THE AUSTRAL BRICK COMPANY PTY LIMITED

ABN: 52 000 005 550

# New Berrima Clay/Shale Quarry

# Air Quality Assessment

Prepared by

Heggies Pty Ltd

August, 2010

Specialist Consultant Studies Compendium:
Part 6

ABN: 52 000 005 550

# New Berrima Clay/Shale Quarry

# Air Quality Assessment

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# EXECUTIVE SUMMARY

An Air Quality Impact and Greenhouse Gas Assessment has been undertaken by Heggies for the proposed New Berrima Clay/Shale Quarry, on the "Mandurama" property east of New Berrima.

Dispersion modelling was conducted utilising the EPA Victoria developed Ausplume for emissions of $PM_{10}$, TSP, and Dust Deposition. The modelling scenario was configured to reflect a worst-case operation scenario at the quarry for pollutants with 24-hour averaging periods ($PM_{10}$). The same scenarios has been used for pollutants with annual averaging periods ($PM_{10}$, TSP and Dust Deposition) to demonstrate adherence with the relevant annual average criteria even under these excessive extraction operations.

The findings of the modelling indicate that 24-hour average $PM_{10}$ and annual average $PM_{10}$, TSP and Dust Deposition levels associated with the Project are predicted to satisfy the project air quality goals and the likelihood of adverse cumulative impact is low.

Greenhouse gas emissions resulting from average and full production operations at the proposed clay / shale quarry, including estimates of direct and indirect GHG emissions, were also assessed.

Calculated direct (Scope 1) emissions from the Project associated with diesel combustion would generate between approximately 399 t $CO_2$-e/annum and 489 t $CO_2$-e/annum. Indirect (Scope 3) emissions would be through employee travel. Annual indirect emissions from the Project were calculated to range between approximately 55 t $CO_2$-e/annum and 69 t $CO_2$-e/annum

A comparison of the annual Scope 1 GHG emissions from the Project against published net total GHG emissions for NSW and Australia during 2007 shows that Scope 1 emissions from the Project would represent between approximately 0.0002 % and 0.0003% of total NSW emissions and approximately 0.0001% of total Australian emissions.

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# 1. INTRODUCTION

Heggies Pty Ltd (Heggies) has been commissioned by R.W Corkery & Co. Pty Ltd (RWC) on behalf of the Austral Brick Company Pty Ltd (hereafter, “the Proponent”) to undertake an Air Quality Impact Assessment for the proposed New Berrima Clay / Shale Quarry (hereafter, “the Project”).

The Proponent proposes to develop and operate a clay / shale extraction project on a property located approximately 1.5km east of New Berrima (hereafter, “the Project Site”).

The Project Site is expected to produce an average of 120 000 tonnes per annum (tpa) with peaks in production of 150 000tpa expected. The extracted Clay / Shale product will be transported to the Bowral Brick Plant for processing via existing heavy vehicle routes and the Hume Highway.

Site establishment and extraction operations at the Project Site will have the potential to generate emissions of dust and particulate matter.

## 1.1 STUDY OBJECTIVE

The main objective of this report is to assess the potential for air quality impacts on nearby receptors as a result of site establishment, extraction and transport activities. Greenhouse gas emissions relating to the proposed clay / shale quarry are also addressed in this report.

# 2. PROJECT SETTING

The Project Site is situated near the Hume Highway approximately half way between Canberra and Sydney in the Southern Highlands district of New South Wales, approximately 50km west-southwest of Wollongong and 6km southwest of Bowral. **Figure 2.1** illustrates the regional setting of the Project site.

The Project Site is located on the “Mandurama” property with grazing / fodder production being the principal land use. Drilling undertaken by the Proponent has established there is approximately 8 million tonnes of recoverable shale on the property. Variable thicknesses of clay / weathered shale and sandstone are also present.

The nearest town to the Project Site is New Berrima, located approximately 1.5km to the west. **Figure 2.2** illustrates the local setting of the Project Site.

## 2.1 PROPOSED DEVELOPMENT

### 2.1.1 Clay and Shale Extraction

The proposed extraction area is approximately 7.7 hectares. Annual average production is estimated at approximately 120,000tpa for a period of 30 years, with an upper limit of 150,000tpa to allow for fluctuations in demand for the clay / shale product. Two or three campaigns (each a period of 4 to 6 weeks) are planned with an extraction rate of 40,000 to 60,000 tonnes of clay / shale per campaign.

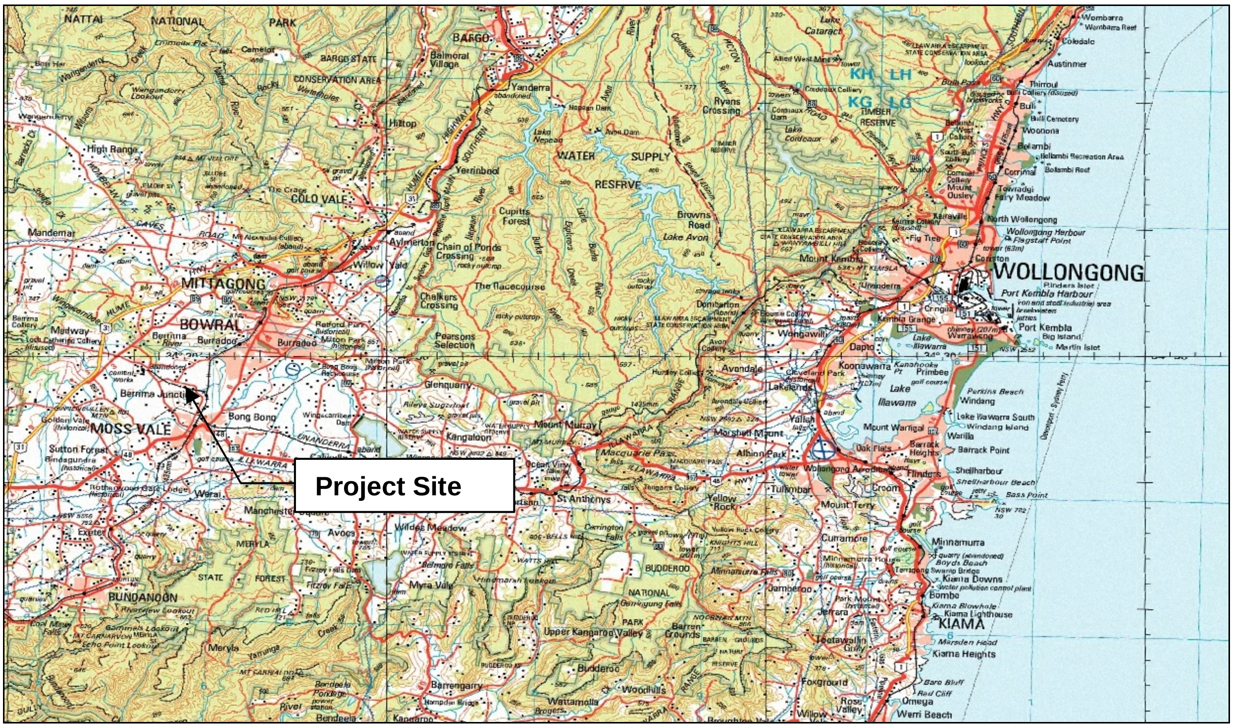



**Figure 2.1**
**Regional Setting of the Project Site**

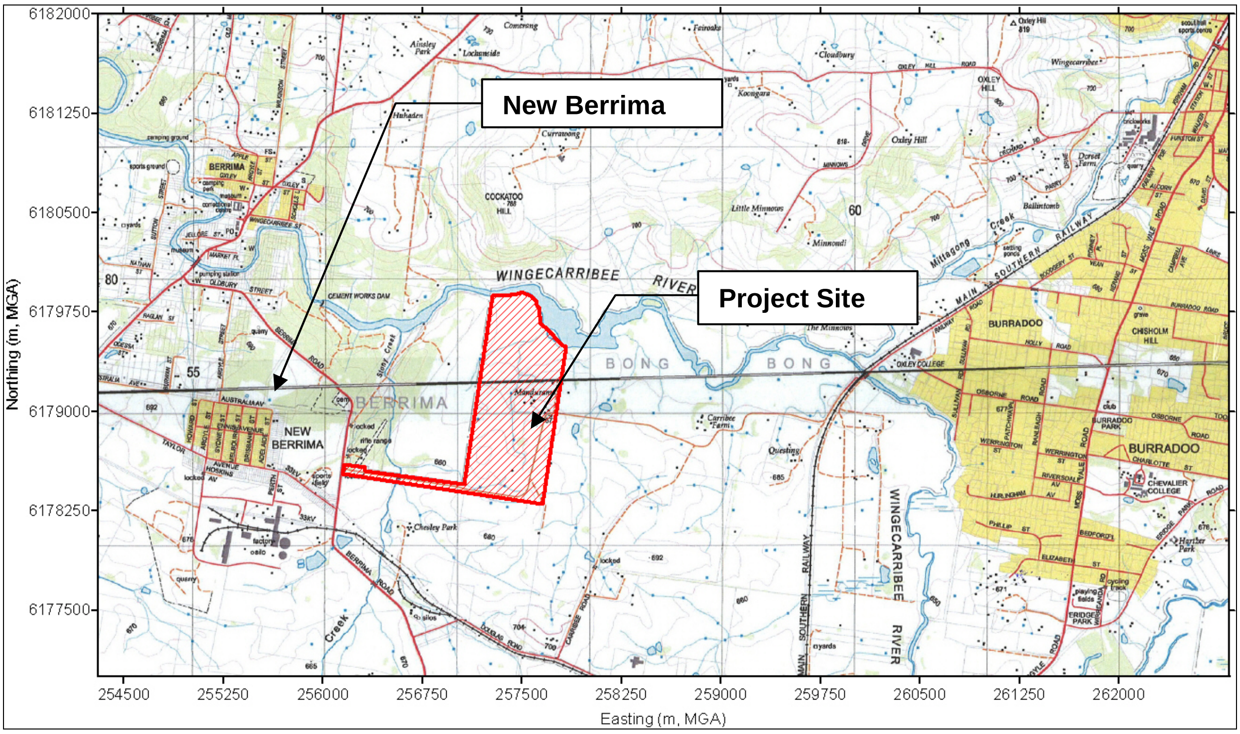



**Figure 2.2**
**Local Setting of Project Site**

Topsoil and subsoil will be used in the construction of three perimeter amenity bunds and for progressive rehabilitation works with surplus overburden stockpiled to the east of the extraction area. Transportation of the clay / shale resource to the Bowral Brick Plant would occur on a full-time basis.

The proposed extraction area, Northern, Western and Southern Amenity Bunds, Surplus Overburden Stockpile Area and haul routes and shown in **Figure 2.3**.

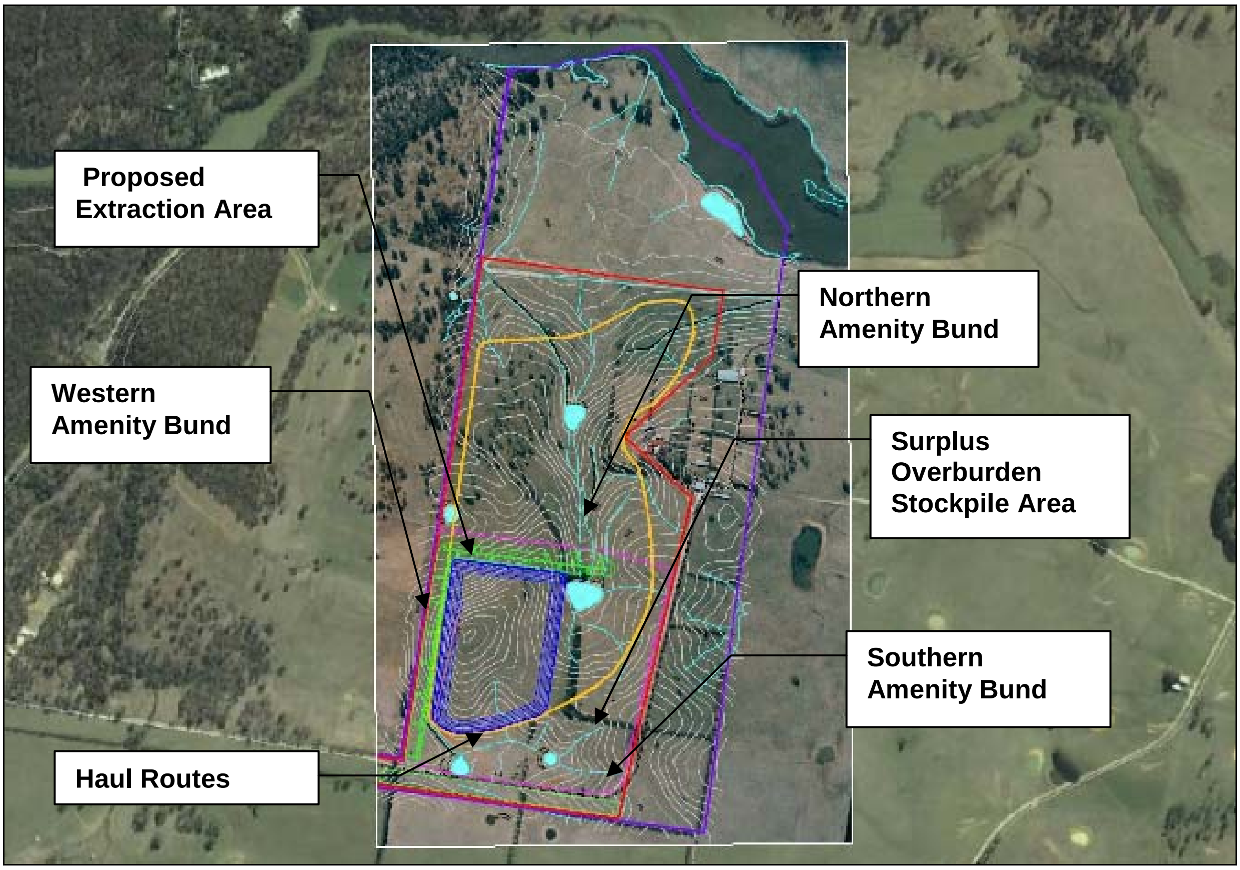



Image Courtesy of Google Earth

**Figure 2.3**
**Proposed Extraction Area**

### 2.1.2 Proposed Equipment

Equipment involved in extraction operations would include the following:

- Scraper – initial topsoil, subsoil / clay removal and construction of amenity bund walls
- Bulldozer – topsoil removal and ongoing topsoil stripping campaigns, ripping and pushing up shale and sandstone, amenity bund construction
- Articulated haul truck – transport of clay / shale and sandstone within the extraction area and transport of extracted clay / shale product to the Bowral Brick Plant
- Front-end loader (FEL) – loading product into despatch trucks and sandstone into articulated haul truck

### 2.1.3 Hours of Operation

Extraction operations will occur 7am to 5pm, Monday to Friday, with wet weather catch up planned for Saturdays, 7am to 2pm.

Transportation of the clay / shale product will occur full-time from 7am to 4pm, Monday to Friday and on weekends as required.

## 2.2 SENSITIVE RECEPTOR LOCATIONS

The NSW Department of Environment, Climate Change and Water (DECCW) specify within the 2005 document, the "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (Approved Methods), that assessment of air quality impacts attributable to an operation should be assessed at the nearest surrounding sensitive receptors.

