**µg/m³**		**µg/m³**		**µg/m³**		**g/m²/month**	
Sensitive Receptor Group	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**	**Incremental**	**Total**
Moranbah	7.9	39.3	53.9	**72.7**	13.4	16.3	1.0	2.6	0.7	2.2
Southern Moranbah	35.4	66.8	87.2	**106.0**	16.0	18.9	3.9	5.5	1.7	3.2
Homesteads N of site	17.4	48.8	73.5	**92.3**	18.3	21.2	1.6	3.2	1.9	3.4
Homesteads E of site	18.0	49.4	62.4	**81.2**	15.4	18.3	1.8	3.4	1.4	2.9
Homesteads W of site	53.0	84.4	90.2	**109.0**	17.1	20.0	5.6	7.2	2.4	3.9
Commercial premises	10.7	42.1	36.8	**55.6**	6.4	9.3	1.2	2.8	0.9	2.4
Background	**31.4**		**18.8**		**2.9**		**1.6**		**1.5**	
EPP(Air) Objective	**90**		**50**		**25**		**8**		**4**	

+ Results for the 5th highest 24-hour average concentration have been reported.

++ Results for the maximum 24-hour average concentration have been reported.



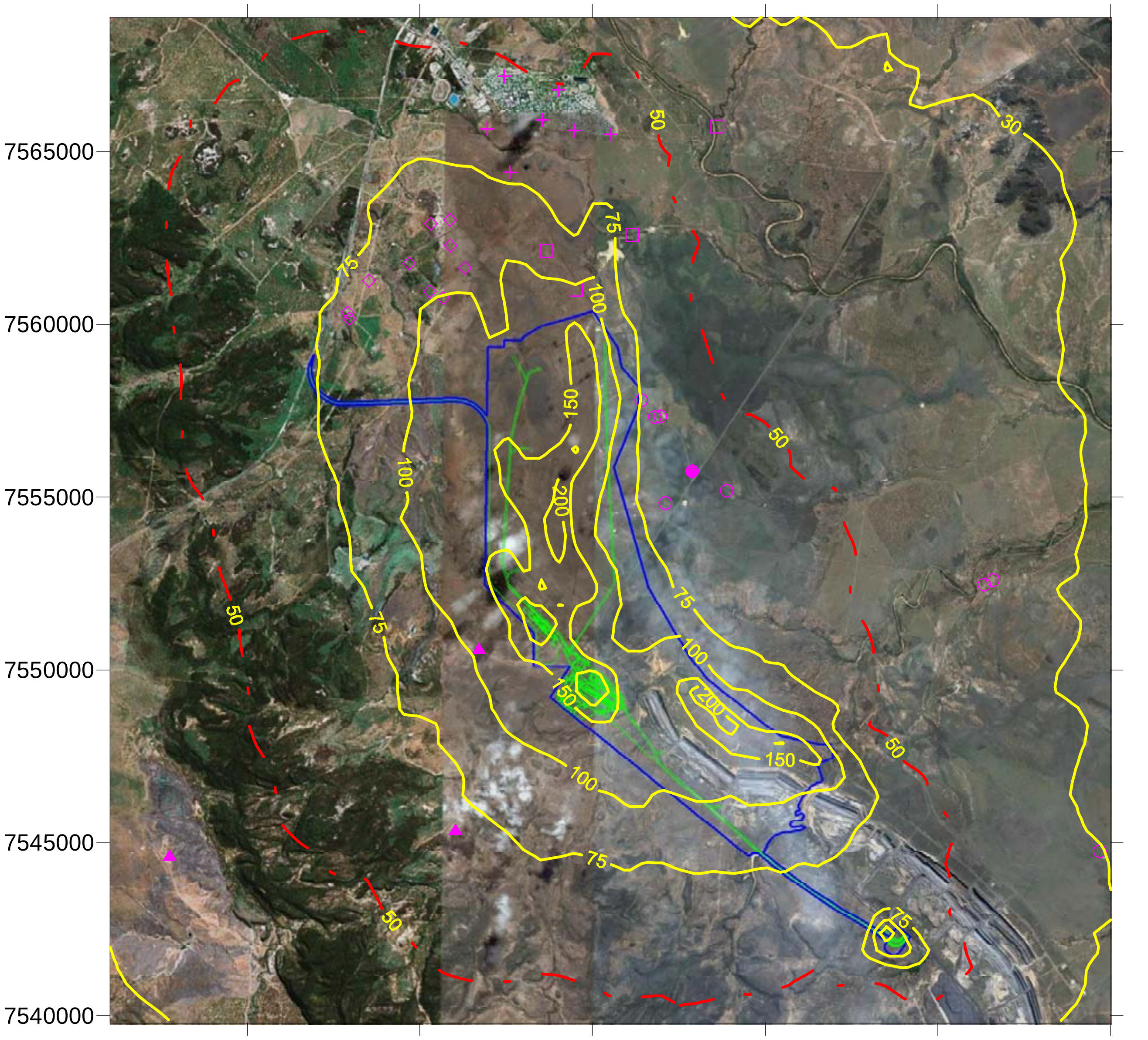
EPP (Air) Guideline: 90 µg/m³

Moranbah +
Southern Moranbah ◇
Homesteads North of site □
Homesteads East of site ○
Homesteads West of site ▲
Commercial premises ●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT			Title: **ANNUAL AVERAGE CONCENTRATION OF TSP (µg/m³) FOR YEAR 20 WITH BACKGROUND**	
	Drawn: DH	Approved: CB	Date: 17-02-2009	Figure: **4-11**	Rev:B
	Job No: **4262 6158** /6161	File: 42626158-g-181b.srf			A4



EPP (Air) Objective: 50 µg/m³

Moranbah +
Southern Moranbah ◇
Homesteads North of site □
Homesteads East of site ○
Homesteads West of site ▲
Commercial premises ●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance

URS

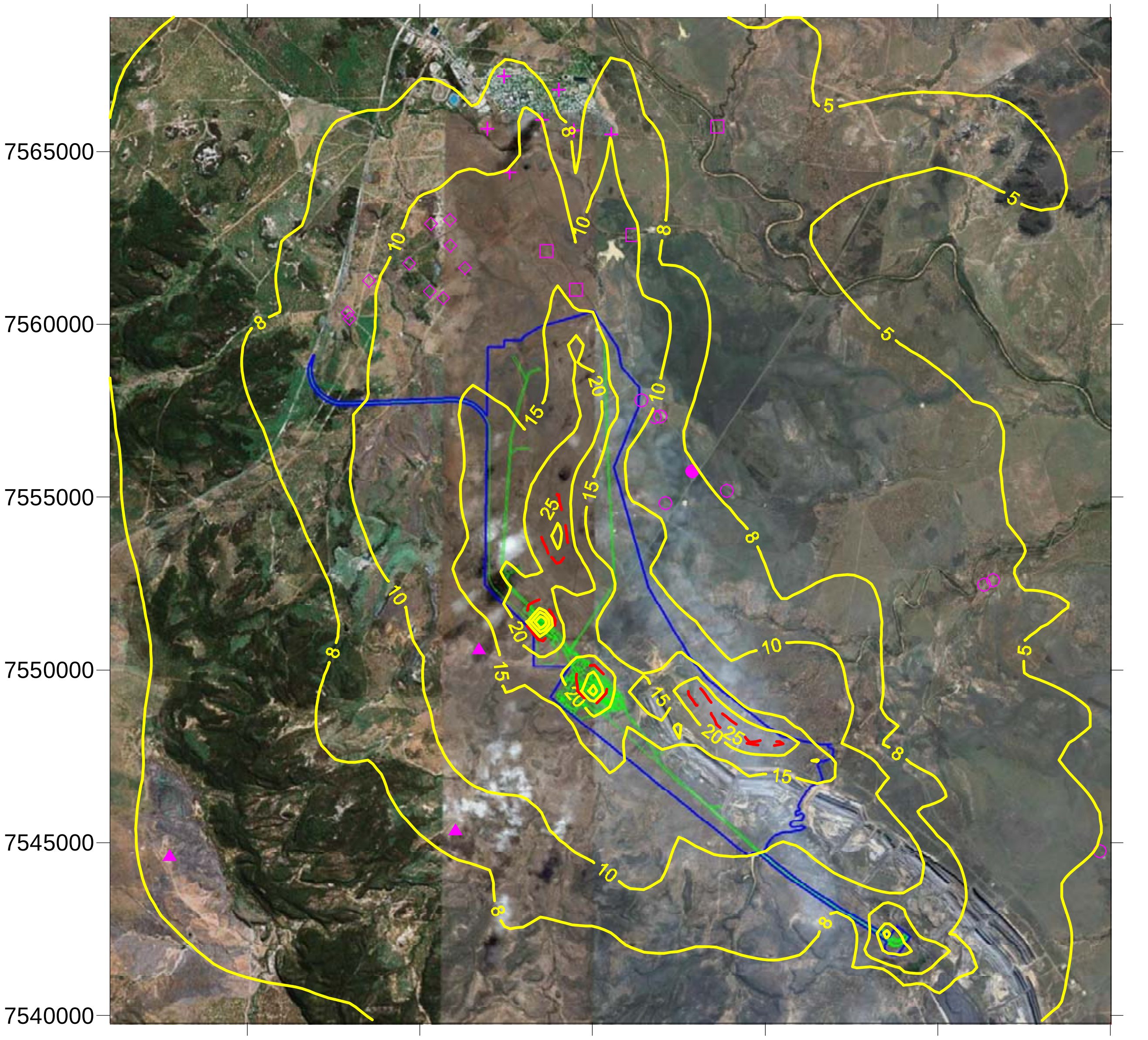
Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT

Title: **FIFTH HIGEST 24 HOUR AVERAGE CONCENTRATION OF PM_{10} (µg/m³) FOR YEAR 20 WITH BACKGROUND**

Drawn: DH | Approved: CB | Date: 17-02-2009

Job No: **4262 6158** /6161 | File: 42626158-g-182b.srf

Figure: **4-12** | Rev: B | A4



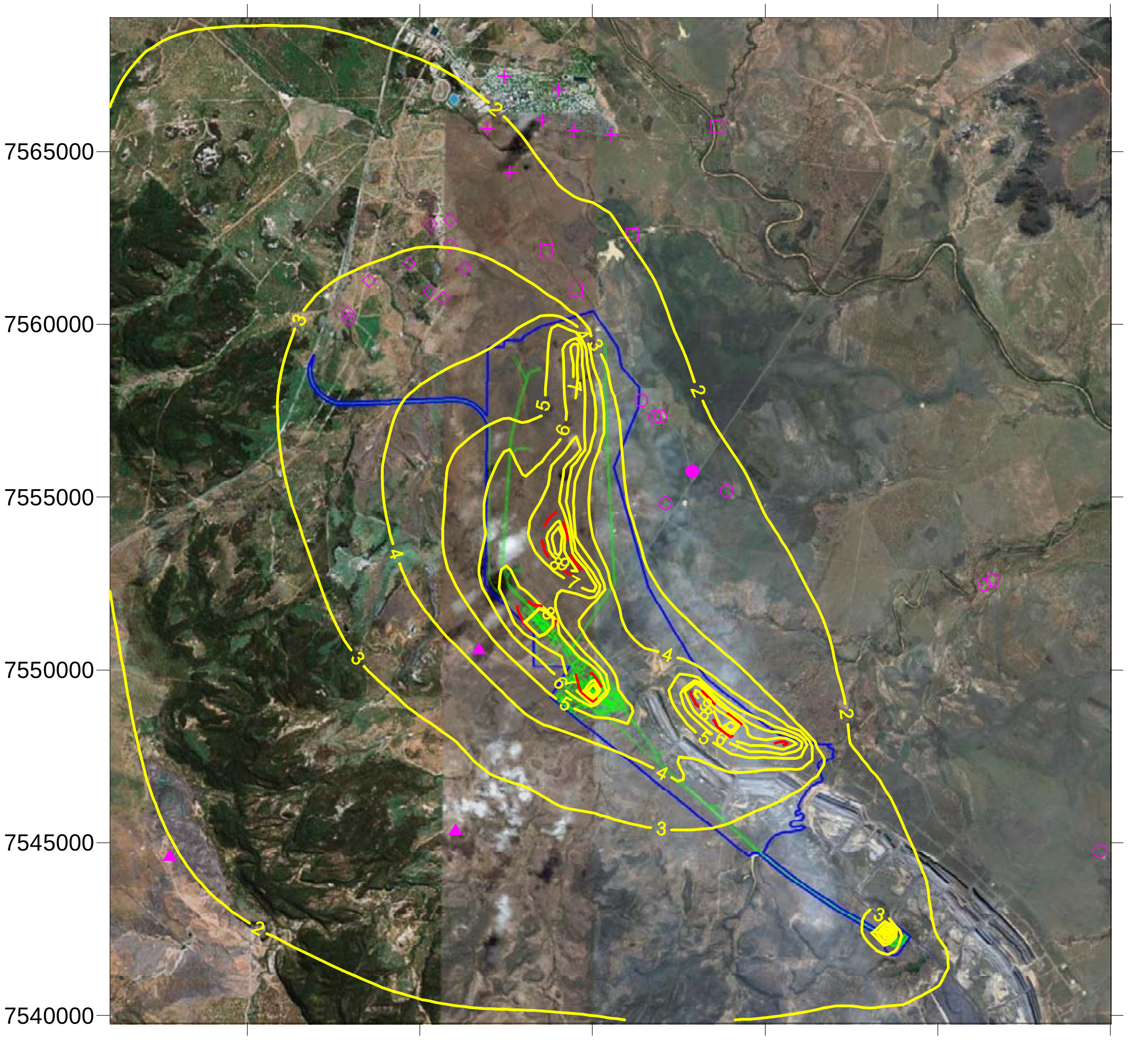
EPP (Air) Objective: 50 µg/m³

Moranbah +
Southern Moranbah ◇
Homesteads North of site □
Homesteads East of site ○
Homesteads West of site ▲
Commercial premises ●

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	Title: **MAXIMUM 24 HOUR AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 20 WITH BACKGROUND**
URS	Drawn: DH / Approved: CB / Date: 17-02-2009	Figure: **4-13** / Rev:B
	Job No: **4262 6158** /6161 / File: 42626158-g-183b.srf	A4



EPP (Air) Objective: 8 µg/m³

Moranbah
Southern Moranbah
Homesteads North of site
Homesteads East of site
Homesteads West of site
Commercial premises

Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT		Title: ANNUAL AVERAGE CONCENTRATION OF $PM_{2.5}$ (µg/m³) FOR YEAR 20 WITH BACKGROUND	
	Drawn: DH	Approved: CB	Date: 17-02-2009	Figure: 4-14	Rev:B
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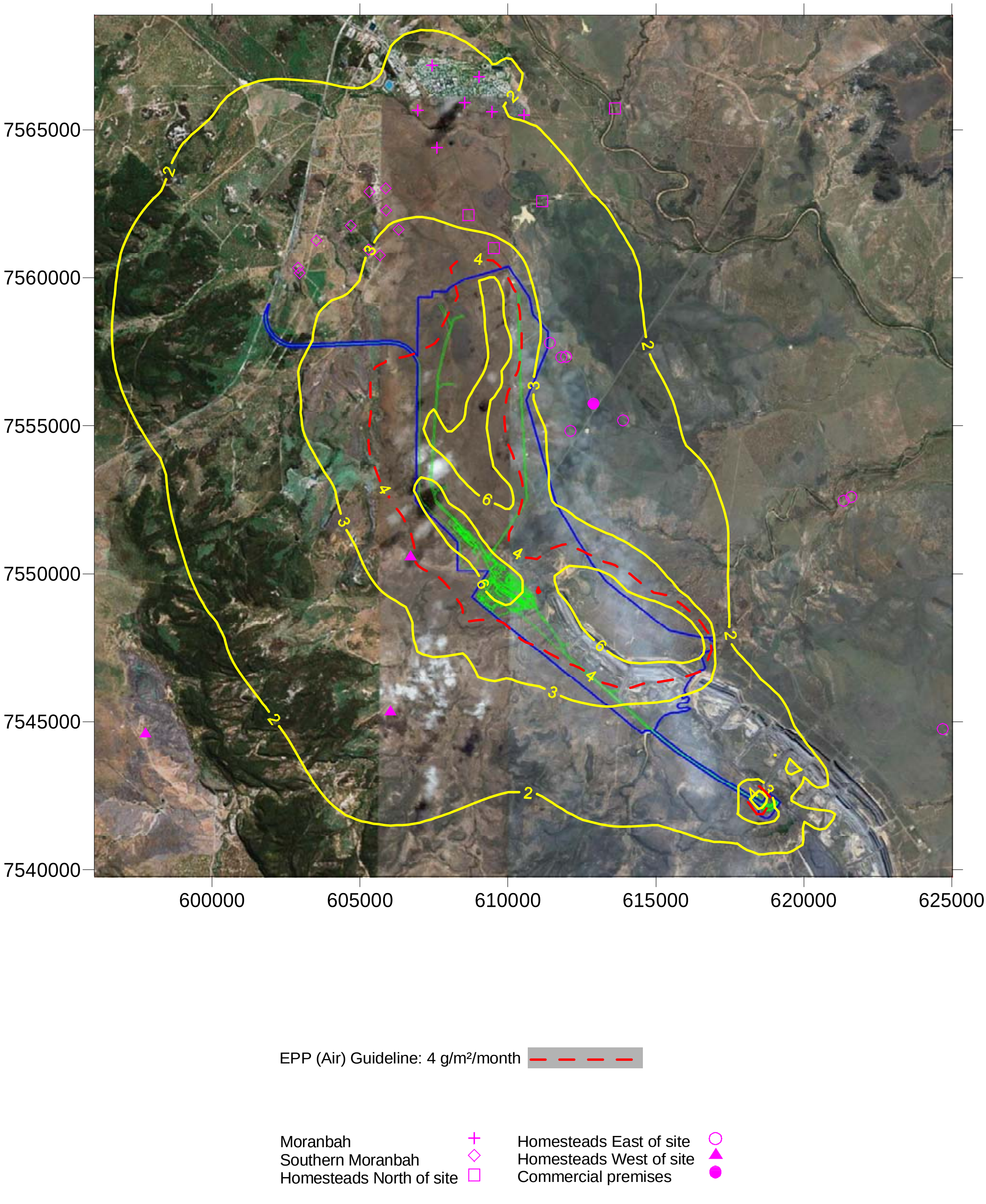