A number of rural residential dwellings exist within the vicinity of the Project Site. The dwellings given in **Table 2.1** and presented in **Figure 2.4** were identified as sensitive receptor locations. Pollutant concentrations have been predicted at these locations.

**Table 2.1**
**Sensitive Receptor Locations**

| Receptor ID | Location (m, MGA) | | Distance (km) / Direction From Project Site Boundary | Elevation (m, AHD) |
|---|---|---|---|---|
| | Easting | Northing | | |
| NB | 255541 | 6178786 | 0.6 / W | 687 |
| R2 | 256547 | 6178153 | 0.3 / S | 663 |
| R3N | 258893 | 6178945 | 1.1 / E | 663 |
| R3S | 257952 | 6177769 | 0.6 / SE | 682 |
| R11 | 256680 | 6179831 | 0.4 / WNW | 667 |
| R12 | 256833 | 6179938 | 0.5 / W | 668 |
| R13 | 256523 | 6180356 | 0.6 / W | 722 |
| R14 | 256806 | 6180492 | 0.8 / NW | 702 |
| R15 | 257568 | 6180481 | 0.6 / N | 764 |
| R19 | 259164 | 6179569 | 1.3 / E | 660 |
| R22 | 259265 | 6180472 | 1.8 / NE | 775 |

## 2.3 LOCAL TOPOGRAPHY

The topography of the Project Site is gently undulating, possessing an approximate altitudinal range between 654m AHD and 678m AHD, increasing along the Site's north-south axis.

To the north of the Project Site is the Wingecarribee River, beyond which is a distinct ridgeline, peaking at an altitude of 788m AHD at Cockatoo Hill. The remainder of the surrounding area's topography possesses a similar altitudinal range to the Project Site.

All surrounding sensitive receptors, identified in **Table 2.1**, are located at an altitude at or above the Project Site.

A three-dimensional representation of the topography of the local area surrounding the Project Site is presented in **Figure 2.5**.

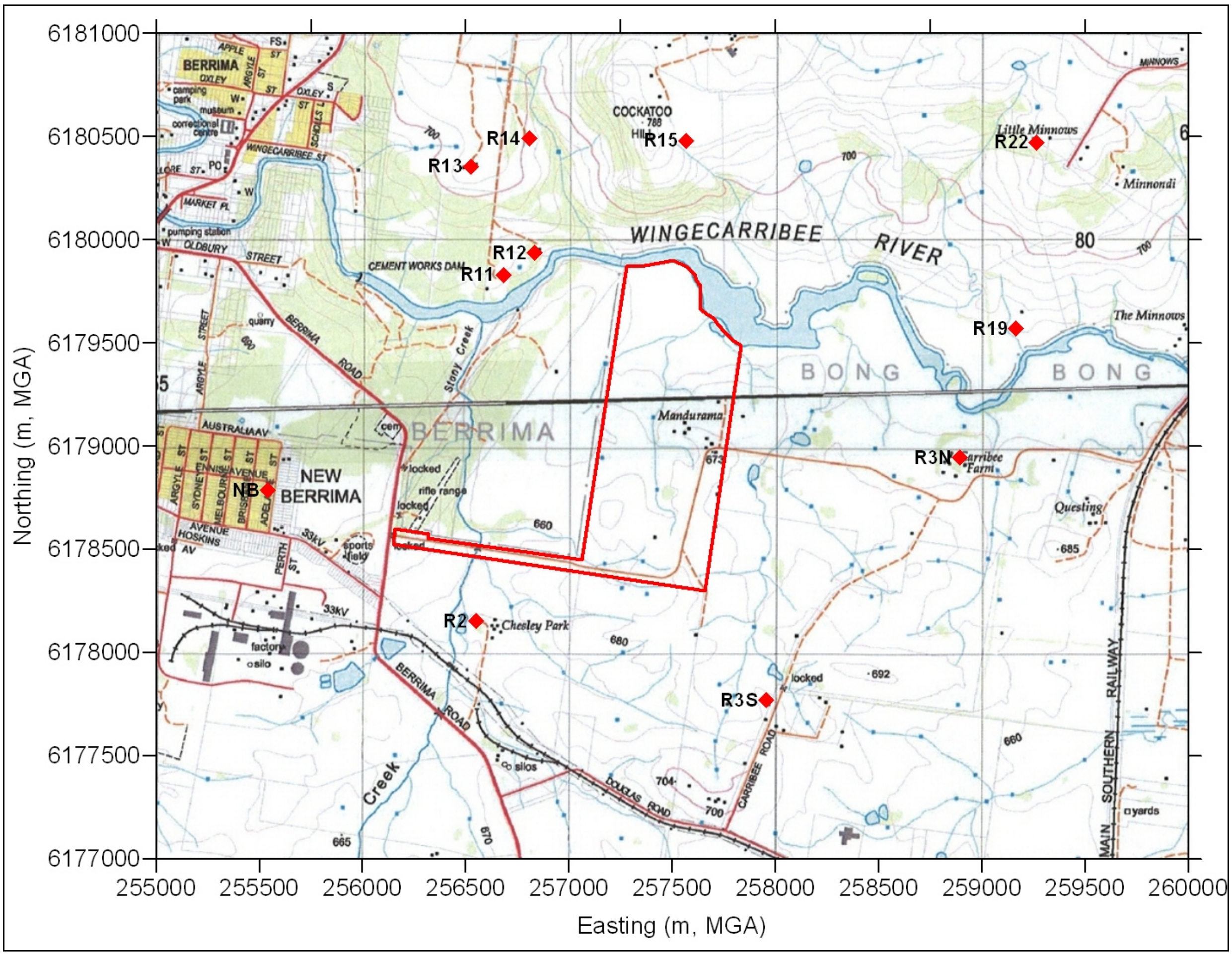
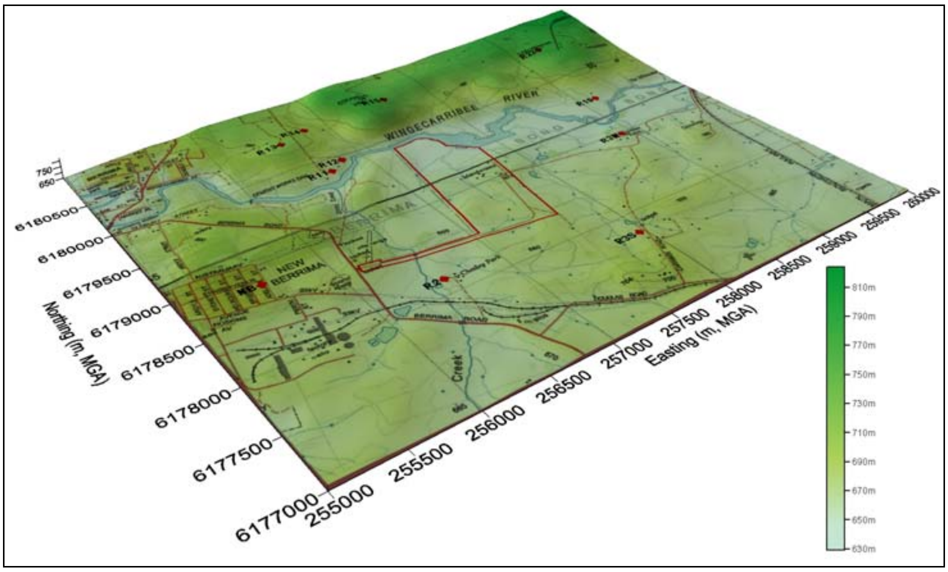



**Figure 2.4**
**Sensitive Receptor Locations**




Note: Topography shown with vertical exaggeration of 2

**Figure 2.5**
**Three-Dimensional Local Topography**

# 3. AIR QUALITY CRITERIA

## 3.1 CRITERIA APPLICABLE TO PARTICULATE MATTER LESS THAN 10 MICRONS ($PM_{10}$)

The term *"particulate matter"* refers to a category of airborne particles typically less than 50µm in aerodynamic diameter and ranging down to 0.1µm in size. Particles less than 10µm are referred to in this report as $PM_{10}$ particles.

Emissions of $PM_{10}$ particles are considered important pollutants in terms of impact due to their ability to penetrate into the respiratory system. Potential adverse health impacts associated with exposure to $PM_{10}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

One of the difficulties in dealing with air quality goals governing fine particles is that the medical community has not been able to establish a threshold value below which there are no adverse health impacts.

The $PM_{10}$ assessment goals as expressed in the DECCW's Approved Methods document are presented in **Table 3.1**.

**Table 3.1**
**DECCW Goals for $PM_{10}$ – 24-hour and Annual**

| Averaging Period | Maximum Concentration |
|---|---|
| 24-hour | 50µg/m$^3$ |
| Annual | 30µg/m$^3$ |

Source: Approved Methods

The 24-hour $PM_{10}$ reporting standard of 50µg/m$^3$ is numerically identical to the equivalent National Environment Protection Measure (or NEPM) reporting standard except that the NEPM reporting standard allows for five exceedances per year. These NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998 to be achieved within 10 years of commencement.

## 3.2 CRITERIA APPLICABLE TO TOTAL SUSPENDED PARTICULATE (TSP)

The annual goal for Total Suspended Particulate (TSP) is given as 90µg/m$^3$, as recommended by the National Health and Medical Research Council (NHMRC) at their 92$^{nd}$ Session in October 1981. It was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to $PM_{10}$ concentrations. This goal has also been adopted in the DECCW's Approved Methods.

## 3.3 NUISANCE IMPACTS OF FUGITIVE EMISSIONS

The preceding section is concerned in large part with the health impacts of particulate matter. Nuisance impacts also need to be considered, mainly in relation to dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m$^2$/month.

To avoid dust nuisance the DECCW has developed assessment goals for dust fallout. **Table 3.2** presents the allowable increase in dust deposition relative to the ambient levels.

**Table 3.2**
**DECCW Goals for Allowable Dust Deposition**

| Averaging Period | Maximum Increase in Deposited Dust Level | Maximum Total Deposited Dust Level |
|---|---|---|
| Annual | $2g/m^2$/month | $4g/m^2$/month |

Source: Approved Methods

## 3.4 PROJECT AIR QUALITY GOALS

In view of the foregoing, the air quality goals adopted for this assessment, which conform to current DECCW and federal air quality criteria, are summarised in **Table 3.3**.

**Table 3.3**
**Project Air Quality Goals**

| Pollutant | Averaging Time | Goal |
|---|---|---|
| $PM_{10}$ | 24 hours<br>Annual | $50\mu g/m^3$<br>$30\mu g/m^3$ |
| TSP | Annual | $90\mu g/m^3$ |
| Dust Deposition | Annual | Maximum incremental increase of $2g/m^2$/month<br>Maximum Total of $4g/m^2$/month |

# 4. EXISTING AIR QUALITY ENVIRONMENT

## 4.1 SURROUNDING SOURCES OF POLLUTANTS

The Project Site is situated in a semi-rural area dominated by agriculture and livestock operations. These operations are unlikely to generate significant levels of the key pollutants expected to be associated with the Project Site. However, following review of the local area and the National Pollution Inventory (NPI) database, a number of industrial operations are currently established.

Of note are the Berrima Cement Works and the Bowral Brickwork Plant, located approximately 2.3km to the west-southwest and 5.1km to the east-northeast of the Project Site respectively. **Figure 4.1** illustrates the proximity of these operations to the Project Site.

Based on the data provided by the NPI, both of these operations generate significant levels of particulate matter amongst others, to the local air shed. Consequently, the potential for cumulative impact of emissions generated from the Project Site and the surrounding industries needs to be considered.

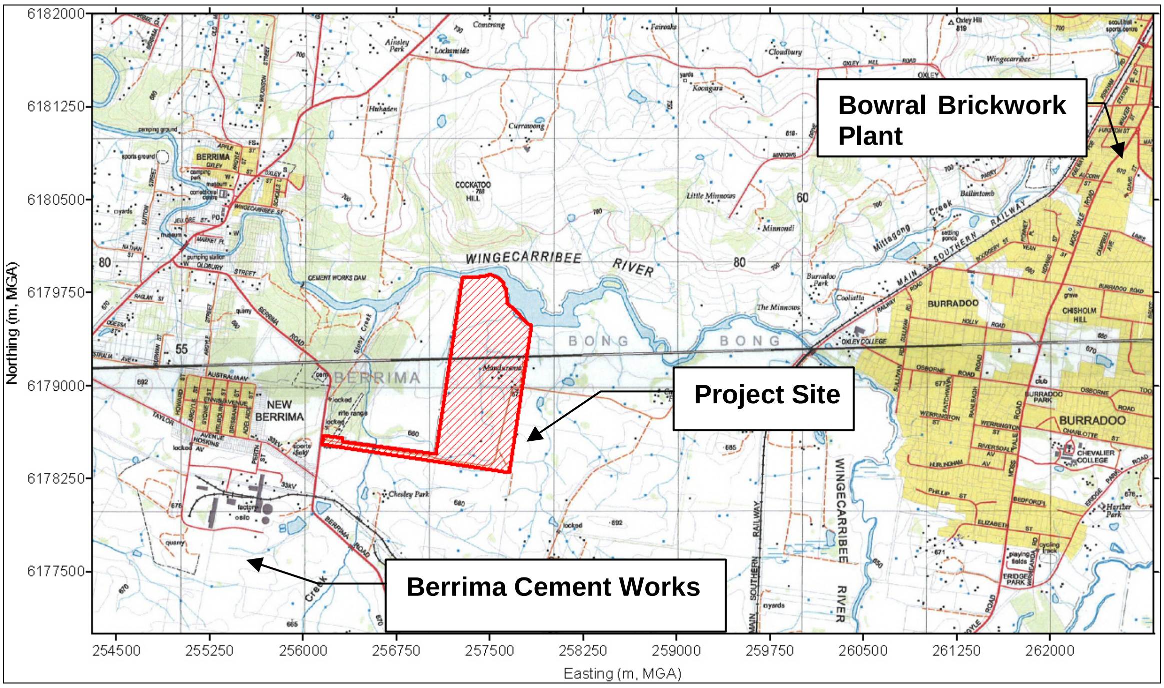



**Figure 4.1**
**Existing Sources Surrounding the Project Site**

## 4.2 DECCW AIR QUALITY MONITORING STATIONS

The DECCW maintains a network of air quality monitoring stations across NSW. At the time of reporting, there is no air quality monitoring currently conducted in the area surrounding the Project Site.

The nearest DECCW air quality monitoring station to the Project Site is located at Bargo on the outskirts of the Sydney Metropolitan Basin, approximately 30km to the northeast. This station currently monitors the following parameters:

- Oxides of Nitrogen (NO, $NO_2$ and $NO_X$);
- Ozone ($O_3$);

- Sulphur Dioxide ($SO_2$); and
- Meteorological Parameters (Wind Speed, Wind Direction, Temperature, etc.).

However, the nearest and most representative DECCW air quality monitoring station to the Project Site that currently monitors fine particulates ($PM_{10}$) is located at Oakdale, approximately 50km to the north-northeast. While it is noted that the DECCW station located at Albion Park is closer, approximately 40km east-southeast of the Project Site, the setting of the Project Site is more comparable with that of the Oakdale station (semi-rural region, inland setting, relatively high altitude).

The DECCW-recorded monitoring data Oakdale ($PM_{10}$) will be used in this report to provide a suitable representation of the air quality environment currently present at the Project Site in the absence of site specific data.