Source: Google 2008

Datum: AGD84, AMG Zone 55

Client: BMA BHP Billiton Mitsubishi Alliance / URS	Project: CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	Title: **MAXIMUM MONTHLY DEPOSITION OF TSP (g/m²/month) FOR YEAR 20 WITH BACKGROUND**
Drawn: DH	Approved: CB	Date: 17-02-2009
Job No: **4262 6158** /6161	File: 42626158-g-185b.srf	Figure: **4-15** Rev:B A4

4.5 Impacts for Worst-case Operations

The predicted impacts for mine operation under worst-case conditions are presented in Table 4-4 (PM_{10}) and Table 4-5 ($PM_{2.5}$) at residential receptor locations. These results are only presented for the 5th highest 24-hour average concentration of PM_{10} and the maximum 24-hour average concentration of $PM_{2.5}$ for comparison with the air quality objective, as the worst-case conditions where pit activities (truck and shovel pre-strip and coal excavation) are co-located will only occur for short periods of time.

Predicted concentrations for Year 1 indicate that exceedance of the EPP(Air) objective for the 24-hour average concentration of PM_{10} may occur during worst-case operations at all locations presented in Table 4-4. Properties that are most affected by dust from the proposed mine include two properties on Railway Siding Road, two properties on Long Pocket Road and one property currently owned by Anglo Coal to the north of the Project. One additional property currently owned by Anglo Coal and an additional property on Railway Siding Road also exceeds the air quality objective for 24-hour average PM_{10} concentration for construction of the box-cut in Year 1.

Results for Year 2 indicate that predicted impacts to the north of the Caval Ridge mine exceed the EPP (Air) objective for the 24-hour average PM_{10} concentration at all locations presented, due to the peak 24 hour scenario with sources located to the north of the pit. The most affected locations are two properties on Moranbah Access Road that are currently owned by Anglo Coal, three properties on Long Pocket Road, four properties on Railway Siding Road and one location used to represent Moranbah close to Railway Siding Road. The homestead to the west of the site is also close to objective levels.

Predicted 24-hour PM_{10} concentrations for Year 20 also show an exceedance of the EPP (Air) objective at all locations presented. Properties that are most affected by dust from the proposed mine include two properties to the north of Caval Ridge on Moranbah Access Road that are currently owned by Anglo Coal. One property on Railway Siding Road to the north of the Project, one property on Long Pocket Road and one property in Moranbah are also predicted to be affected by high dust levels. The BMA-owned homesteads to the east of the mine are predicted to exceed the air quality objective for 24-hour average PM_{10} concentration, but these locations will be vacated before mine operation commences. The homestead to the west of the mine is shown to have impacts that exceed the air quality objectivefor this worst-case 24-hour scenario.

Results for $PM_{2.5}$ (Table 4-5) suggests that elevated levels above the EPP(Air) objective of 25 µg/m^3 are possible, with the number of locations predicted to exceed the objective increasing from Year 1 through Year 2 to Year 20.

Table 4-4 Predicted Short-term Impacts of PM10 at Residential Locations for Year 1, Year 2 and Year 20 for Worst-case Operations

Sensitive Receptor Group	Fifth Highest 24-hour Average of PM_{10} (µg/m³)					
	Year 1		Year 2		Year 20	
	Incremental	Total	Incremental	Total	Incremental	Total
Moranbah	52.5	**71.3**	72.7	**91.5**	**93.3**	**112.1**
Southern Moranbah	134.5	**153.3**	148.4	**167.2**	113.1	**131.9**
Homesteads N of site	101.4	**120.2**	97.5	**116.3**	194.3	**213.1**
Homesteads E of site	48.9	**67.7**	58.6	**77.4**	120.1	**138.9**
Homesteads W of site	100.2	**119.0**	110.7	**129.5**	107.2	**126.0**
Commercial premises	35.3	**54.1**	45.1	**63.9**	61.5	**80.3**

Sensitive Receptor Group	Fifth Highest 24-hour Average of PM_{10} (µg/m³)					
	Year 1		Year 2		Year 20	
	Incremental	Total	Incremental	Total	Incremental	Total
Background	**18.8**					
EPP(Air) Objective	**50**					

Table 4-5 Predicted Short-term Impacts of $PM_{2.5}$ at Residential Locations for Year 1, Year 2 and Year 20 for Worst-case Operations

Sensitive Receptor Group	Maximum 24-hour Average of $PM_{2.5}$ (µg/m³)					
	Year 1		Year 2		Year 20	
	Incremental	Total	Incremental	Total	Incremental	Total
Moranbah	20.1	23.0	27.0	**29.9**	31.6	**34.5**
Southern Moranbah	33.1	**36.0**	37.4	**40.3**	31.2	**34.1**
Homesteads N of site	27.6	**30.5**	32.7	**35.6**	50.9	**53.8**
Homesteads E of site	14.5	17.4	15.5	18.4	27.9	**30.8**
Homesteads W of site	21.9	24.8	25.6	**28.5**	24.9	**27.8**
Commercial premises	12.5	15.4	15.1	18.0	16.6	19.5
Background	**2.9**					
EPP(Air) Objective	**25**					

4.6 Impacts for Upset Conditions

Predicted impacts under the potential upset condition where dust control measures on the haul roads are inadequate or absent have been modelled, with the results presented in Table 4-6 for PM_{10} and Table 4-7 for $PM_{2.5}$. These results are presented for 24-hour averaging period only, as any failure of controls would be quickly rectified as part of the mine's operations.

These results indicate that for the three year scenarios modelled, high dust levels are predicted for residential areas to the north of the mine, southern Moranbah and residences to the west. The magnitude of these dust impacts show that if there was a total failure of the normal dust suppression technique of watering of haul roads, exceedances of regulatory criteria could potentially occur.

Requirements for maintaining adequate dust controls for acceptable operation of the site are to be included in the operational management of the site to prevent dust impacts of this magnitude affecting residential locations. Consideration could also be given to the restriction of the number of vehicle movements on haul roads closest to residential locations in the event of failure of haul road watering.

Table 4-6 Predicted Worst-case Impacts of PM_{10} at Residential Locations for Year 1, Year 2 and Year 20 for Upset Conditions

Sensitive Receptor Group	Fifth Highest 24-hour Average of PM_{10} (µg/m³)					
	Year 1		Year 2		Year 20	
	incremental	total	incremental	total	incremental	total
Moranbah	66.5	85.3	53.6	72.4	75.9	94.7
Southern Moranbah	155.0	173.8	135.6	154.4	150.7	169.5
Homesteads N of site	103.5	122.3	69.2	88.0	107.4	126.2
Homesteads E of site	70.5	89.3	66.9	85.7	93.3	112.1
Homesteads W of site	163.4	182.2	150.0	168.8	166.5	185.3
Commercial premises	50.6	69.4	51.0	69.8	60.2	79.0
Background	**18.8**					
EPP(Air) Objective	**50**					

Table 4-7 Predicted Worst case Impacts of $PM_{2.5}$ at Residential Locations for Year 1, Year 2 and Year 20 for Upset Conditions

Sensitive Receptor Group	Maximum 24-hour Average of $PM_{2.5}$ (µg/m³)					
	Year 1		Year 2		Year 20	
	incremental	total	incremental	total	incremental	total
Moranbah	22.3	**25.2**	19.0	21.9	24.8	**27.7**
Southern Moranbah	36.0	**38.9**	30.6	**33.5**	34.2	**37.1**
Homesteads N of site	30.3	**33.2**	22.3	**25.2**	30.9	**33.8**
Homesteads E of site	18.0	20.9	16.0	18.9	28.5	**31.4**
Homesteads W of site	40.9	**43.8**	36.8	**39.7**	40.0	**42.9**
Commercial premises	13.9	16.8	13.9	16.8	16.6	19.5
Background	**2.9**					
EPP(Air) Objective	**25**					

Dust mitigation for the operation of Caval Ridge Mine involves several elements to ensure adequate management of air quality in the vicinity of the mine, namely:

- Engineering control measures;
- Dust suppression measures;
- Rehabilitation of exposed surfaces;

- Operational procedures; and
- Measurement of ambient air quality.

5.1 Engineering Control Measures

BMA has designed engineering control measures into the Caval Ridge Mine where appropriate and technically possible. In particular, these control measures have been applied at the CHPP and include the following:

- Enclosure of transfer points and sizing stations;
- Roof on overland conveyors;
- Belt washing and belt scrapers to minimise dust from the return conveyors;
- Reduced drop height from stackers to stockpiles; and
- Enclosure of raw coal surge bins.