## 4.3 BACKGROUND PARTICULATE MATTER ENVIRONMENT

The verified data for 2007 showing 24-hour average $PM_{10}$ concentrations at the Oakdale DECCW monitoring station is presented in **Figure 4.2**.

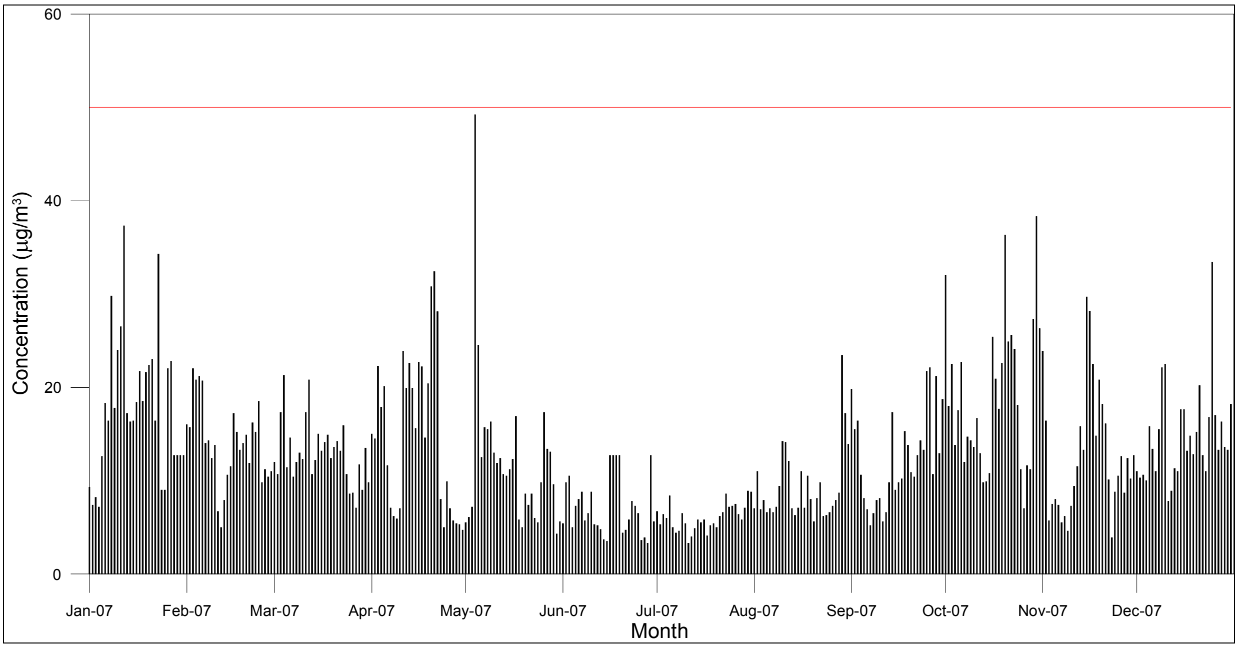



**Figure 4.2**
**DECCW $PM_{10}$ (24-hour Average) Monitoring Results for Oakdale, 2007**

Data for 2007 has been selected as the most recent validated data set available from the DECCW at the time of writing. The results indicate that the highest 24-hour average $PM_{10}$ concentration at the Oakdale monitoring site was 49.2µg/m$^3$, recorded on 4 May 2007.

The annual average $PM_{10}$ concentration for 2007, recorded at the DECCW's Oakdale monitoring site was 12.8µg/m$^3$.

## 4.4 BACKGROUND TSP ENVIRONMENT

No monitoring data is available for TSP for the area surrounding the Project Site.

It is noted that the $PM_{10}$ sub-set is typically approximately 50% of TSP in the ambient air in regions where road traffic is not the dominant particulate source, such as rural areas (US EPA, 2001). Consequently, the annual average TSP criterion of 90 µg/m$^3$ is consistent with an annual average $PM_{10}$ criterion of approximately 45µg/m$^3$.

In the interest of conservatism, annual average TSP concentrations have been assumed to be 1.5 times the annual average $PM_{10}$ concentrations. This equates to 19.2µg/m$^3$.

## 4.5 BACKGROUND DUST DEPOSITION ENVIRONMENT

Dust deposition monitoring data for the Project Site is currently not available. As it is not appropriate to assume negligible levels of dust deposition due to the surrounding industrial and agricultural operations, dust deposition associated with the Project Site will be assessed based on the incremental guideline of 2g/m$^2$/month.

## 4.6 ASSESSING CUMULATIVE IMPACTS

The Berrima Cement Works operated by Blue Circle Southern Cement is the closest operation to the Project Site, located 2.3km to the southwest.

Annual emissions of $PM_{10}$ have been reported to the National Pollution Inventory (NPI) for the period June 2007 to July 2008 (73 tonnes). This data has been used to conduct a screening level dispersion model to return approximate potential $PM_{10}$ concentrations that may be associated with this licensed operation. This modelling should be viewed as crude, given that no knowledge of individual site operations (including source types, hours of operation, and site specific parameters) was available. The operation was represented as a single volume source, with continuous operations assumed for the entire modelling period.

Dispersion modelling was conducted using the Ausplume model configured for the assessment of operations at the Project Site. Further discussion on the methods applied in the configuration of this model is provided in Section 6.

The predicted 24-hour and annual average $PM_{10}$ concentrations from this dispersion modelling exercise at each of the relevant residences listed in **Table 2.1** are presented in **Table 4.1** and **Table 4.2**.

As illustrated in **Table 4.1**, the residences most likely to be influenced by the surrounding licensed operations are those to the south and southeast of the Project Site (receptors R2 and NB). While both maximum 24-hour incremental and annual average predicted concentrations have been reported in **Table 4.1** and **Table 4.2**, emissions were estimated based on total annual $PM_{10}$ emissions and details relating to potential peak operations is unknown. Therefore, it is considered that only the annual average concentrations provide a meaningful reflection of impacts likely to be attributed to the Berrima Cement Works.

On this basis, given the predicted annual average $PM_{10}$ concentration at receptor R2 of 3.9µg/m$^3$ and the recorded annual average $PM_{10}$ concentration from the 2007 Oakdale dataset of 12.8µg/m$^3$ (as discussed in Section 4.3), it is considered that use of the daily varying 2007 Oakdale $PM_{10}$ data will appropriately account for any cumulative impacts the Berrima Cement Works may have in combination with emissions from the Project Site.

Furthermore, given that receptor R2 lies mid way between the Berrima Cement Works and the Project Site, cumulative impacts seem unlikely as winds in the area should carry air pollution in only one direction at any given time.

**Table 4.1**
**Predicted Incremental 24 hr $PM_{10}$ Concentrations Attributable to Berrima Cement Works**

| 24 hr $PM_{10}$ Concentration ($\mu g/m^3$) | Receptor | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NB | R2 | R3N | R3S | R11 | R12 | R13 | R14 | R15 | R19 | R22 |
| Maximum | 44.0 | 45.2 | 10.6 | 11.3 | 36.1 | 35.1 | 21.1 | 24.2 | 28.7 | 14.0 | 10.0 |
| 2nd highest | 39.7 | 44.8 | 9.9 | 10.6 | 16.8 | 16.1 | 10.4 | 11.7 | 12.6 | 6.6 | 8.3 |
| 3rd highest | 36.4 | 33.4 | 5.2 | 8.2 | 14.1 | 14.0 | 10.1 | 10.0 | 12.2 | 6.4 | 8.1 |
| 4th highest | 34.2 | 32.4 | 5.2 | 7.2 | 14.0 | 12.9 | 9.4 | 9.2 | 8.8 | 5.4 | 6.8 |
| 5th highest | 33.0 | 29.3 | 5.0 | 6.6 | 11.9 | 11.2 | 7.2 | 8.2 | 8.6 | 5.2 | 6.2 |

**Table 4.2**
**Predicted Incremental Annual Average $PM_{10}$ Concentrations Attributable to Berrima Cement Works**

| Receptor | Annual Average $PM_{10}$ Concentration ($\mu g/m^3$) |
|---|---|
| NB | 3.7 |
| R2 | 3.9 |
| R3N | 0.5 |
| R3S | 1.1 |
| R11 | 0.8 |
| R12 | 0.8 |
| R13 | 0.6 |
| R14 | 0.6 |
| R15 | 0.6 |
| R19 | 0.5 |
| R22 | 0.4 |

It is noted that the Bowral Brickwork Plant, located approximately 5km to the northeast of the Project Site does generate particulate pollution, but taking into account the distance between the Project Site and this source, it is considered that the cumulative impacts upon receptors surrounding the Project Site will be low.

Other potential sources of atmospheric emissions in the vicinity of the Project Site include:

- agricultural activities, including ploughing, harvesting and stock movements;
- dust entrainment due to non-project related vehicle movements along unsealed roads and sealed roads with high silt loading levels;
- farm and household activities contributing to seed, pollen and smoke levels;
- vehicle exhaust;
- wind blown dust from open areas; and,
- episodic emissions from vegetation fires.

It is considered that the use of the Oakdale $PM_{10}$ dataset will suitably account for any potential emission contributions from the above.

In order to assess likely background concentrations and potential cumulative impacts with emissions from the quarry operations, the following has been undertaken:

- Each individual 24-hour average predicted $PM_{10}$ concentration has been paired in time with the corresponding 24-hour concentration within the adopted 2007 monitoring dataset to obtain total impact at each receptor. This is in accordance with Section 5.1.1 of the Approved Methods.
- The frequency distribution of predicted 24-hour average concentrations of $PM_{10}$ will be compared with the corresponding frequency distribution of the monitoring dataset to provide an indication of the likelihood of elevated cumulative impacts occurring.
- Annual average $PM_{10}$, TSP and monthly dust deposition has been assessed through the addition of the dataset average concentrations, as identified in the preceding sections (12.8µg/m$^3$, 19.2µg/m$^3$ and 2g/m$^2$/month respectively).

The site-specific background air quality levels adopted for this assessment are presented in **Table 4.3**.

**Table 4.3**
**Background Air Quality Environment for Assessment Purposes**

| Air Quality Parameter | Averaging Period | Assumed Background Concentration / Level | Assessment Criteria |
|---|---|---|---|
| $PM_{10}$ | 24-hour | Daily Varying | 50 |
| | Annual | 12.8 µg/m$^3$ | 30 |
| TSP | Annual | 19.2 µg/m$^3$ | 90 |
| Dust | Annual | 2 g/m$^2$/month | 4 g/m$^2$/month |

# 5. DISPERSION METEOROLOGY

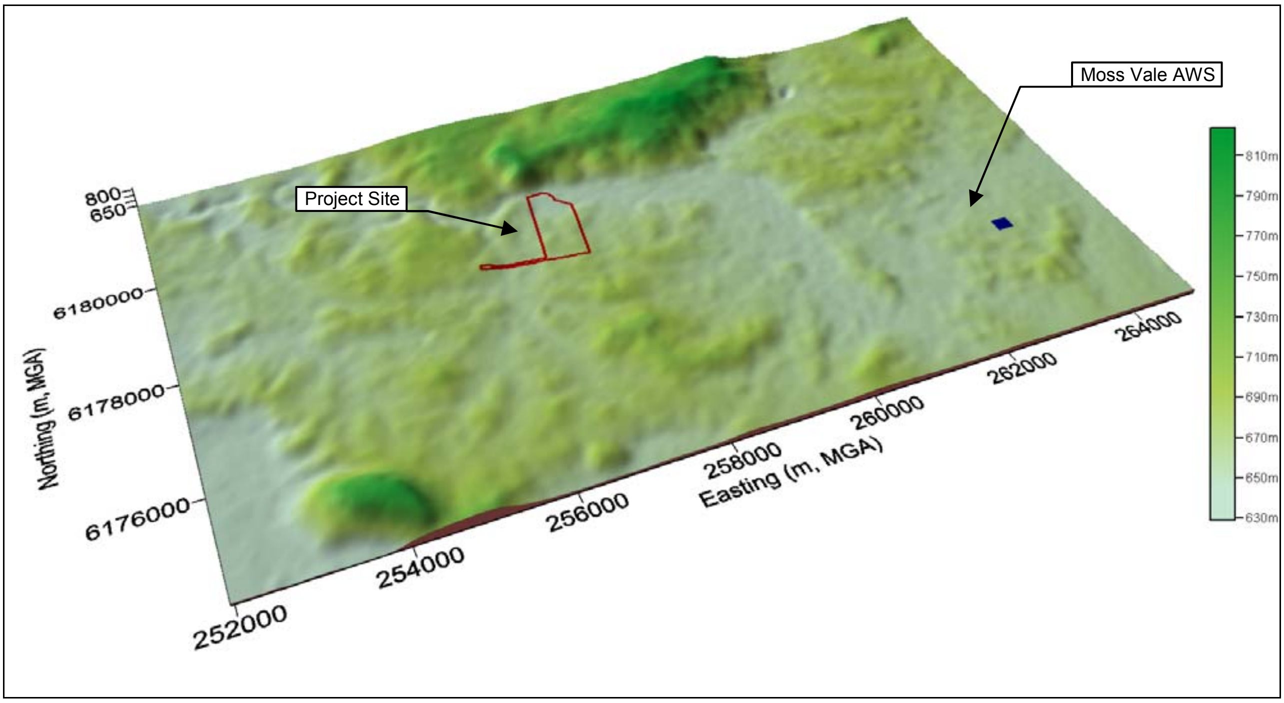
To adequately characterise the dispersion meteorology of the study site, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The climate and meteorology of the study area was characterised based on:

- Climate statistics obtained from the nearest Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Moss Vale (Station Number 068239); and
- Hourly meteorological data from the BoM weather station at Moss Vale.

The location details of the Moss Vale AWS, situated in relatively close proximity to the Project Site, is summarised in **Figure 5.1**. Monitoring data from this station was used to characterise the local meteorology and provide an input dataset for the meteorological modelling undertaken. It is considered that in the absence of site specific meteorological observations for the Project Site, the use of data from the BoM Moss Vale AWS is appropriately representative of meteorological conditions likely to be experienced at the Project Site. The proximity of Moss Vale AWS to the Project Site and the topographical features between is presented in Figure 5.1. It is clear from this figure that the topographical features of the Moss Vale AWS location are similar to that of the Project Site.

**Table 5.1**
**Meteorological Monitoring Station Details**

| Station Name | Location (m, MGA) | | Distance (km) / Direction From Project Site | Elevation (m, AHD) |
|---|---|---|---|---|
| | Easting | Northing | | |
| Moss Vale AWS | 263347 | 6176578 | 6.2 km / WSW | 680 m |




Note: Topography shown with vertical exaggeration of 2

**Figure 5.1**
**Regional Topography Surrounding the Project Site**

## 5.1 METEOROLOGICAL MODELLING

As previously detailed, no meteorological data for the Project Site was available at the time of reporting. In the absence of this data, The Air Pollution Model (TAPM) meteorological model (Version 3) was used to generate a complete meteorological dataset, centred over the Moss Vale AWS, for use in modelling of emissions from the Project Site.

TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations, with no local data inputs required.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate hourly meteorological observations.

Additionally, the TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. The wind speed and direction observations are used to realign the predicted solution towards the observation values. This function of accounting for actual meteorological observations within the region of interest is referred to as "data assimilation".

Thus, direct measurements for 2007 of hourly average wind speed and wind direction recorded at the BoM's Moss Vale AWS were input into the TAPM simulations to provide realignment to local conditions. Annual wind roses of recorded data at the Moss Vale AWS between 2003 and 2007 are presented **Appendix 1**. It can be seen that, based on comparison with the four preceding years, with regards to wind speed and direction, data recorded during 2007 at Moss Vale is representative of the Project Site.

**Table 5.2** details the parameters used in the meteorological modelling for this assessment.

**Table 5.2**
**Meteorological Parameters Used for this Study**

| Parameter | Measure |
|---|---|
| Number of grids (spacing) | 5 (30 km, 10 km, 3 km, 1 km, 300 m) |
| Number of grid points | 25 x 25 x 30 |
| Year of analysis | 2007 |
| Centre of analysis | 34°31' S, 150°25' E |
| Data assimilation | Meteorological data assimilation using wind data from Moss Vale AWS |

## 5.2 METEOROLOGICAL CONDITIONS

### 5.2.1 Wind Regime

A summary of the 2007 annual wind behaviour predicted at the Moss Vale AWS by TAPM is presented as a wind rose in **Figure 5.2.** This wind rose displays occurrences of winds from all quadrants.

**Figure 5.2** indicates that winds experienced at the Moss Vale AWS are predominately light to strong (from 1.5m/s to greater than 10.5m/s) from the west (approximately 18% of the time). Calm wind conditions (wind speed less than 0.5m/s) were predicted to occur approximately 6% of the time throughout 2007.

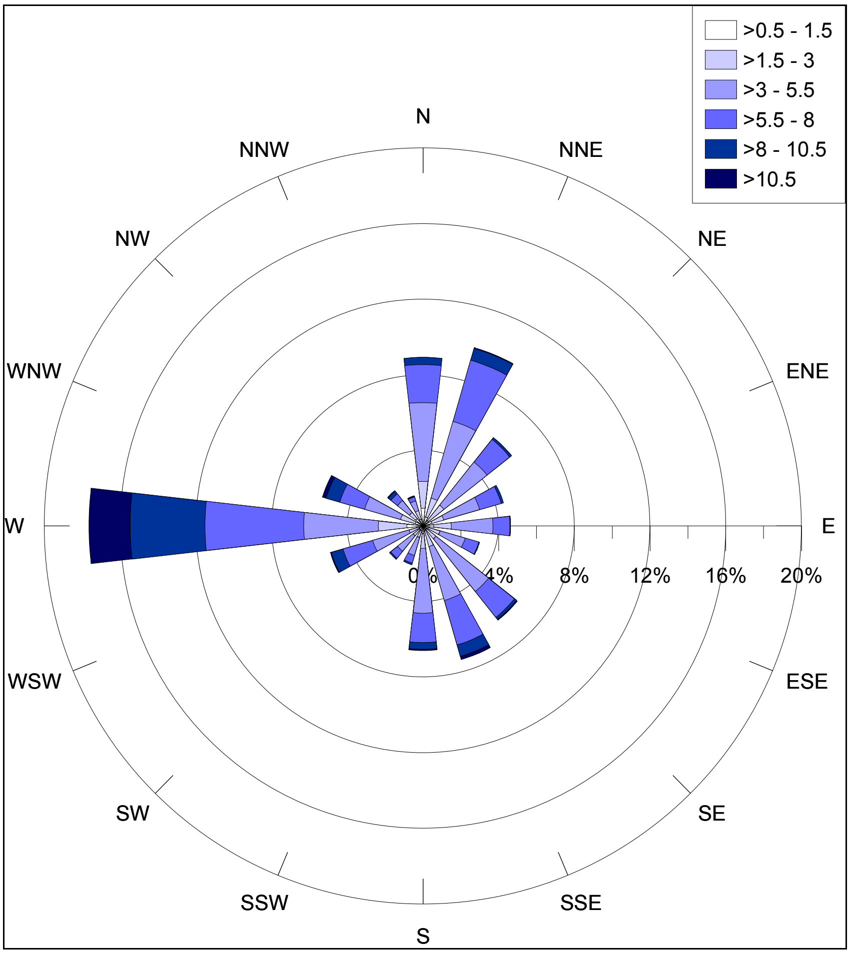



**Figure 5.2**
**Annual Wind Rose TAPM-predicted for the Moss Vale AWS - 2007**

The seasonal variation in predicted wind behaviour at the Moss Vale AWS is presented in **Appendix 2**. The seasonal wind roses indicate that:

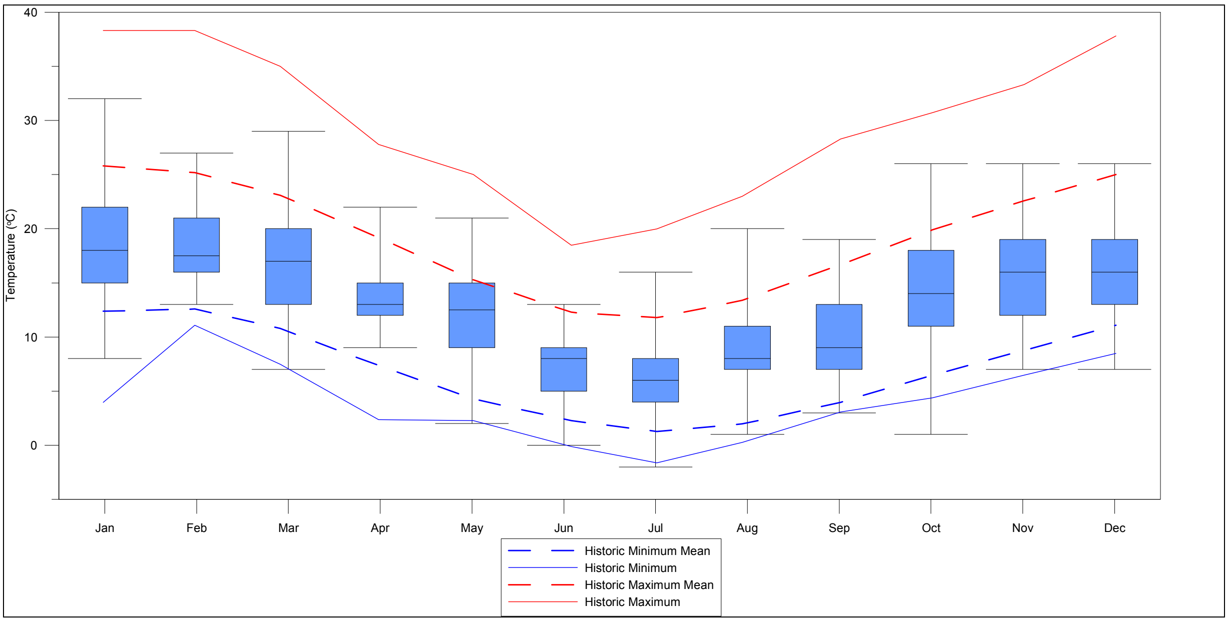
- In summer, light to fresh winds are experienced predominantly from the north-northeast (approximately 18% of the time).
- In autumn, light to strong winds are experienced predominantly from the west (approximately 16% of the time).
- In winter, light to strong winds are experienced predominantly from the west (approximately 30% of the time).
- In spring, light to strong winds are experienced predominantly from the west (approximately 18% of the time).

### 5.2.2 Temperature

Predicted temperature variance by month for the Moss Vale AWS for 2007 is presented in **Figure 5.3**. Additionally overlayed in **Figure 5.3** are the historic maximum / minimum and mean maximum / minimum temperatures recorded at the Moss Vale AWS between 1962 and 2008.

It can be seen in **Figure 5.3** that the TAPM-predicted temperature for Moss Vale AWS during 2007 matches well with the historical measurements at Moss Vale. It can therefore be considered that the 2007 dataset is representative of the temperature likely to be experienced within the region of the Project Site.

From analysis of the recorded historic data, the temperature of the Moss Vale area may be described as cold to warm overall. Average air temperatures during the day tend to vary between 11.8°C and 13.4°C in winter and 25.0°C and 25.8ºC in summer. Average air temperatures during the night tend to be cold to cool, varying between 1.3ºC and 2.3ºC in winter and between 11.1ºC and 12.6ºC in summer.



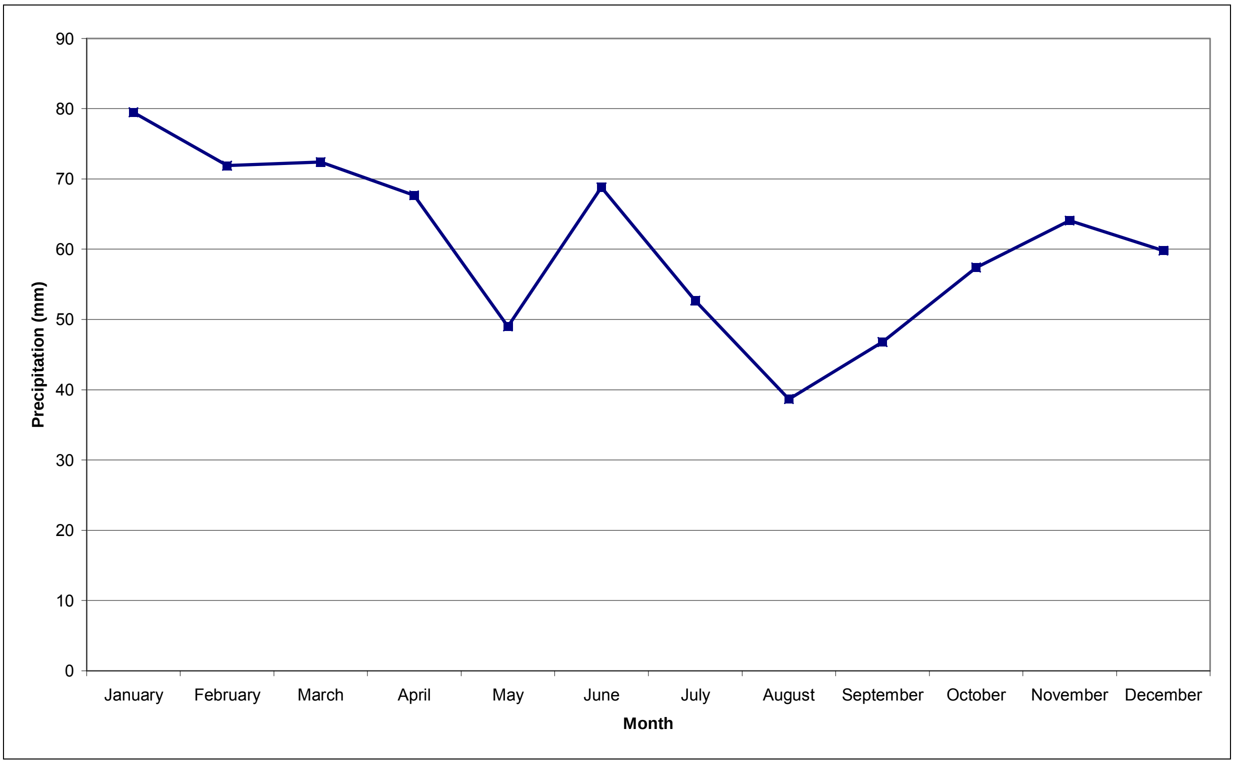

Note: In the above figure, the shaded boxes represent values from the lower to upper quartile (25 - 75 percentile) of the TAPM predicted temperature variances for Moss Vale AWS, 2007, while the middle line depicts the median value and the horizontal lines extend to the minimum and maximum values.

**Figure 5.3**
**Monthly Temperature Variance – TAPM predicted Moss Vale AWS (2007) and Regional Historic data for Moss Vale**

### 5.2.3 Rainfall

Precipitation is important to air pollution studies since it reduces the potential for fugitive dust emissions and represents an effective removal mechanism of atmospheric pollutants. A graph displaying the median ($5^{th}$-decile) monthly rainfall at Moss Vale is shown in **Figure 5.4**.

The rainfall experienced at Moss Vale can be described as moderate, with the area receiving, on average, approximately 933mm per annum. Rainfall at Moss Vale is typically lower between late winter to spring months than at any other time of the year, while reaching a maximum during late summer.




Note: The 5th decile (or 50th quartile) represents the median rainfall for each month. The median value is the preferred measure of 'average' rainfall from a meteorological point of view due to the high variability of daily rainfall.

**Figure 5.4**
**Median (5th decile) Monthly Rainfall Measurements, Moss Vale**

### 5.2.4 Relative Humidity

The relative humidity at Moss Vale can be described as moderate. The mean 9am relative humidity varies between 60% and 82% throughout the year.

### 5.2.5 Atmospheric Stability and Mixing Depth

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill -Turner assignment scheme identifies six Stability Classes, “A” to “F”, to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models (**Table 5.3**).

**Table 5.3**
**Description of Atmospheric Stability Classes**

| Atmospheric Stability Class | Category | Description |
|---|---|---|
| A | Very unstable | Low wind, clear skies, hot daytime conditions |
| B | Unstable | Clear skies, daytime conditions |
| C | Moderately unstable | Moderate wind, slightly overcast daytime conditions |
| D | Neutral | High winds or cloudy days and nights |
| E | Stable | Moderate wind, slightly overcast night-time conditions |
| F | Very stable | Low winds, clear skies, cold night-time conditions |

The percentage of occurrences (or frequency) of each stability class in 2007, as predicted by TAPM, is presented in **Figure 5.5**. The seasonal stability class distributions for each station are included in **Appendix 3**.

The results indicate a high frequency of conditions typical to Stability Class "D". Stability Class "D" is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing.