The dust mitigation associated with these engineering controls has been incorporated into the impact assessment for the mine.

5.2 Dust Suppression Measures

Dust suppression measures primarily include the application of water to control dust emissions. BMA has advised that the following measures will be implemented:

- Watering of haul roads to best-practice level of more than 2 litres/m^2/hour of water applied;
- Watering of ROM stockpiles using water sprays and water cannons that are operated on timers. The use of timers avoids the potential for missing a scheduled watering operation. The timers can also be operated manually in particularly hot or windy conditions;
- Fogging system on outlets from transfer points and sizing stations;
- Water sprays on stacker/reclaimer units;
- High moisture content of product coal and reject material as they leave the CHPP which avoids the need for supplementary watering. Immediately after the coal is dewatered in the CHPP, the coal will be above the dust extinction moisture limit (the lower limit at which dust-prone materials will no longer create dust) and so will not be a source of dust; and
- Train load-out to incorporate chemical reagent to be sprayed onto the surface of each loaded wagon. This will form a barrier that binds small dust particles together and prevents dust generation from the coal trains as they are transported from Caval Ridge mine to the port.

In the event that adverse conditions are encountered during operation of Caval Ridge, additional dust suppression measures will have to be implemented. The circumstances where this might be required include pre-strip and overburden dumping operations in the north of Horse Pit and during construction of the CHPP and associated infrastructure.

5.3 Rehabilitation of Exposed Surfaces

Rehabilitation of exposed surfaces will be undertaken progressively as mining and stockpiling activities are completed. The effective time from first mining activities on each area of land, until that area is rehabilitated and hence has effective dust control from vegetation, has been estimated to be 5 years. A detailed rehabilitation plan will be developed for the project, which will include the use of fast-growing temporary cover material to accelerate the effectiveness of dust controls. Improving the effectiveness and time for rehabilitation measures will result in reduced dust emissions from exposed areas, however these benefits cannot be incorporated into modelling until the rehabilitation strategy has been formulated.

5.4 Operational Procedures

Operational procedures set out how the Caval Ridge project is to be operated in order to meet targets for air quality performance. In relation to air quality, the following procedures will be incorporated into the site operational procedures:

- Use of water trucks to achieve sufficient watering of haul roads and other high-risk areas. The schedule for truck use will be developed for the project and will incorporate consideration of recent rainfall and weather conditions;
- Use of water sprays and foggers as directed, with additional use as determined by ambient conditions;
- Maintenance of water spray equipment and engineering controls to minimise dust emissions;
- Sufficient number of watering trucks to allow for continuation of dust suppression when one or more truck is out of service;
- Reduction or cessation of haul truck movements in the event of failure of dust control measures. This strategy must be undertaken in conjunction with data on ambient impacts and weather conditions;
- Monitoring of ambient air quality in the vicinity of the mine. This is discussed further in Section 5.5;
- Restrictions on pre-strip and overburden dumping in the north of Horse Pit for adverse weather conditions as assessed by visual inspection combined with on-site meteorological monitoring data; and
- Restrictions on the co-location of pre-strip, overburden dumping, coal excavation and draglines in the north of Horse Pit for adverse weather conditions as assessed by visual inspection combined with on-site meteorological monitoring data.

These procedures will be incorporated into the site Environmental Management Plan (EMP). The EMP will be regularly audited to ensure that these key elements for air quality management are satisfied.

Prevention and Mitigation of Worst Case Impacts

Operational procedures that prevent these worst-case conditions from occurring will be implemented by BMA. Due to the varying depths of pit activities, particular consideration needs to be paid to operations that are close to the natural surface level, such as truck and shovel operations and overburden dumping. To prevent worst-case conditions from occurring, it is recommended that the EMP give consideration to:

- Scheduling pit activities, particularly for activities to the north of Horse Pit, to stagger the operation of equipment;
- Maintaining adequate separation of pre-strip truck and shovel, coaling fleet and dragline operations, particularly for activities to the north of Horse Pit;
- Implementing additional dust control measures for operations that are close to the natural surface level. These could include watering of truck and shovel operations that are close to the northern end of Horse Pit;
- Implementation of dust monitoring to gauge the level of off-site impacts to the north of the mine; and
- Implementation of management strategies that restrict operations in the north of Horse Pit for adverse meteorological conditions. These could include cessation of mining activities under dry, windy conditions or strong winds from a southerly direction.

5.5 Measurement of Ambient Air Quality

It is widely recognised that although elevated levels of TSP may lead to dust nuisance, it is elevated levels of PM_{10} that is associated with an increased risk of adverse impacts on human health. Even more recent studies suggests that particulate matter in the range associated with $PM_{2.5}$ may pose an even greater risk to human health as the smaller sized particles have an increased the potential to penetrate deep into the lungs.

The results of the dispersion modelling presented in Section 4 have highlighted the potential for adverse air quality impacts at some of the nearby receptor locations. As discussed in Section 3.5.3 the confirmation of (both adverse and absence of) air quality impacts predicted by the model can only be validated by observational data.

As noted in Section 3.4.1, in general, the mechanical generation of dust (as opposed to particulate matter associated with combustion processes) is associated with only a small fraction (i.e. 10% - 20%) of particulate matter in the range of $PM_{2.5}$. Thus the proposed site-based ambient air quality monitoring program focuses on dust deposition and PM_{10}.

A three-staged monitoring program is proposed for the purpose of monitoring air quality within the region predicted to be directly impacted upon by dust generating activities at the proposed Caval Ridge Mine site. This monitoring program will allow BMA to monitor local air quality on a monthly basis with the level of review of activities that is dependent on the stage of monitoring that is required to be implemented.

The outcomes of the ambient monitoring program outlined in Appendix B will be used by BMA to determine whether the mine's operations are contributing to excessive dust levels at nearby residential locations. BMA will take action to avoid adverse impacts on air quality at nearby receptor locations. The monitoring data will be used to provide an indication of excessive off-site dust levels that may be attributable to the mine's operations in order that appropriate and effective corrective actions can be identified and implemented.

5.5.1 Regional Ambient Air Quality Monitoring Program

As noted in the Introduction, the Bowen Basin is home to a number of existing mines as well as other major dust-generating emission sources.

The site-based monitoring program outlined in Appendix B has been designed to complement a regional program. Under a regional program, the monitoring location to the north of the mine site at which dust deposition and PM_{10} monitoring has been proposed under the local program is ideally situated for upgrading to include the monitoring of additional pollutant species or the use of alternate sampling methodologies if required.

The air quality assessment of the Caval Ridge Mine has comprised a comprehensive assessment of existing air quality and potential dust impacts from the project under typical operating conditions, worst-case conditions and under upset conditions. The years assessed were Year 1, Year 2 and Year 20.

An in depth analysis of the model results has highlighted the dependence of model predicted ground-level concentrations of dust on the model input default parameter for the minimum mixing height. This insight into the model behaviour has lead to BMA commissioning a model input validation exercise in order to assess the degree of overestimating of night time impacts that may be attributable to this tuneable parameter. This study is currently underway.

The predicted impacts at residential locations show that the impacts of the Project are acceptable under typical operating conditions. Dust impacts are generally higher to the west and north of the site, attributable to the prevailing wind direction from the south-east and the location of the haul roads to the west of the Project.

Worst-case impacts were evaluated, accounting for the possible proximity of key dust-generating equipment to either the north or south of each pit. These impacts demonstrated that high dust levels are likely to arise to the north of the Project, with potential exceedances of air quality objectives levels at residential locations under adverse meteorological conditions. BMA will need to implement operational measures and possibly additional control measures to avoid the combination of worst-case meteorological conditions with the peak dust generation from activities in the north of Horse Pit.

Upset conditions were evaluated for the failure of dust suppression measures on the haul roads. This has shown that dust levels may be elevated under these conditions. BMA will manage operations and the appropriate level of controls needed to ensure that these conditions are prevented through the implementation of the mitigation measures.

Mitigation measures for the Project have been proposed. Some of these measures have been incorporated into the air quality modelling, such as the engineering controls and dust suppression measures, consequently reducing the impacts from the site. Other measures need to be implemented during project operation, such as the operational procedures, rehabilitation strategy and the ambient air quality modelling program. These measures will ensure that the worst-case conditions and the upset conditions modelled do not lead to the level of impact predicted by the model. The proposed three-staged monitoring program will be used to assist in early detection of elevated levels of dust at sensitive locations that are attributable to the Project.

Due to the implications of the differences in the EPP(Air) Policy 2008 which came into affect on January 1, 2009, and the EPP(Air) Policy 1997 which was in affect in mid 2008 at the time this assessment methodology was developed, refinement of the applied methodology is currently under review.