Diurnal variations in maximum and average mixing depths predicted by TAPM during 2007 are illustrated in **Figure 5.6**. It can be seen that an increase in the mixing depth during the morning, arising due to the onset of vertical mixing following sunrise, is apparent with maximum mixing heights occurring in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

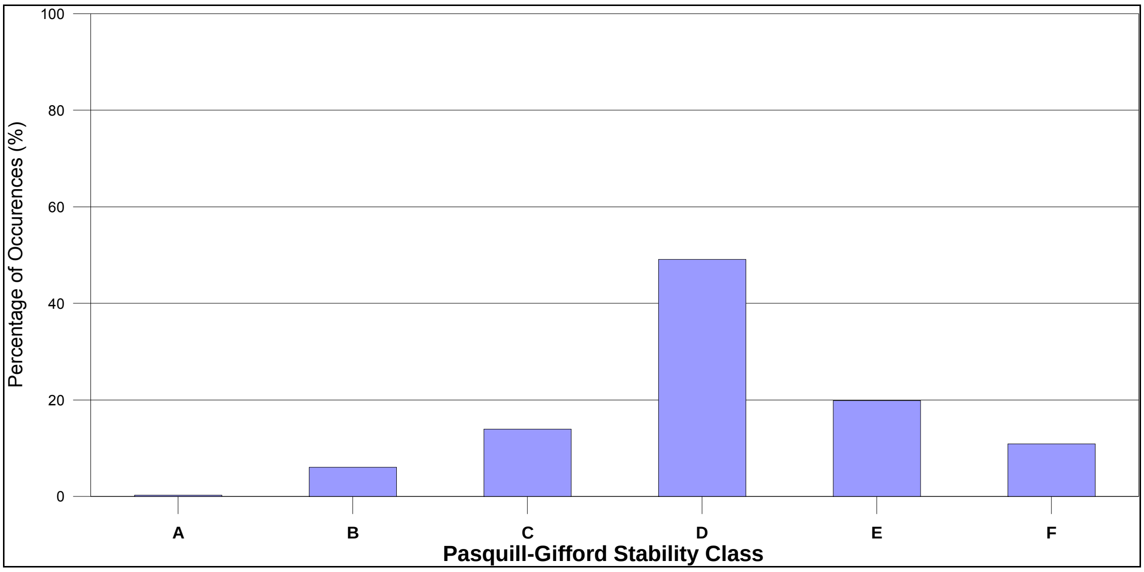



**Figure 5.5**
**TAPM-Predicted Annual Stability Class Distributions for the Moss Vale AWS, 2007**

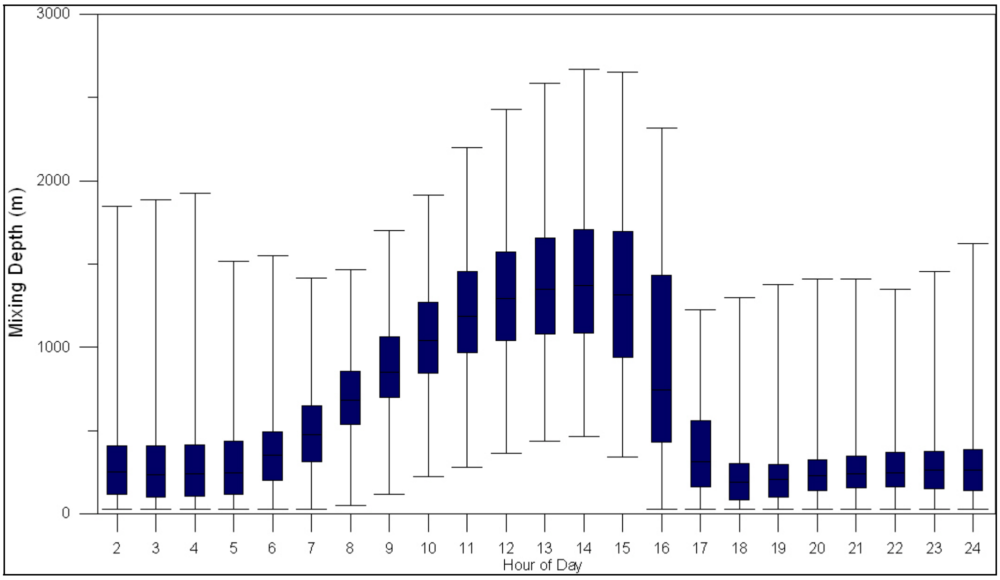



**Figure 5.6**
**TAPM-Predicted Diurnal Variation in Mixing Depth for the Moss Vale AWS, 2007**

# 6. ATMOSPHERIC DISPERSION MODELLING

Atmospheric dispersion modelling has been undertaken to assess the potential for dust and particulate generation from activities at the extraction site.

## 6.1 MODEL SELECTION AND CONFIGURATION

The atmospheric dispersion modelling carried out for the site utilises the Ausplume Gaussian Plume Dispersion Model software developed by EPA Victoria, Version 6.0.

Ausplume is the approved dispersion model for use in the majority of applications in NSW. Default options used (as specified in the Technical Users Manual (EPA Victoria, 2000)) comply with DECCW's Approved Methods document.

## 6.2 MODELLING SCENARIO

One modelling scenario was configured to represent extraction operations at peak production rates in order to reflect worst case emission estimates.

The following conservative (worse case) assumptions were applied:

- Equipment including scraper, bulldozer and FEL, operate full-time during quarry extraction operations between 7am and 5pm, Monday - Friday.
- For worst case emission estimations at the nearest receptor (R2 to the south), it has been assumed that extractive operations occur continuously at the southern end of the extraction area.
- Despatch of product to processing plant and haulage of overburden to the supplementary overburden stockpile area occurs full-time between 7am and 4pm daily.
- An extraction rate of 2000 tonnes per day was assumed during the extraction campaigns. To ensure that all meteorological conditions were assessed in conjunction with an extraction campaign, the campaign has been assumed to be continuous. This results in an annual production rate of 520,000 tonnes.
- The assessment of pollutant emissions with annual averaging periods has been undertaken using the daily production rate of 2000 tonnes per day.
- For transportation of product off-site, a total of 68 truck loads were assumed per day throughout the year. This represents the maximum number of trucks operational on-site in any one day and will generally be much lower. This number will only be operational during 'catch-up' haulage following periods of wet weather.
- A surplus stockpile haulage rate of approximately 9 truck loads per day (calculated according to 280,000$m^3$ total overburden with a density of 2 tonnes/$m^3$, a haulage rate of 70,000tpa over 8 years (during Stage 1) and a truck capacity of 30 tonnes was assumed.
- Non extraction and transportation related emissions generating activities have also been assumed to be operational for a full year. This includes the construction of the amenity bund, wind erosion from the amenity bund and surplus overburden stockpile area. In reality, many of these activities will not be undertaken or active concurrently. Stabilisation of the amenity bunds may be expected to occur through vegetation for example.

## 6.3 EMISSION ESTIMATION

In order to predict pollutant concentrations likely to be associated with operations at the Project Site, published emission estimation methods from USEPA AP-42 documentation and the Australian Government National Pollution Inventory (NPI) document, *Emission Estimation Technique Manual for Mining* (EETMM, NPI 2001) were used. Where possible, emission estimation equations have been implemented to reflect site specific parameters as provided by the Proponent. Alternatively, default emission factors have been adopted.

Assumptions used in emissions estimation and details of the emissions inventory calculations are presented in detail in the following section.

### 6.3.1 Wind Erosion from Stockpiles

The suspension of particulate matter typically commences when wind speed approaches 5m/s (SKM, 2005). To reflect this within the modelling process, the annual wind erosion amount has been divided proportionally across the hours throughout the year that are greater than 5m/s.

Ausplume provides the following default wind speed bands by which the emission rate for a source can be varied: 0-1.54, 1.54-3.09, 3.09-5.14, 5.14-8.23, 8.23-10.8 and 10.8+ m/s.

To derive a wind erosion proportion for each wind speed band, the US EPA's erosion potential equation within Chapter 13, Section 13.2.5 Industrial Wind Erosion (US EPA, 2006), was used to estimate the erosion potential for each band. Within this equation, a Particle Threshold Friction Velocity of 0.5m/s (considered highly conservative as fine coal dust is quoted as 0.54m/s) was assumed. Hourly friction velocity was derived from on-site hourly wind speed data and the US EPA's conversion equation (US EPA, 2006).

It is considered that by distributing the wind erosion proportionally by wind speed, a more realistic approach to estimating likely impacts has been achieved.

Emission Estimation Equation

Annual Wind Erosion from Northern, Western, Southern and the supplementary overburden stockpile area at the Project Site were estimated using the following equation, as per Section A1.1.15 of the EETMM:

$$EF = 1.9 \times \left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \text{ kg/ha/year TSP}$$

where s= silt content, p = number of days when rainfall is greater than 0.25mm, f = percentage of time that wind speed at the mean height of the stockpile is greater than 5.4 m/s. $PM_{10}$ represents 50% of TSP, as derived by this equation.

### 6.3.2 Extraction Operations

A scraper and bulldozer are likely to be employed for topsoil removal and construction of amenity bund walls.

Taking into account the varying silt and moisture contents assumed for topsoil and shale, bulldozer operation has been split between time spent on amenity bund construction (50%) and time spent ripping and pushing up shale (50%).

Trucks will be loaded by FEL with either clay / shale product for despatch to the Berrima Brick Plant or overburden to be relocated to the supplementary overburden stockpile area.

<u>Emission Estimation Equations</u>

Scraper activities at the Project Site were estimated using the following equation, as per Section A1.1.10 of the EETMM:

$$EF = k \times s^{a} W^{b} \text{ kg/VKT}$$

where k = 0.0000076 for TSP and 0.00000132 for $PM_{10}$, a = 1.3 for TSP and 2.4 for $PM_{10}$, b = 1.4 for TSP and 2.5 for $PM_{10}$, s= silt content, W = vehicle gross mass.

Bulldozer activities (ripping and pushing shale) at the Project Site were estimated using the following equation, as per Section A1.1.5 of the EETMM:

$$EF = k \times \frac{s^{1.2}}{M^{1.3}} \text{ kg/h}$$

where k = 2.6 for TSP and 0.34 for $PM_{10}$, a = 1.2 for TSP and 1.5 for $PM_{10}$, b = 1.3 for TSP and 1.4 for $PM_{10}$, s = silt content and M = moisture content.

FEL activities at the Project Site were estimated using the following equation, as per Section A1.1.5 of the EETMM:

$$E = k \times 0.0016 \times (U / 2.2)^{1.3} \times (M / 2)^{-1.4} \text{ kg/t}$$

where k = 0.74 (TSP) / 0.35 ($PM_{10}$) and U = mean wind speed.

### 6.3.3 Despatch and Overburden Relocation

Despatch trucks will travel approximately 1.5km along the proposed haul route on site and then west along the property’s existing road before continuing off site along the existing paved roads to the Berrima Brick Plant.

A maximum haulage rate (68 loads per day) has been assumed for worst case emissions estimation.

Overburden haulage trucks will travel approximately 0.6km east to the supplementary overburden stockpile area. A haulage rate of approximately 9 loads per day has been calculated using information provided by the Proponent and assuming a density of 2 tonnes per $m^3$.

A vehicle gross mass of 40 tonnes (assuming 10 tonnes tare plus 30 tonnes load) has been assumed for haulage trucks.

<u>Emission Estimation Equation</u>

Wheel generated dust at the Project Site was estimated using the following equation, as per Section A1.1.11 of the EETMM:

$$EF = k_i x (s / 12)^{A} x \left( \frac{(W / 3)^{B}}{(M / 0.2)^{C}} \right) \text{ kg/VKT}$$

where k = 2.82 (TSP) / 0.733 ($PM_{10}$), A = empirical constant: 0.8, B = empirical constant: 0.5 (TSP) or 0.4 ($PM_{10}$), C = empirical constant 0.4 (TSP) or 0.3 ($PM_{10}$) and (i) = particle size category.

### 6.3.4 Emission Control Factors

Bulldozer emission estimations have been adjusted (using 30% emission reduction) to take into consideration the windbreak effect of the amenity bund around the bulldozer during ripping and pushing up shale within the quarry.

Level 1 watering has been assumed to be applied to the product transport route from the extraction area to the main highway. This represents a watering rate of 2 litres/m$^2$/hour (and an emission reduction of 50%).

Other emission control factors have not been considered in emission rate calculations as modelling reflects worst case operations at the Project Site.

### 6.3.5 Summary of Parameters for Emission Estimation

Various parameters applied in emission estimation equations are shown in **Table 6.1** and **Table 6.2** below.

**Table 6.1**
**Parameters used in Emission Estimation**

| Parameter | Value | Units | Source | Notes |
|---|---|---|---|---|
| Silt Content (s) | 25 | % | Assumed | Applied to topsoil |
| | 19.5 | % | Based on average of test results across site | Applied to extracted material (shale) |
| | 5.6 | % | Based on Heggies measurements conducted on site | Applied to roads |
| Moisture Content (M) | 5 | % | Assumed | Applied to soils, roads and shales |

**Table 6.2**
**Meteorological data required for Emissions Estimation**

| Parameter | Value | Units | Source |
|---|---|---|---|
| Mean wind speed (U) | 4.7 | m/s | Based Moss Vale (BoM) AWS data |
| Percentage of time when wind speed > 5.4 m/s (*f*) | 36.4 | % | Based Moss Vale (BoM) AWS data |
| Number of days with rainfall > 0.25 mm (*p*) | 133 | days | Based Moss Vale (BoM) AWS data |

# 7. DISPERSION MODELLING RESULTS

Results of the dispersion model predictions for extraction operations at the Project Site are presented in the following sections.

## 7.1 $PM_{10}$ (24-HOUR AND ANNUAL AVERAGE)

### 7.1.1 24 hr average $PM_{10}$

The maximum predicted incremental increase in 24-hour average $PM_{10}$ at the sensitive receptor locations presented in **Section 2.2** is presented in **Table 7.1**.

**Table 7.1**
**Maximum Predicted 24-hour Average Incremental $PM_{10}$ Concentrations**

| Receptor ID | Maximum Predicted Increment |
|---|---|
| NB | 9.5 |
| R2 | 19.5 |
| R3N | 17.9 |
| R3S | 18.9 |
| R11 | 25.3 |
| R12 | 17.8 |
| R13 | 14.6 |
| R14 | 10.7 |
| R15 | 15.4 |
| R19 | 12.4 |
| R22 | 13.2 |

As discussed in **Section 4.6**, Section 5.1.1 of the DECCW's Approved Methods document states that each individual 24-hour average predicted $PM_{10}$ concentrations should be paired in time with their corresponding 24-hour concentration within the adopted 2007 monitoring dataset to obtain the total cumulative impact at each receptor. **Table 7.2** presents the maximum predicted 24 hour $PM_{10}$ concentration at each receptor using this approach.

As can be seen from the results presented in **Table 7.2**, the contemporaneous analysis approach calculates exceedance of the 50µg/m$^3$ assessment criterion at R3N and R19 on a day when background levels are abnormally high (and the predicted 24-hour increment on this day is a low 1.4µg/m$^3$). This indicates that the potential for cumulative exceedance of the 24-hour average $PM_{10}$ assessment criterion does exist during proposed operations at the Project Site.

However, in order to understand the likelihood of an exceedance occurring, the frequency distribution of predicted 24-hour average incremental $PM_{10}$ concentrations is presented in **Figure 7.1**.

**Table 7.2**
**Maximum Predicted 24-hour Average Incremental $PM_{10}$ Concentrations (µg/m$^3$)**

| Receptor ID | Maximum Predicted Cumulative Concentration | Highest Background Concentration | DECCW Goal |
|---|---|---|---|
| NB | 49.2 | 49.2 (04/05/2007) | 50 |
| R2 | 49.2 | 49.2 (04/05/2007) | 50 |
| R3N | 56.0 | 49.2 (04/05/2007) | 50 |
| R3S | 49.5 | 49.2 (04/05/2007) | 50 |
| R11 | 49.2 | 49.2 (04/05/2007) | 50 |
| R12 | 49.2 | 49.2 (04/05/2007) | 50 |
| R13 | 49.2 | 49.2 (04/05/2007) | 50 |
| R14 | 49.2 | 49.2 (04/05/2007) | 50 |
| R15 | 49.2 | 49.2 (04/05/2007) | 50 |
| R19 | 50.6 | 49.2 (04/05/2007) | 50 |
| R22 | 49.3 | 49.2 (04/05/2007) | 50 |

Note: Exceedances marked in grey

It is clear from the data presented in **Figure 7.1**, that the predicted incremental increase likely to be associated with the modelled worst case scenario (peak operations) at the Project Site at all surrounding sensitive receptor locations will be low (i.e. less than 10µg/m$^3$). According to the below frequency distribution plot, the most likely affected sensitive receptor locations are R3N, R3S and R2.

The percentage of time that concentrations are predicted to be 10ug/m$^3$ or less at each receptor is presented in **Table 7.3**. It is clear that in the absolute worst case conditions, incremental 24-hour average $PM_{10}$ concentrations attributable to operations at the Project Site are predicted to be less than or equal to 10µg/m$^3$ for 97.3% of the modelling period at receptor R3N, 98.1% at receptor R3S and 97% at receptor R2 during worst case scenario operations.

On the basis of this analysis, it is considered that the potential for adverse impacts from proposed quarry operational emissions on the surrounding environment in relation to 24-hour average $PM_{10}$ concentrations is low.

A contour plot illustrating the distribution of maximum predicted incremental 24-hour average $PM_{10}$ concentrations for the modelling scenario is presented in **Appendix 4**.

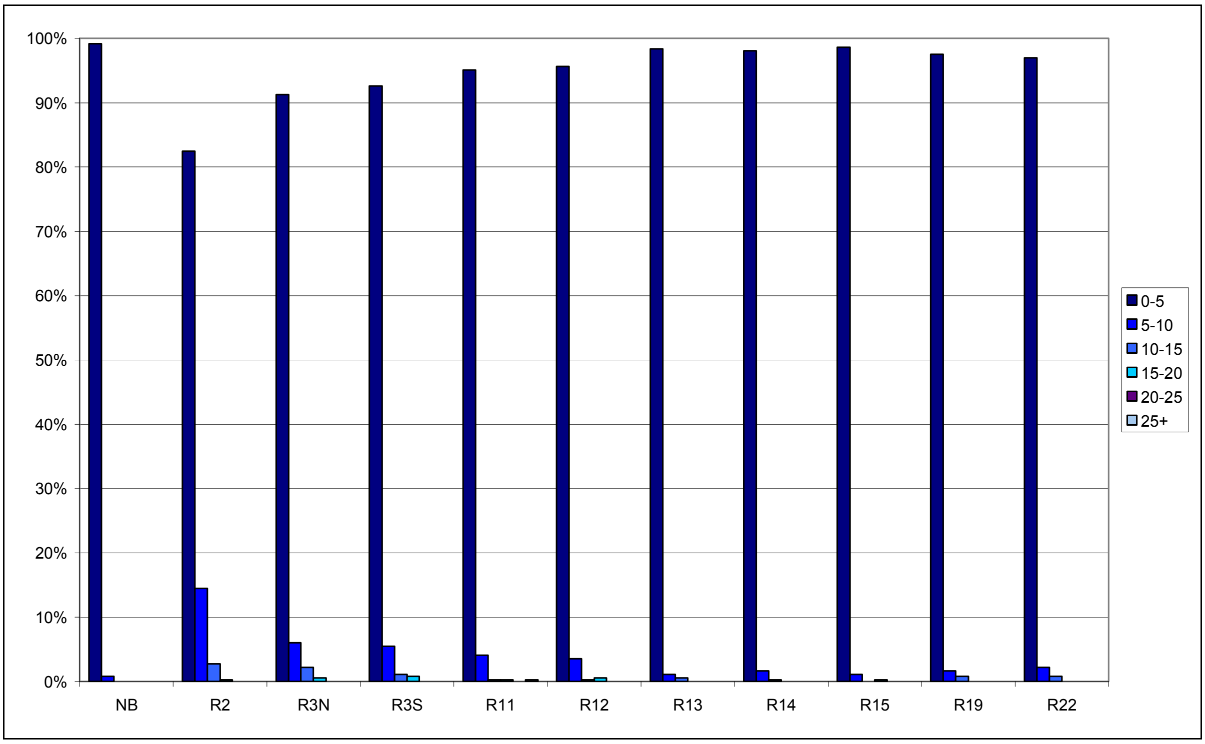



**Figure 7.1**
**Frequency Distribution of Predicted Incremental 24-hour Average $PM_{10}$**

**Table 7.3**
**Percentage of Predicted 24-hour Average Incremental $PM_{10}$ Concentrations less than 10 µg/$m^3$**

| Receptor | Worst Case Scenario |
|---|---|
| NB | 100.0% |
| R2 | 97.0% |
| R3N | 97.3% |
| R3S | 98.1% |
| R11 | 99.2% |
| R12 | 99.2% |
| R13 | 99.5% |
| R14 | 99.7% |
| R15 | 99.7% |
| R19 | 99.2% |
| R22 | 99.2% |

### 7.1.2 Annual Average $PM_{10}$

The total predicted incremental increase in annual average $PM_{10}$ attributable to the Project at all identified sensitive receptors is presented in **Table 7.4**. Addition of the adopted background annual average $PM_{10}$ concentration of 12.8µg/m$^3$ (refer **Section 4.3**) allows assessment against the DECCW annual average $PM_{10}$ criterion.

**Table 7.4**
**Predicted Annual Average $PM_{10}$ Concentration (µg/m$^3$)**

| Receptor | Predicted Incremental Concentration | Adopted Background Concentration | Predicted Cumulative Concentration | DECCW Goal |
|---|---|---|---|---|
| NB | 0.4 | 12.8 | 13.2 | 30 |
| R2 | 2.3 | 12.8 | 15.1 | 30 |
| R3N | 1.7 | 12.8 | 14.5 | 30 |
| R3S | 1.2 | 12.8 | 14.0 | 30 |
| R11 | 1.0 | 12.8 | 13.8 | 30 |
| R12 | 0.9 | 12.8 | 13.7 | 30 |
| R13 | 0.6 | 12.8 | 13.4 | 30 |
| R14 | 0.5 | 12.8 | 13.3 | 30 |
| R15 | 0.4 | 12.8 | 13.2 | 30 |
| R19 | 0.7 | 12.8 | 13.5 | 30 |
| R22 | 0.4 | 12.8 | 13.2 | 30 |

As can be seen from the results in **Table 7.4**, the incremental increase in annual average $PM_{10}$ is predicted to be less than 2.3µg/m$^3$ at all sensitive receptor locations for the modelled scenario. When the adopted ambient annual average $PM_{10}$ concentration, 12.8µg/m$^3$ as per **Section 4.3**, is applied to these model predictions, the total annual average $PM_{10}$ is predicted to be less than 15.1µg/m$^3$ at all locations. Based on the DECCW assessment criterion for annual average $PM_{10}$, 30µg/m$^3$, emissions of $PM_{10}$ from the Project Site are not predicted to adversely impact upon the surrounding environment.

A contour plot illustrating the distribution of predicted incremental annual average $PM_{10}$ concentrations for each modelling scenario is presented in **Appendix 5**.

## 7.2 ANNUAL AVERAGE TSP

The total predicted incremental increase in annual average TSP is presented in **Table 7.5**.

**Table 7.5**
**Predicted Annual Average TSP Concentration (µg/m$^3$)**

| Receptor | Predicted Incremental Concentration | Adopted Background Concentration | Total Predicted Concentration | DECC Goal |
|---|---|---|---|---|
| NB | 1.3 | 19.2 | 20.5 | 90 |
| R2 | 7.2 | 19.2 | 26.4 | 90 |
| R3N | 4.3 | 19.2 | 23.5 | 90 |
| R3S | 3.6 | 19.2 | 22.8 | 90 |
| R11 | 2.8 | 19.2 | 22.0 | 90 |
| R12 | 2.5 | 19.2 | 21.8 | 90 |
| R13 | 1.7 | 19.2 | 20.9 | 90 |
| R14 | 1.5 | 19.2 | 20.7 | 90 |
| R15 | 1.3 | 19.2 | 20.5 | 90 |
| R19 | 2.0 | 19.2 | 21.2 | 90 |
| R22 | 1.4 | 19.2 | 20.6 | 90 |

As can be seen from the results above, the incremental increase in annual average TSP is predicted to be less than 7.2µg/m$^3$ at all sensitive receptor locations across the modelled scenario. When the adopted ambient annual average TSP concentration, 19.2µg/m$^3$ as per **Section 4.4**, is applied to these model predictions, the total annual average TSP is predicted to be less than 26.4µg/m$^3$ at all locations.

Based on the DECCW assessment criterion for annual average TSP, 90µg/m$^3$, emissions of TSP from the Project are not predicted to adversely impact upon the surrounding environment.

A contour plot illustrating the distribution of predicted incremental annual average TSP concentrations for each modelling scenario is presented in **Appendix 6**.

## 7.3 MONTHLY AVERAGE DUST DEPOSITION

The total predicted incremental increase in monthly average dust deposition is presented in **Table 7.6**.

**Table 7.6**
**Predicted Dust Deposition (g/m$^2$/month)**

| Receptor | Predicted Incremental Concentration | Adopted Background Concentration | Total Predicted Concentration | DECC Goal |
|---|---|---|---|---|
| NB | 0.2 | 2 | 2.2 | 4 |
| R2 | 1.3 | 2 | 3.3 | 4 |
| R3N | 1.9 | 2 | 3.9 | 4 |
| R3S | 0.7 | 2 | 2.7 | 4 |
| R11 | 0.9 | 2 | 2.9 | 4 |
| R12 | 0.8 | 2 | 2.8 | 4 |
| R13 | 0.6 | 2 | 2.6 | 4 |
| R14 | 0.4 | 2 | 2.4 | 4 |
| R15 | 0.2 | 2 | 2.2 | 4 |
| R19 | 0.5 | 2 | 2.5 | 4 |
| R22 | 0.1 | 2 | 2.1 | 4 |

As can be seen from the results above, the incremental increase in monthly average dust deposition is predicted to be less than 1.9µg/$m^3$ at all sensitive receptor locations across the modelled scenario.

Based on the DECCW assessment criterion for dust deposition, as listed in **Section 3.3**, a maximum incremental increase of 2g/$m^2$/month, emissions of dust from the Project Site are not predicted to adversely impact upon the surrounding environment.

A contour plot illustrating the distribution of predicted incremental monthly average dust deposition levels for each modelling scenario is presented in **Appendix 7**.

# 8. RECOMMENDED EMISSION MITIGATION MEASURES

It is understood that progressive rehabilitation will take place throughout the life of the Project. This will help to minimise the amount of exposed surface areas of the Project Site.

Further controls that could be implemented, if necessary include:

- Routine water spraying of haul routes and unsealed surfaces.
- Amending of dust-generated construction activities during adverse wind conditions
- Water spraying of stockpiles.
- Water spraying during excavation activities e.g. ripping and pushing shale / sandstone.
- Maintaining control of the state of trucks when leaving the Project Site (i.e. ensuring truck loads are covered and tailgate effectively sealed) in order to minimise truck fall out of material which may lead to enhanced paved road silt loading. Placement of a truck shaker grid or truck washing station along the transport route leading off site will assist in this matter.
- Reducing the idling time of diesel-powered vehicles on site and ensuring trucks are maintained in accordance with the manufacturer's specifications.

# 9. GREENHOUSE GAS ASSESSMENT

A quantitative greenhouse gas assessment has been undertaken to estimate potential greenhouse gas (GHG) emissions associated with the Project. The Department of Climate Change document, *National Greenhouse Accounts (NGA) Factors* (June 2009) (hereafter, "NGA Workbook"), will be used to estimate GHG emissions from the Project.

The Proponent has advised that the Project's electricity use will be minimal as no plant equipment will be electrically operated. Therefore, only fuel consumption is addressed in this report.

Fuel consumption rates have been calculated based on an average extraction volume of 120,000 tonnes per annum and an upper limit extraction volume of 150,000 tonnes per annum over a Project lifetime of 30 years in relation to mining, loading, handling of overburden and transport activities.

## 9.1 GREENHOUSE GAS EMISSION SCOPES

The NGA Workbook defines three greenhouse gas emission scopes, which are defined as follows:

- Scope 1 emissions are those which result from activities under a company's control or from sources which they own (e.g. on-site generation of electricity, use of fuel in company-owned vehicles). Scope 1 emissions are also termed 'direct emissions'.
- Scope 2 emissions are those which relate to the generation of purchased electricity consumed in its owned or controlled equipment or operations.
- Scope 3 emissions are defined as those which do not result from the activities of a company although arise from sources not owned or controlled by the company (e.g. off-site transportation of purchased fuels, the use of sold products and services). Scope 2 and 3 emissions are also termed 'indirect emissions'.

## 9.2 GREENHOUSE GAS CALCULATION METHODOLOGY

Quantification of potential Project emissions has been undertaken in relation to both Carbon Dioxide ($CO_2$) and other non-$CO_2$ GHG emissions.

For comparative purposes, non-$CO_2$ greenhouse gases are awarded a "$CO_2$-equivalence" based on their contribution to the enhancement of the greenhouse effect. The $CO_2$-equivalence of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-$CO_2$ greenhouse gases are contained within Table 24 of the NGA Workbook. The GWPs of relevance to this assessment are:

- Methane ($CH_4$): GWP of 21 (21 times more effective as a greenhouse gas than $CO_2$).
- Nitrous Oxide ($N_2O$): GWP of 310 (310 times more effective as a greenhouse gas than $CO_2$).

The short-lived gases such as CO, $NO_2$, and NMVOCs vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

In accordance with the NGA Workbook, the greenhouse gas emissions that are required for measurement from the Project are Direct (Scope 1) emissions relating to fuel combustion (for stationary energy and transport purposes), and Indirect (Scope 3) emissions associated with employee travel to and from the Project Site. Scope 2 emissions resulting from emissions associated with the purchase of electricity are not discussed further due to the minimal amount of electricity consumed during the operation of the Project.

### 9.2.1 Scope 1: Direct Emissions

Scope 1 GHG emissions attributable to diesel relate to the use of mobile equipment on site (e.g. Scraper, FEL etc.) and the transport of materials to the Bowral Brick Plant in proponent-owned vehicles.

The primary fuel source for the vehicles operating at the Project Site would be automotive diesel oil (ADO). Figures provided by the Proponent indicate annual diesel consumption at the Project Site of 56 kL/year for mobile equipment and 92 kL/year for transport activities. Total annual diesel consumption for proposed operations is predicted to be approximately 148 kL/year for a 120 ktpa extraction scenario. Scaled diesel consumption rates for a 150 ktpa extraction rate indicates consumption to be of the order of 181 kL/year.

Annual Scope 1 emissions of $CO_2$ and other GHG from diesel combustion have been estimated using emission factors contained in Table 4 of the NGA Workbook. The emission factor of 69.9 kg $CO_2$-e / GJ has been used, with the energy content of diesel oil 38.6 GJ/kL as per Table 4 of the NGA Workbook.

The calculated Scope 1 diesel combustion related emissions for the Project are presented in **Table 9.1**.

**Table 9.1 Scope 1 Diesel Combustion Related GHG Emissions**

| Scenario | Consumption Rate (kL/year) | GHG Emissions (t $CO_2$-e / year) | | | Total Emissions (t $CO_2$-e year) |
|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | |
| 120 ktpa | 148 | 395 | 1 | 3 | 399 |
| 150 ktpa | 181 | 484 | 1 | 4 | 489 |

### 9.2.2 Scope 2: Electricity Indirect Emissions

GHG emissions associated with the consumption of electricity have not been calculated within this assessment as the Proponent has identified that electricity consumption will be minimal, powering only a small number of minor office based equipment on site.

### 9.2.3 Scope 3: Other indirect Emissions

#### 9.2.3.1 EMPLOYEE TRAVEL

GHG emissions resulting from employee travel to and from the Project Site can be calculated and accounted for under Scope 3 emissions.

Employee vehicle movements have been estimated based on full-time staff numbers provided by the proponent and the following broad assumptions:

- Car fuel consumption rate of 10 L/100km.
- Average employee round trip distance of 7.2 km (assuming staff travel from Berrima each day).