Commonwealth Government (2001) *NPI Emission Estimation Technique Manual for Mining,* Version 2.3, December 2001

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

National Environmental Protection Council, *National Environment Protection Measure for Ambient Air Quality*, 1988, with amendment in 2003

Section 7 References

Queensland Government, *Environmental Protection Regulation 2008*, Office of the Queensland Parliamentary Counsel

Queensland Government, *Environmental Protection (Air) Policy 2008*, Office of the Queensland Parliamentary Counsel

Richardson C., *Fine Dust: Implications for the Coal Industry*, The Australian Coal Review, April 2000

Sinclair Knight Merz (2005), *Improvement of NPI Fugitive Particulate Matter Emission Estimation Techniques*, May 2005

USEPA *AP-42 - Compilation of Air Pollutant Emission Factors,* Fifth Edition, Volume 1

Victorian Government Gazette, Special, Friday 21 December 2001.

Worst Case Meteorological Conditions — Appendix A

In this Appendix we present details of the modelling results at the location of Receptor 10 (Figure 3-1) which is predicted to be the most affected by emissions from the site for the Year 20 Operational Scenario.

Presented in Figure A-1 is a time series of the 24-hour average ground-level concentration of PM_{10} at the location of Receptor 10 and includes 365 days of 24-hour averages. For illustration purposes, the EPP(Air) 1998 Schedule 1, Part 3 goal of 150 µg/m^3 and the EPP(Air) 2008 Schedule 1 objective of 50 µg/m^3 for the 24-hour average of PM_{10} are included in the figure. A background concentration of 18.8 µg/m^3 has also been included. This figure illustrates the frequency of exceedences of the EPP(Air) 2008 objective at this location as predicted by the dispersion model.

Although presenting 24-hour averages of particulate matter allows for comparison with the EPP(Air) objective, additional insight into the meteorological factors that influence periods of predicted elevated levels of PM_{10} at receptor locations can be obtained from the model output of the 1-hour average ground-level concentration which includes 8760 hours of model predictions. As there is no EPP(Air) objective for this averaging period the time series has been scaled by the maximum 1-hour average concentration over the entire 1-year period with results presented over the range of (0,1). This approach allows the reader to focus on the trend of the model results as opposed to the predicted 1-hour average concentrations.

Presented in Figure A-2 is the normalised 1-hour average ground-level concentration of PM_{10} at the location of Receptor 10 as a function of the hour of day. Results suggest that the model predicts significantly elevated levels of dust during the period from 5 pm through 7 am when compared with ground-level concentrations predicted between 8 am and 4 pm. These elevated dust levels during the evening, night and early morning hours are associated with correspondingly low mixing height during this same period (Figure A-3). Driven by solar radiative forcing, the diurnal cycle of the convective mixed layer includes a growth phase during the morning, with the maximum height attained during the late morning/early afternoon and maintained throughout the afternoon, followed by a collapse of the mixed layer (as illustrated by the rapid reduction in the mixing height) in the late afternoon/early evening.

Since the air quality assessment of the Caval Ridge mine is dominated by low-level emission sources, combined with a constant hourly emission rate for every hour of the day, the particulate matter ground-level concentration will be highly influenced by the height of the mixed layer with vertical mixing and diffusion inhibited during night time stable and/or neutral conditions. As illustrated in Figure A-4, the model default minimum mixing height of 50 m plays an integral role in the elevated levels of particulate matter predicted at this location. This influence of the dispersion model default parameter in leading to elevated ground-level concentration of pollutants is a fundamental factor in assessments of non-buoyant ground-level sources and highlights the need for model validation of this crucial meteorological parameter.

For completeness, Figure A-5 presents the normalised 1-hour average ground-level concentration of PM_{10} at the location of Receptor 10 as a function of the stability class. This confirms the assertion of stable, night time conditions (class 5 and 6) that lead to predicted high ground-level concentrations.

Figure A-6 highlights wind direction dependence and Figure A-7, wind speed dependence of the normalised 1-hour average model output.

Appendix A Worst Case Meteorological Conditions

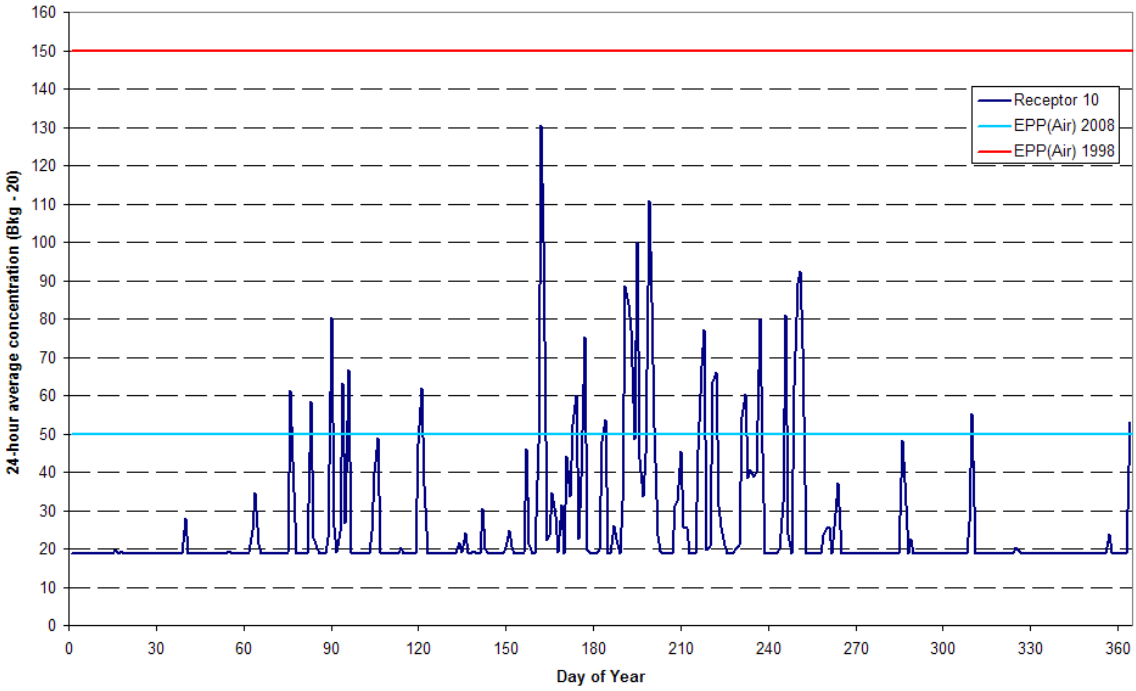


Figure A-1 Time series of the 24-hour average ground-level concentration of PM_{10} at the location of Receptor 10

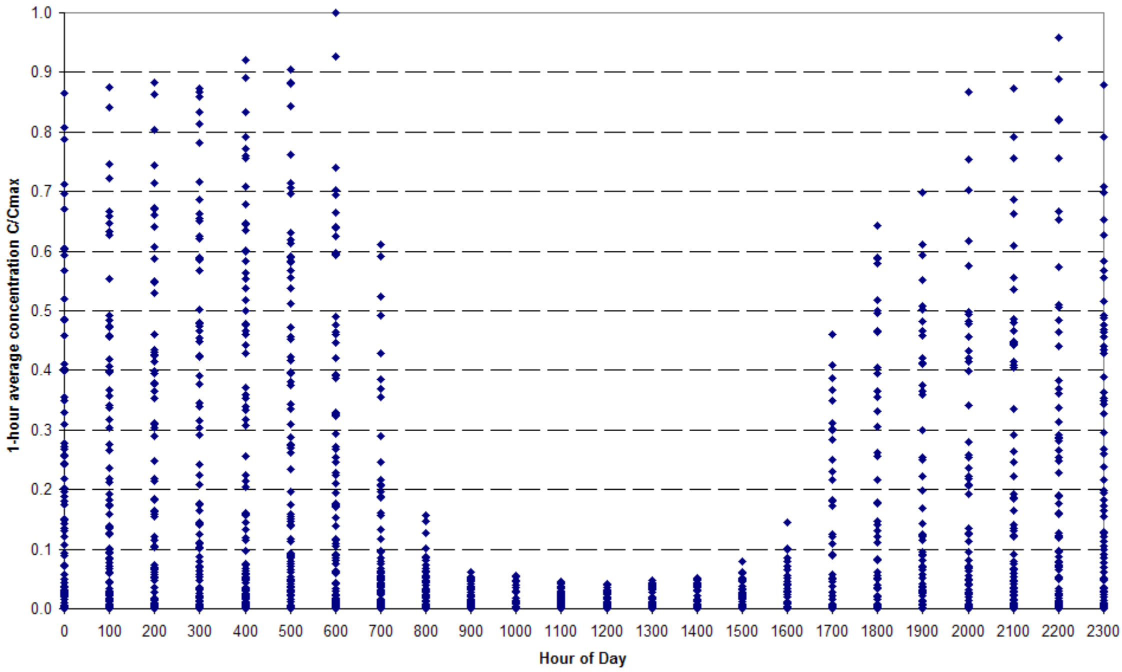


Figure A-2 Normalised one-hour average ground-level concentration of PM_{10} at Receptor 10 as a function of hour of day

Worst Case Meteorological Conditions

Appendix A

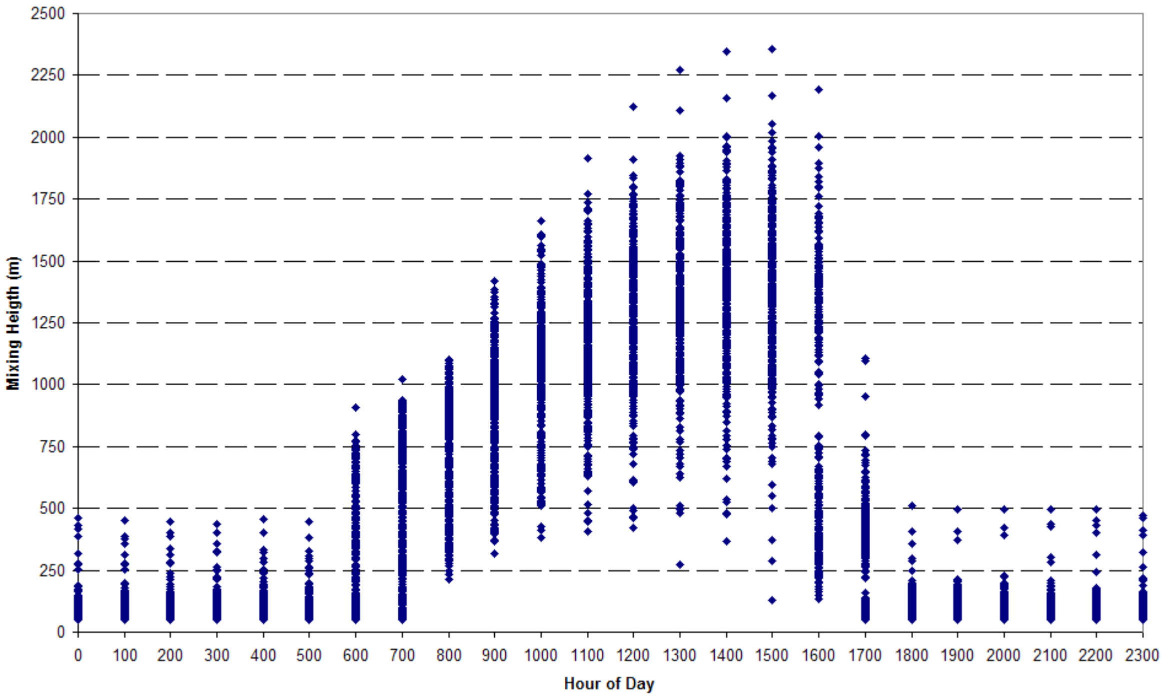


Figure A-3 Mixing height as a function of the hour of day

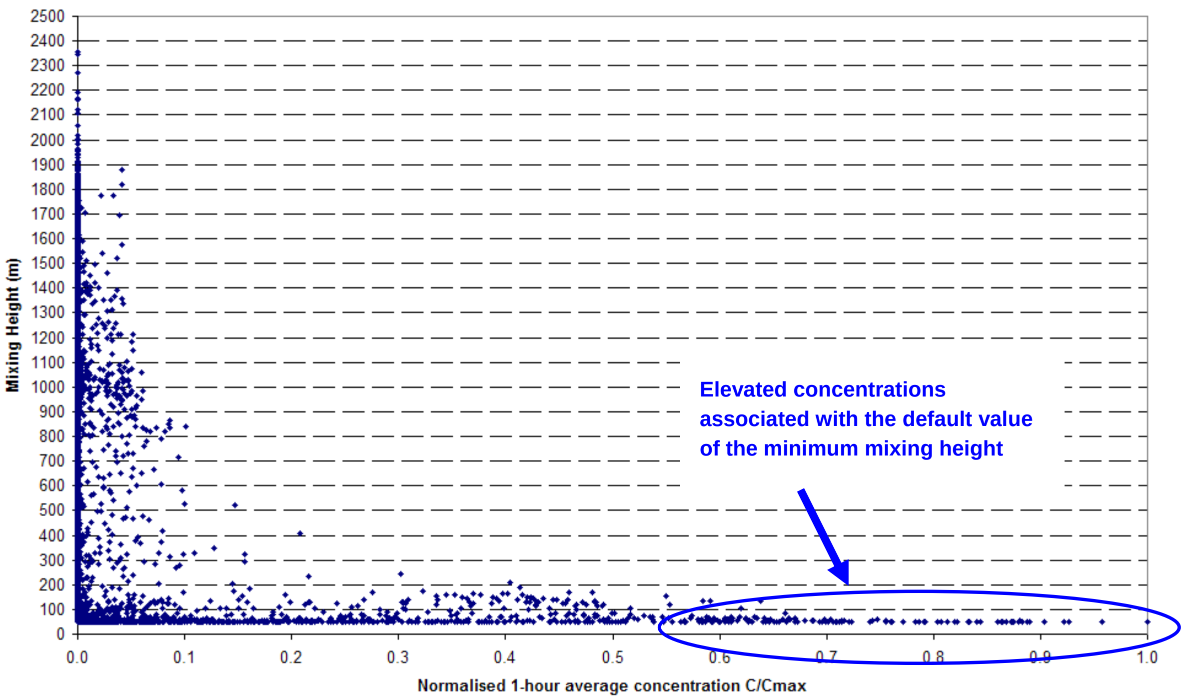


Figure A-4 Normalised 1-hour average ground-level concentration of PM_{10} at Receptor 10 as a function of mixing height

Appendix A Worst Case Meteorological Conditions

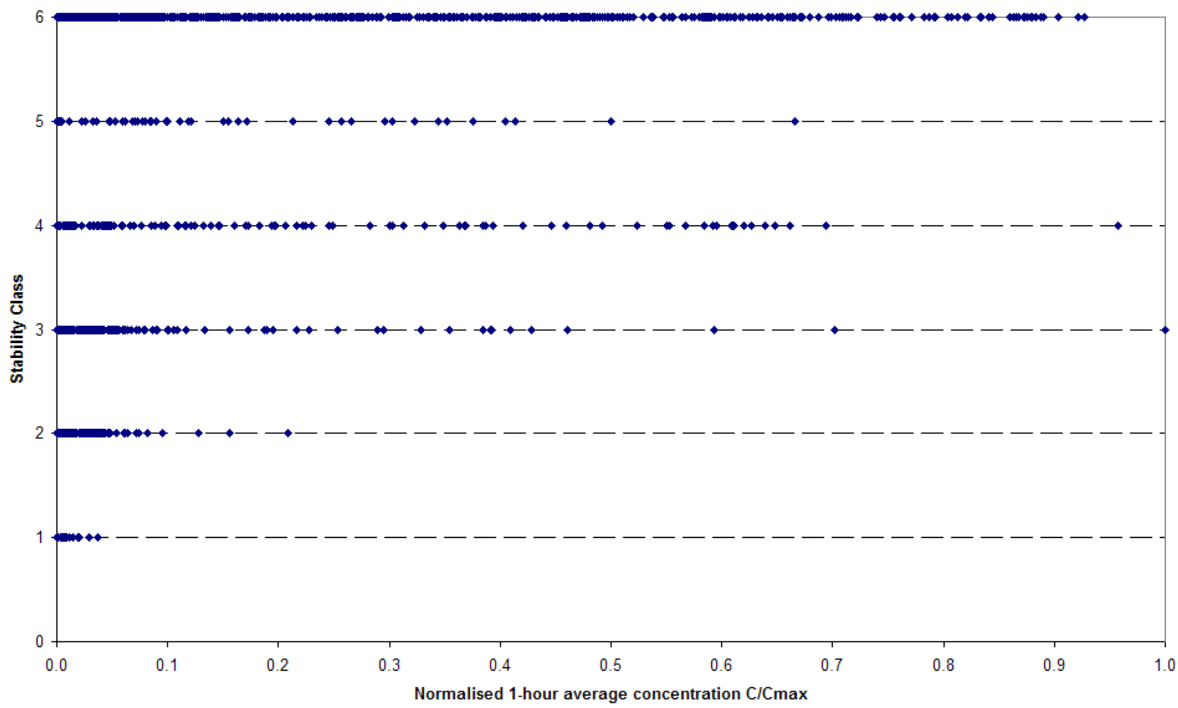


Figure A-5 Normalised 1-hour average ground-level concentration of PM_{10} at Receptor 10 as a function of stability class