The annual emissions of $CO_2$ and other GHG from this source have been estimated using Table 4 of the NGA Workbook. It has been assumed that an energy content of 34.2 MJ/L for petrol is applicable for employee travel (DCC 2009a). The Scope 3 emission factor for liquid fuel consumption (5.3 kg $CO_2$-e/GJ, as per Table 38 of the NGA Workbook) has been applied to calculate total GHG emissions. Total annual Scope 3 GHG emissions related to employee travel are presented in **Table 9.2**.

**Table 9.2**
**Scope 3 GHG Emissions – Product Transportation and Employee Travel**

| Scenario | Petrol Consumption Rate (L/year) Employee Vehicles | Total $CO_2$-e Emissions (t/year) |
|---|---|---|
| 120 ktpa | 259 | 47 |
| 150 ktpa | 324 | 59 |

#### 9.2.3.2 EXTRACTION, PRODUCTION AND TRANSPORT OF DIESEL CONSUMED AT THE PROJECT

Scope 3 GHG emissions attributable to diesel used at the Project relate to its extraction, production and transport. These emissions are associated with the diesel consumed by mobile equipment and transport and are separate from the emissions calculated in **Table 9.1**.

The Scope 3 emission factor for liquid fuel consumption (5.3 kg $CO_2$-e/GJ, as per Table 38 of the NGA Workbook) has been applied to calculate total GHG emissions. The calculated Scope 3 diesel combustion related emissions for the Project are presented in **Table 9.3**.

**Table 9.3 Scope 3 Diesel Combustion Related GHG Emissions**

| Scenario | Consumption Rate (kL/year) | Total Emissions (t $CO_2$-e year) |
|---|---|---|
| 120 ktpa | 148 | 8 |
| 150 ktpa | 181 | 10 |

## 9.3 GREENHOUSE GAS EMISSIONS SUMMARY

Calculated Scope 1 and Scope 3 emissions of greenhouse gas resulting from the emissions sources outlined above are summarised in **Table 9.4**.

**Table 9.4 Total GHG Emissions by Project Scenario**

| Scenario | GHG Emissions by Scope (t $CO_2$-e/year) | | Total Emissions (t $CO_2$-e/year) |
|---|---|---|---|
| | Scope 1 | Scope 3 | |
| 120 ktpa | 399 | 55 | 454 |
| 150 ktpa | 489 | 69 | 558 |

In order to derive an indicative value for total project life GHG emissions, the following broad assumptions are made:

- Project lifetime of 30 years.
- Annual extraction rate remains constant over the Project lifetime.

The application of the assumptions above returns total GHG emissions of approximately 13,620 tonnes over the Project lifetime. However, this value may be variable given the variable nature of extraction per annum and the project lifetime.

Nevertheless, a comparison of the annual Scope 1 GHG emissions from the Project against published net total GHG emissions for NSW and Australia during 2007 has been conducted. Net emissions of 162.7 Mt $CO_2$-e and 597.2 Mt $CO_2$-e were reported for 2007 for NSW and Australia respectively by the DCC (2009b). Scope 1 emissions from the Project would represent between approximately 0.0002 % and 0.0003% of total NSW emissions and approximately 0.0001% of total Australian emissions.

# 10. CONCLUSION

Heggies has been commissioned by RWC on behalf of the Proponent to undertake an Air Quality Impact and Greenhouse Gas Assessment for the proposed New Berrima Clay / Shale Quarry, on the “Mandurama” property east of New Berrima.

Dispersion modelling has been conducted utilising the EPA Victoria developed Ausplume for emissions of $PM_{10}$, TSP, and Dust Deposition. The Air Pollution Model (TAPM) was used to generate a meteorological dataset, using the data assimilation option to incorporate observations from the Bureau of Meteorology’s Moss Vale Automatic Weather Station located approximately 6km from the Project Site.

Particulate emissions were estimated utilising published emission literature from the National Pollution Inventory and USEPA AP-42. The modelling scenario was configured to reflect a worst-case operation scenario at the quarry for pollutants with 24-hour averaging periods ($PM_{10}$). The same scenario has been used for pollutants with annual averaging periods ($PM_{10}$, TSP and Dust Deposition) to demonstrate adherence with the relevant annual average criteria even under these excessive extraction operations.

The findings of the modelling indicate that 24-hour average $PM_{10}$ and annual average $PM_{10}$, TSP and Dust Deposition levels associated with the Project are predicted to satisfy the project air quality goals and the likelihood of adverse cumulative impact is low.

The modelling methodology contains a number of assumptions which mean that conservative ‘worst case’ scenarios were modelled. Therefore, all particulate predictions should be viewed as highly conservative, with levels expected to be lower than those modelled during standard operations.

The assessment also considers emissions of greenhouse gas emissions from the New Berrima Quarry and includes estimates of direct and indirect GHG emissions for both an average and maximum yearly extraction rate. It is noted that Scope 2 emissions due to electricity consumption have not been assessed on the proponent's request.

Calculated direct (Scope 1) emissions from the Project associated with diesel combustion would generate between approximately 399 t $CO_2$-e/annum and 489 t $CO_2$-e/annum. Indirect (Scope 3) emissions would be through employee travel. Annual indirect emissions from the Project were calculated to range between approximately 55 t $CO_2$-e/annum and 69 t $CO_2$-e/annum.

A comparison of the calculated direct (Scope 1) emissions against Australia's 2007 net emissions of 597 Mt $CO_2$-e demonstrates the Project would represent an increase of approximately 0.0001 % of the total Australian emissions. A comparison of the calculated Scope 1 emissions against NSW emissions in 2007 (162.7 Mt $CO_2$-e) demonstrates that the Project would represent an increase of between approximately 0.0002 % and 0.0003 % of NSW emissions.

# 11. REFERENCES

The following documents and resources have been used in the production of this report:


- Australian Government Department of Climate Change (2009a), Australia's National Greenhouse Accounts Factors, June 2009
- Australian Government Department of Climate Change (2009b), Australia's National Greenhouse Accounts, State and Territory Greenhouse Gas Inventories 2007
- Bureau of Meteorology, Hourly observations for 2003 to 2007 from the Moss Vale AWS.
- Bureau of Meteorology (2008), Historical climate data between 1962 and 2006 at Moss Vale AWS.
- Department of Climate Change, Australian Government (2009), National Greenhouse Accounts (NGA) Factors, June 2009.
- Environment Australia National Pollution Inventory (2001), Emission Estimation Technique Manual for Mining, Version 2.3.
- Heggies generated meteorology file (hourly observations for the year 2007) for Project Site referencing TAPM software outputs.
- National Environmental Protection Council, 1998 National Environment Protection Measure reporting standard.
- NSW Department of Environment, Climate Change and Water (2005), Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.
- NSW Department of Environment and Conservation (2007), $PM_{10}$ data as measured at the DECCW's Oakdale monitoring site.
- US EPA (2001). AP-42: Compilation of Air Pollutant Emission Factors, Fifth Edition.
- US EPA (2006) Compilation of Air Pollutant Emission Factors AP-42 (Chapter 13, Section 13.2.5 Industrial Wind Erosion).

# 12. GLOSSARY OF ACRONYMS AND SYMBOLS

| | |
|---|---|
| AHD | Australian Height Datum |
| Approved Methods | Approved Methods for the Modelling and Assessment of Air Pollutants in NSW |
| AWS | Automatic Weather Station |
| BoM | Bureau of Meteorology |
| CO | Carbon Monoxide |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| DECCW | NSW Department of Environment, Climate Change and Water |
| Heggies | Heggies Pty Ltd |
| mg | Milligram (g x $10^{-3}$) |
| µg | Microgram (g x $10^{-6}$) |
| µm | Micrometre or micron (metre x $10^{-6}$) |
| $m^3$ | Cubic metre |
| MGA | Map Grid of Australia |
| NEPC | National Environment Protection Council |
| NEPM | National Environment Protection Measure |
| $NO_2$ | Nitrogen Dioxide |
| $NO_X$ | Oxides of Nitrogen |
| NPI | National Pollution Inventory |
| $PM_{10}$ | Particulate matter less than 10microns in aerodynamic diameter |
| The Proponent | Austral Brick Company Pty Ltd |
| tpa | Tonnes per Annum |
| RWC | R.W. Corkery & Co. Pty Ltd |
| TAPM | “The Air Pollution Model” |

# *APPENDICES*

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# Appendix 1

## Moss Vale Annual Wind Roses 2003-2007

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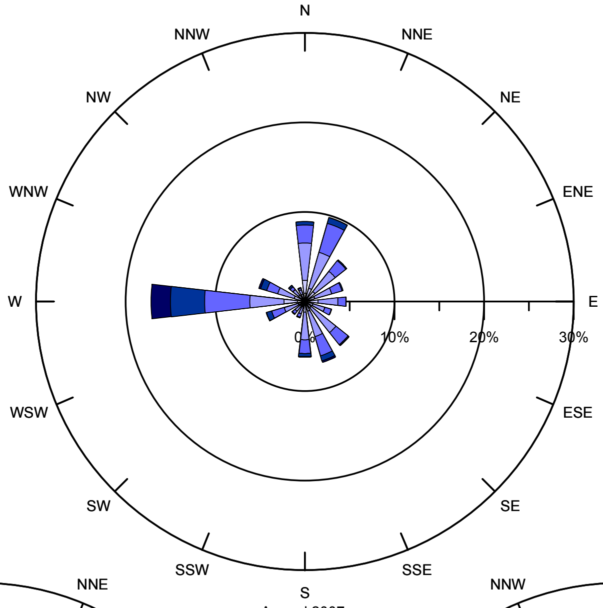
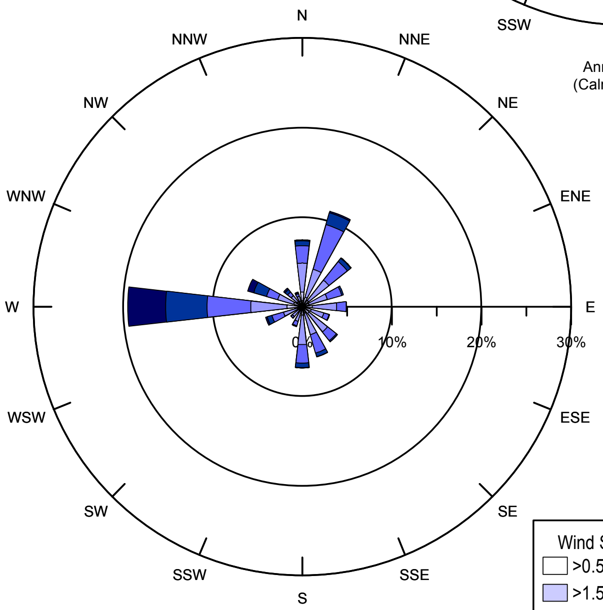
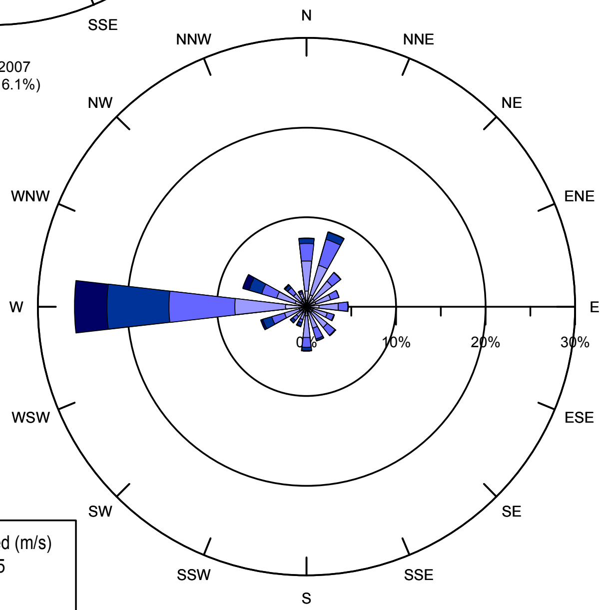


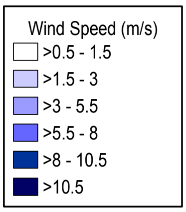
Annual 2007
(Calms = 6.1%)

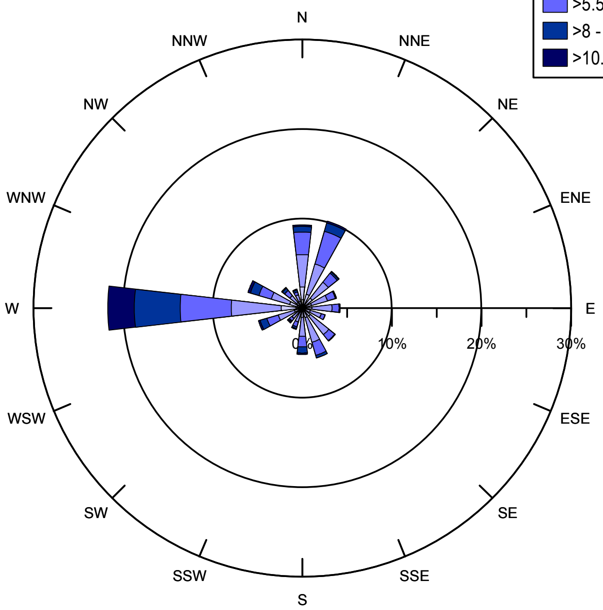


Annual 2003
(Calms = 5.5%)

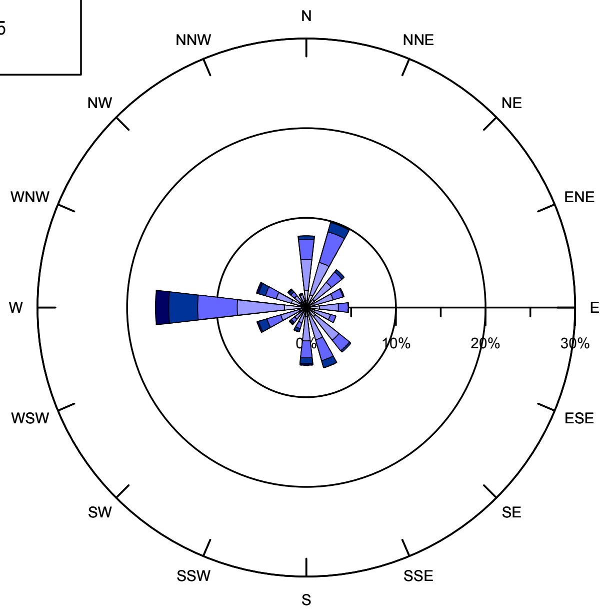


Annual 2004
(Calms = 5.5%)



Annual 2005
(Calms = 6.0%)



Annual 2006
(Calms = 6.4%)