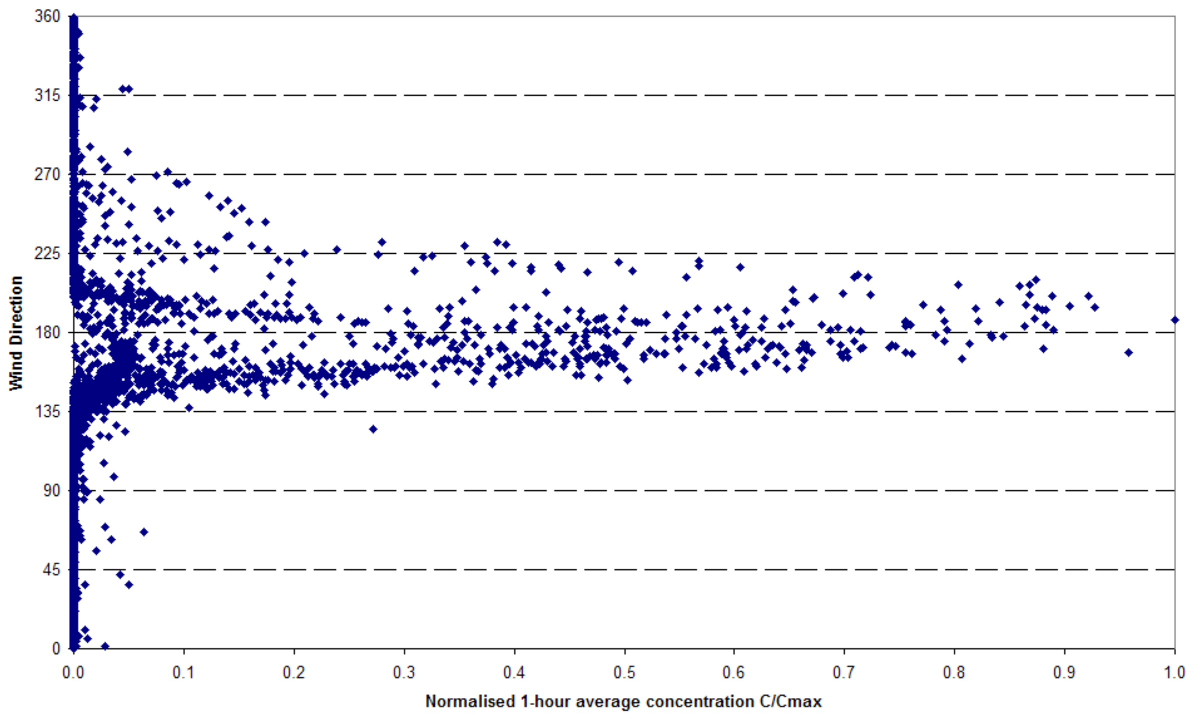


Figure A-6 Normalised 1-hour average ground-level concentration of PM10 at Receptor 10 as a function of wind direction

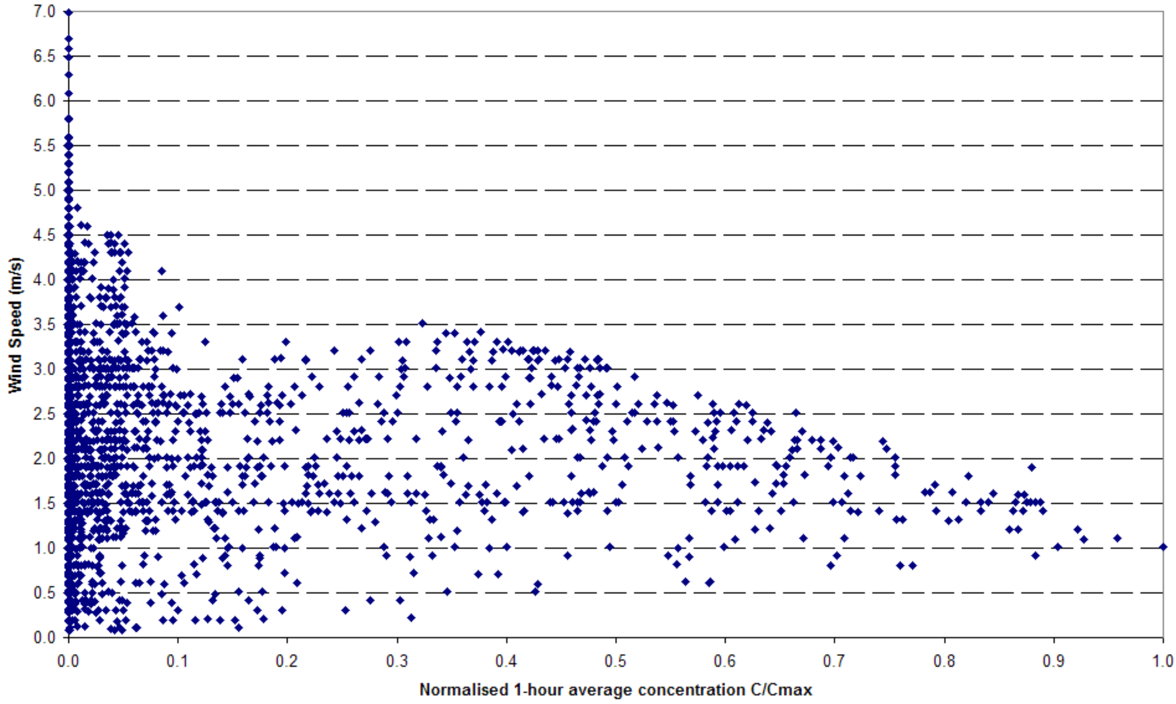


Figure A-7 Normalised 1-hour average ground-level concentration of PM_{10} at Receptor 10 as a function of wind speed

Appendix B Ambient Monitoring Program

The ambient air monitoring program developed for Caval Ridge Mine has been designed to monitor air quality impacts over a large area using dust deposition gauges (Stage 1) while allowing flexibility in the monitoring program in order to focus the monitoring of PM_{10} in those areas that are found to be most affected by site-based dust-generating activities (Stage 2).

Data obtained from the monitoring program will be used to identify potential air quality issues related to the operational management of mining activities at the Project site. The data will aid in the identification of key dust-emission source(s) and will allow BMA to develop targeted and effective mitigation measures than can be incorporated into the operational procedures for the daily management of dust impacts.

B.1 Stage 1 Monitoring

Stage 1 of the Caval Ridge monitoring program will be implemented as follows:

Monitoring Locations and Program[12]:

- An indication of the location of the proposed monitoring sites is provided in Figure C-1, and includes:
  - Dust deposition monitoring at ten locations on a 30 ± 2 day cycle;
  - Monitoring of PM_{10} at one location using either one or both of the following techniques:
    - High volume sampling of PM_{10} during the construction phase and for the first year of mining operations;
    - Continuous monitoring of PM_{10}, using an industry accepted method;
  - The requirement for additional monitoring of PM_{10} will be reviewed after the initial one year monitoring of operational mining;
  - Monitoring of the meteorological parameters of wind speed, wind direction, temperature, and relative humidity (as a minimum) at two locations, at 15 minute intervals;
  - One meteorological station will be located in the vicinity of the CHPP, the other will be located in the vicinity of Receptor 7;

Monitoring Methodology:

- The precise location of monitoring equipment will be dependent on siting requirements of the instrumentation to be implemented at each site. Ambient air monitoring will be conducted in accordance with and/or in consideration of:
  - AS/NZS 3580.1.1:2007, *Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment*;

[12] Sampling locations will be selected in consideration of and accordance with AS/NZS 3580.1.1:2007, *Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment*

- AS/NZS 3580.9.10:2006, *Methods for sampling and analysis of ambient air Method 9.10: Determination of suspended particulate matter—PM2.5 low volume sampler— Gravimetric method*;
- AS/NZS 3580.9.9:2006, *Determination of suspended particulate matter – PM_{10} Low volume sampler – Gravimetric method*;
- AS/NZS 3580.9.3.2003 *Determination of suspended particulate matter-Total suspended particulate matter (TSP) - High volume sampler gravimetric method*;
- AS/NZS 3580.9.6:2003, *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} High Volume sampler with size selective inlet - Gravimetric method*;
- AS/NZS 3580.10.1:2003, *Methods for sampling and analysis of ambient air – Determination of ambient air - Determination of suspended particulate matter – Deposited matter – Gravimetric method*;
- Queensland Government, *Air Quality Sampling Manual*;
- A method determined in consultation with the QLD EPA

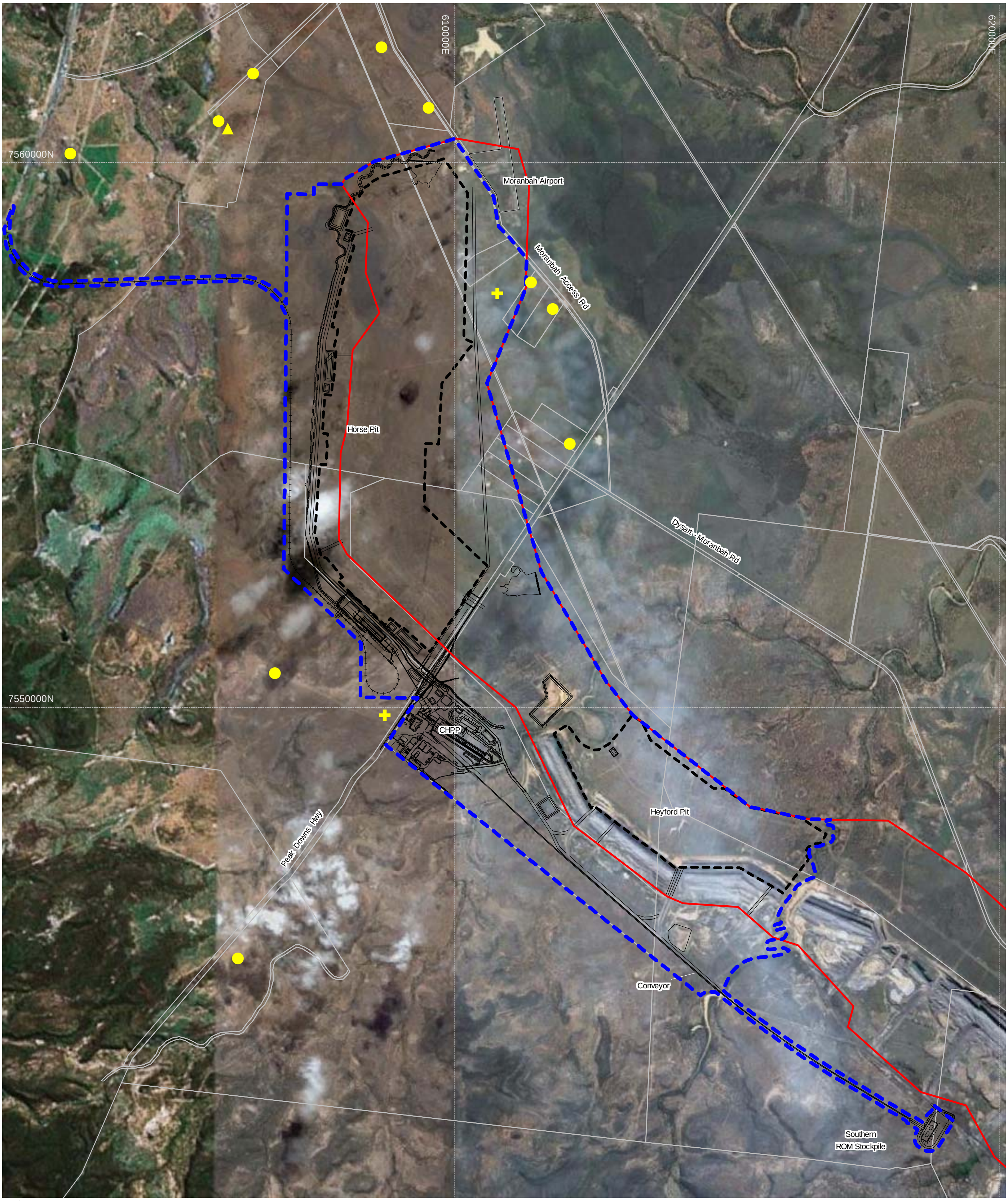
Processing of monthly observational data will involve:

- Review of dust deposition results; and
- Preparation of a wind rose covering the same 30 days of the dust deposition monitoring period.

Corrective action(s) as required:

- If an exceedence of the EPA dust deposition goal of 4 g/m^2/month[13] is obtained at any of the monitoring locations, the following actions will be implemented;
  - Query the laboratory in relation to any unusual findings during the analysis;
  - Review wind rose data in order to identify general direction of possible dust emission source(s);
  - Review site-based activities focusing on identifying if there have been any changes to activities in locales identified by the monthly wind rose compared with the previous month;
  - If corrective measures are identifiable, these will be implemented;
  - Exceedence, corrective actions and outcomes will be recorded and reported based on the site-based incident report procedure.

[13] Note that the correlation in data obtained from the co-located dust deposition and PM_{10} monitoring site (Stage 1) will be used to assess the use of the 4/g/m^2/month criteria as a suitable trigger value for the initiation of Stage 2 monitoring. Based on the findings of the Stage 1 monitoring program, this 4/g/m^2/month trigger value may be adjusted downwards.



N

0 1 2km

Scale 1:100,000 (A4)

Datum: AGD84, AMG Zone 55

Project Site

ML1775

Proposed Pit Outline

Project Infrastructure Components

Opertaions Monitoring Locations

Dust Deposition Gauges

High Volume Sampler Station - PM_{10} Monitoring

Meteorological Monitoring Station

Source: Google Earth Imagery, 2008

Client	Project	Title
BMA BHP Billiton Mitsubishi Alliance URS	CAVAL RIDGE PROJECT AIR QUALITY ASSESSMENT	**INDICATIVE AMBIENT AIR MONITORING LOCATIONS**

Drawn: VH	Approved: RS	Date: 15-05-2009	Figure: **Appendix B - 1**	Rev:A
Job No: **4262 6158** /6161	File No: 42626158-g-186.wor			A4

B.2 Stage 2 Monitoring

Stage 2 of the Caval Ridge monitoring program will be implemented at any and all sites for which there is an exceedence of the EPA dust deposition goal of 4 g/m^2/month for two consecutive months.

It is noted that in general, laboratory results for the dust deposition gauge analysis are available approximately 14 days after the end of the monitoring period. Should a second consecutive exceedence at any particular site be obtained, the instrumentation to conduct Stage 2 monitoring will be organised in time for implementation at the next change over of dust deposition bottles which corresponds to the beginning of month 4. Results from the month 3 dust deposition monitoring will not be available prior to the implementation of Stage 2 monitoring. Laboratory dust deposition analysis results for month 3 will not affect the Stage 2 monitoring program. A review of month 3 laboratory results should be conducted in accordance with the Stage 2 monitoring program.

Stage 2 Actions

- Continuation of Stage 1 monitoring at all locations;
- An review of the local environment at the location of the dust deposition monitoring locations by a suitably qualified site personnel in order to identify local factors or activities that may have caused high dust levels.
- Additional monitoring at the site(s) for which there have been exceedences of the EPA dust deposition goal of 4 g/m^2/month for two consecutive months will include:
  - One month of continuous monitoring of PM_{10} using a method approved in consultation with the QLD EPA. The one month period is to coincide with the 30 day cycle of the dust deposition monitoring.

Processing of information will involve:

- Weekly downloading of continuous PM_{10} monitoring data;
- Weekly downloading and processing of meteorological information from the most representative on-site meteorological station;
- Review of monthly dust deposition laboratory results;
- Preparation of a wind rose covering the same 30 days of the dust deposition monitoring period;
- Detailed weekly review of continuous PM_{10} monitoring data and meteorological data;
- Detailed weekly review of site-based activities. The review will focuses on identifying activities during the week that may have attributed to elevated levels of PM_{10}. Changes to activities in locales identified by the monthly wind rose compared with the previous monitoring period will be identified if possible;
- Changes to conditions (meteorological, off-site, or site-based) between the Stage 2 monitoring period and the previous 3 months will be documented;

Corrective action(s) as required:

- If corrective measures are identifiable, these will be implemented;
- Exceedences, corrective actions and outcomes will be recorded and reported based on the site-based incident reporting procedure.

Appendix B Ambient Monitoring Program

B.3 Stage 3 Monitoring

Stage 3 monitoring will be implemented if there is an exceedence of the Qld EPA guideline of 4 g/m^2/month for a period of 4 consecutive months, or if Stage 2 monitoring highlights that dust emissions from site-based activities are attributing to elevated levels of PM_{10} that are considered harmful by the regulatory authority. The need to implement Stage 3 monitoring will result from the inability of the Stage 2 monitoring program to isolate and mitigate problematic dust emission source(s).

Stage 3 Actions

- Continuation of Stage 1 monitoring at all locations;
- Continuation of Stage 2 monitoring at locations for which there have been exceedences of the Qld EPA guideline for dust deposition of 4 g/m^2/month.
- An air quality specialist will be commissioned to:
  - Conduct a site-based Dust Audit;
  - Review the suitability of the site-based monitoring program;
  - Provide recommendations;
  - Prepare a report outlining the findings and recommendations of the Dust Audit;

Processing of information will involve:

- Continuation of the processing of observational data in accordance with Stage 2 monitoring program;

Corrective action(s) as required:

- If corrective measures are identifiable, these will be implemented;
- Exceedences, corrective actions and outcomes will be recorded and reported based on the site-based incident reporting procedure.

B.4 Caval Ridge complaints-based monitoring program

Should a dust complaint be received, the following course of action will be taken:

- Details of the complaint will be taken including:
  - Nature of the complaint, such as dust plume visible, nuisance dust, etc.
  - General location of the complainant from the site;
  - Time that a visible dust plume was observed;
- A review of site-based dust-generating activities will be conducted by a suitably qualified site personnel to identify whether site activities contributed to the complaint:
- For a genuine complaint;

- A minimum of 7 days of PM_{10} monitoring will be conducted at the location of the complainant;
- Data will be analysed in conjunction with representative meteorological data;
- Site-based activities in area(s) that may be contributing to impacts at the location of the complainant will be reviewed during the 7 day monitoring period;
- Corrective actions and outcomes will be recorded and reported as required by the site-based incident reporting procedure.