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# Appendix 2

## TAPM-Predicted Seasonal Wind Roses for Project Site - 2007

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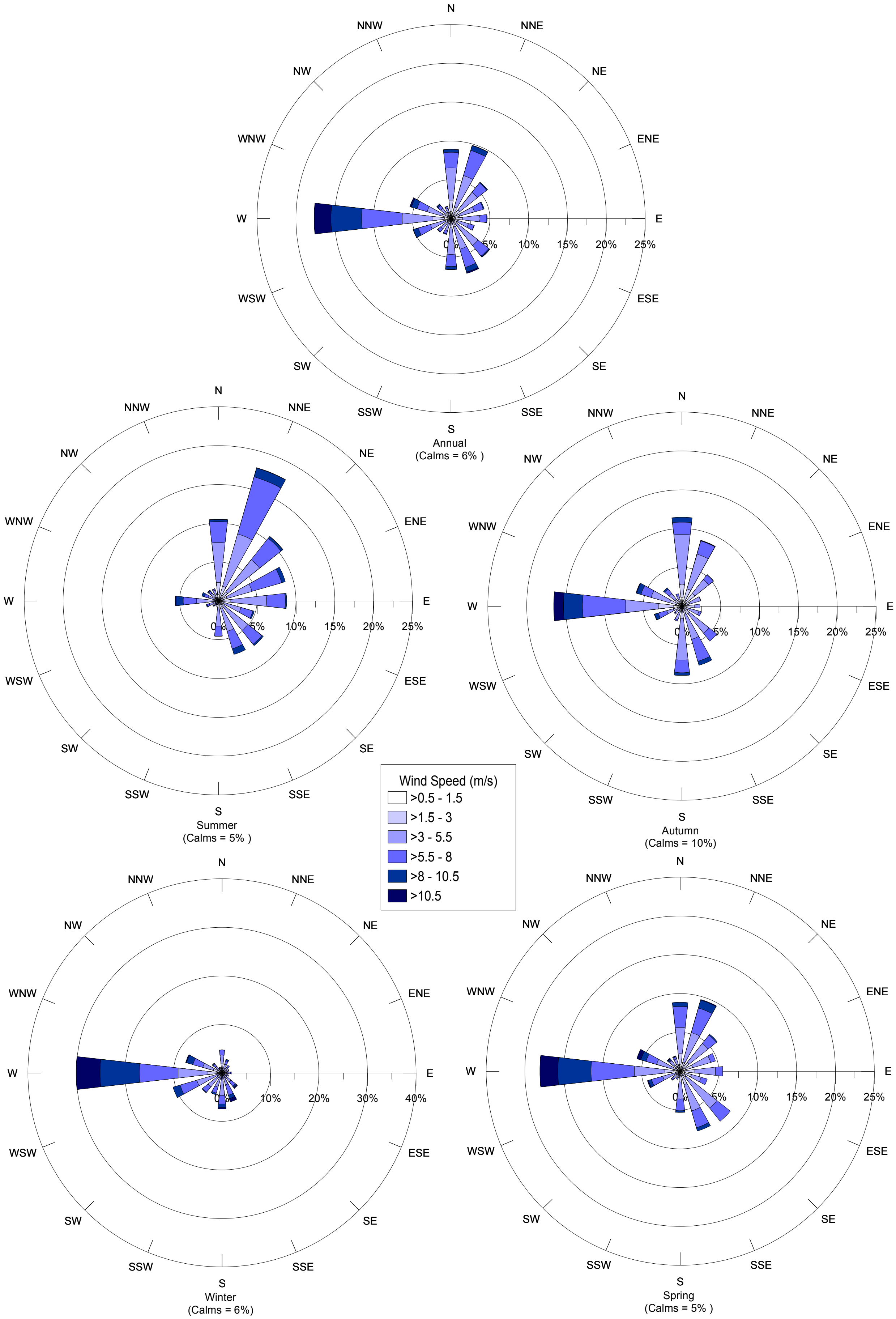
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0%
5%
10%
15%
20%
25%
Annual
(Calms = 6% )
Summer
(Calms = 5% )
Autumn
(Calms = 10%)
10%
20%
30%
40%
Winter
(Calms = 6%)
Spring
(Calms = 5% )
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5

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# Appendix 3

## TAPM-predicted Seasonal Variation in Stability Class for the Moss Vale AWS - 2007

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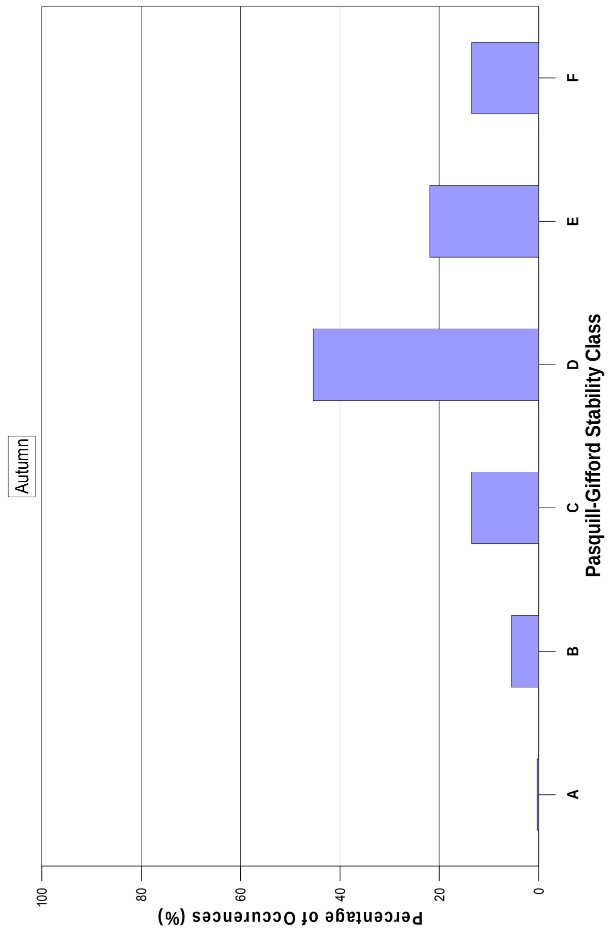
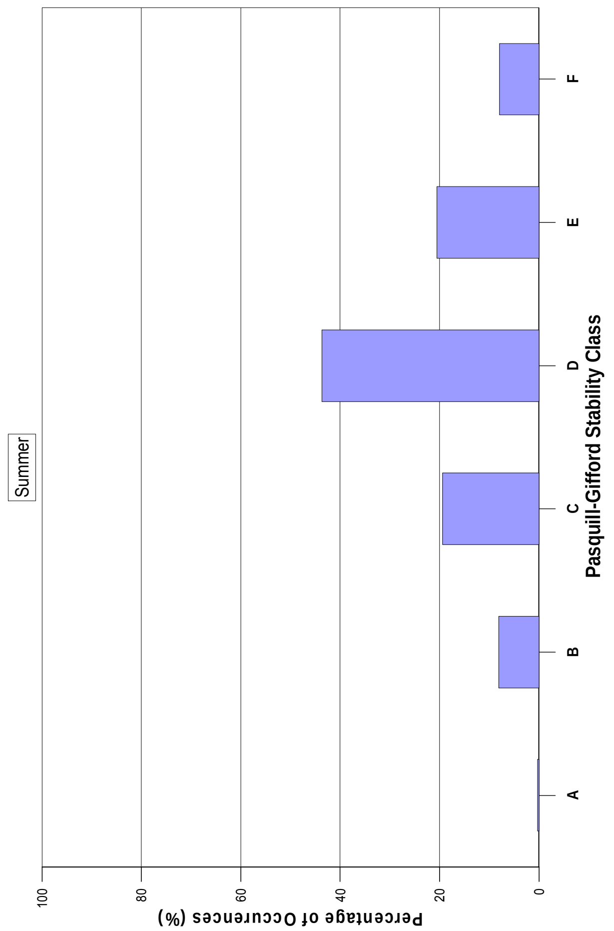
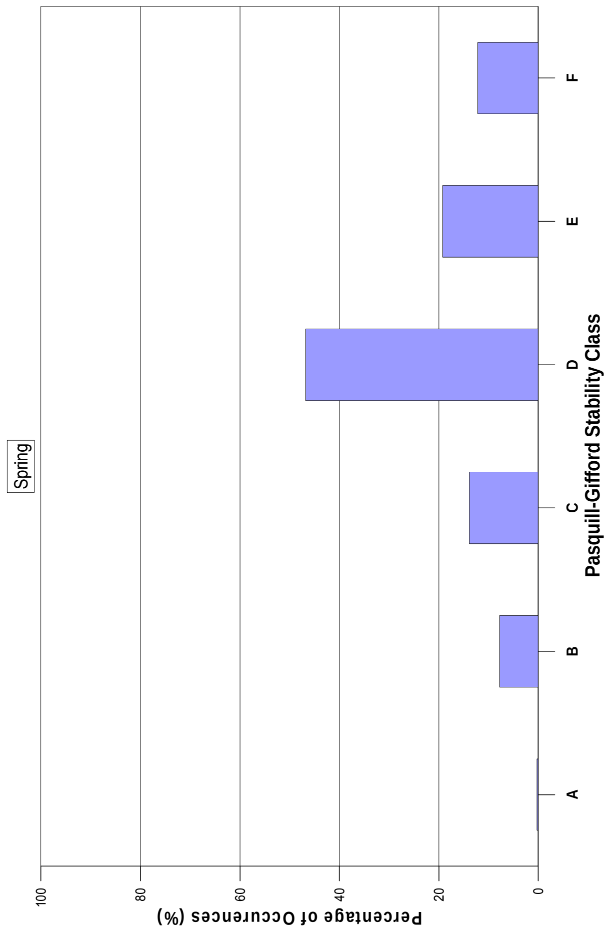
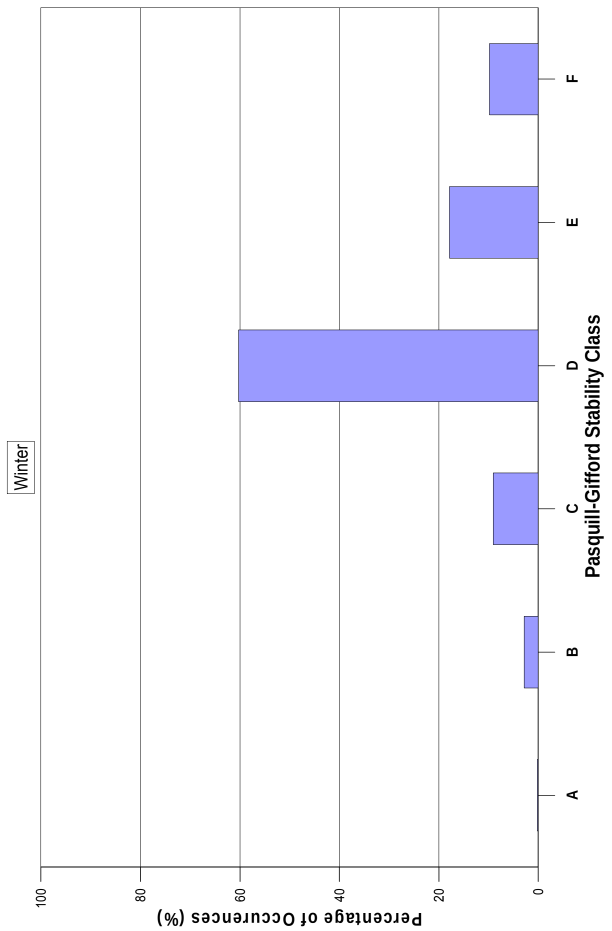

Autumn
Percentage of Occurences (%)
100
80
60
40
20
0
A
B
C
D
E
F
Pasquill-Gifford Stability Class


Summer
Percentage of Occurences (%)
100
80
60
40
20
0
A
B
C
D
E
F
Pasquill-Gifford Stability Class


Spring
Percentage of Occurences (%)
100
80
60
40
20
0
A
B
C
D
E
F
Pasquill-Gifford Stability Class


Winter
Percentage of Occurences (%)
100
80
60
40
20
0
A
B
C
D
E
F
Pasquill-Gifford Stability Class

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# Appendix 4

## $PM_{10}$ 24-hour Average Predicted Incremental Contour Plot

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Note: This Plot is included in colour on the Project CD

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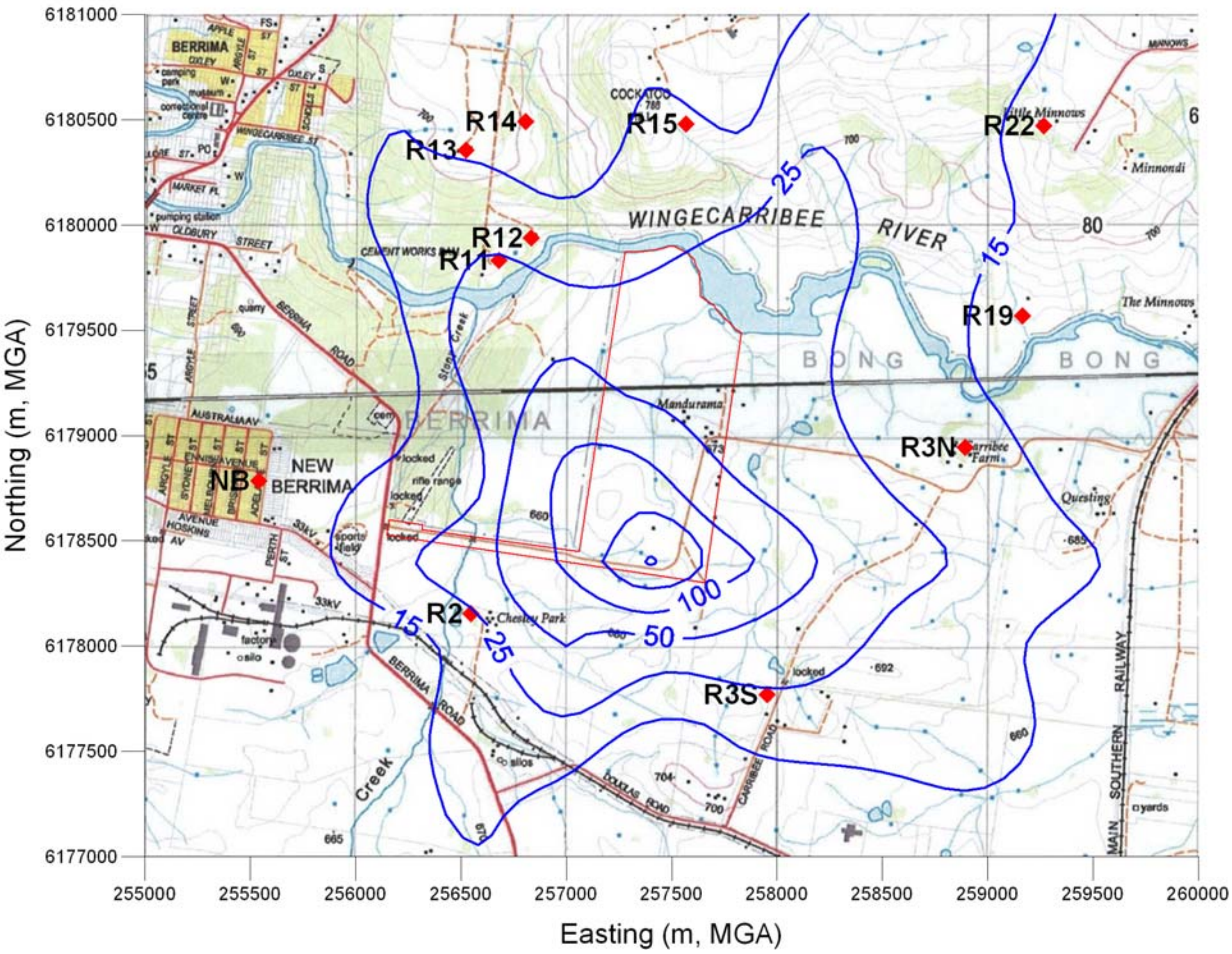
## $PM_{10}$ 24-hour Average Predicted Incremental Contours (µg/m³)



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# Appendix 5

## $PM_{10}$ Annual Average Predicted Incremental Contour Plot

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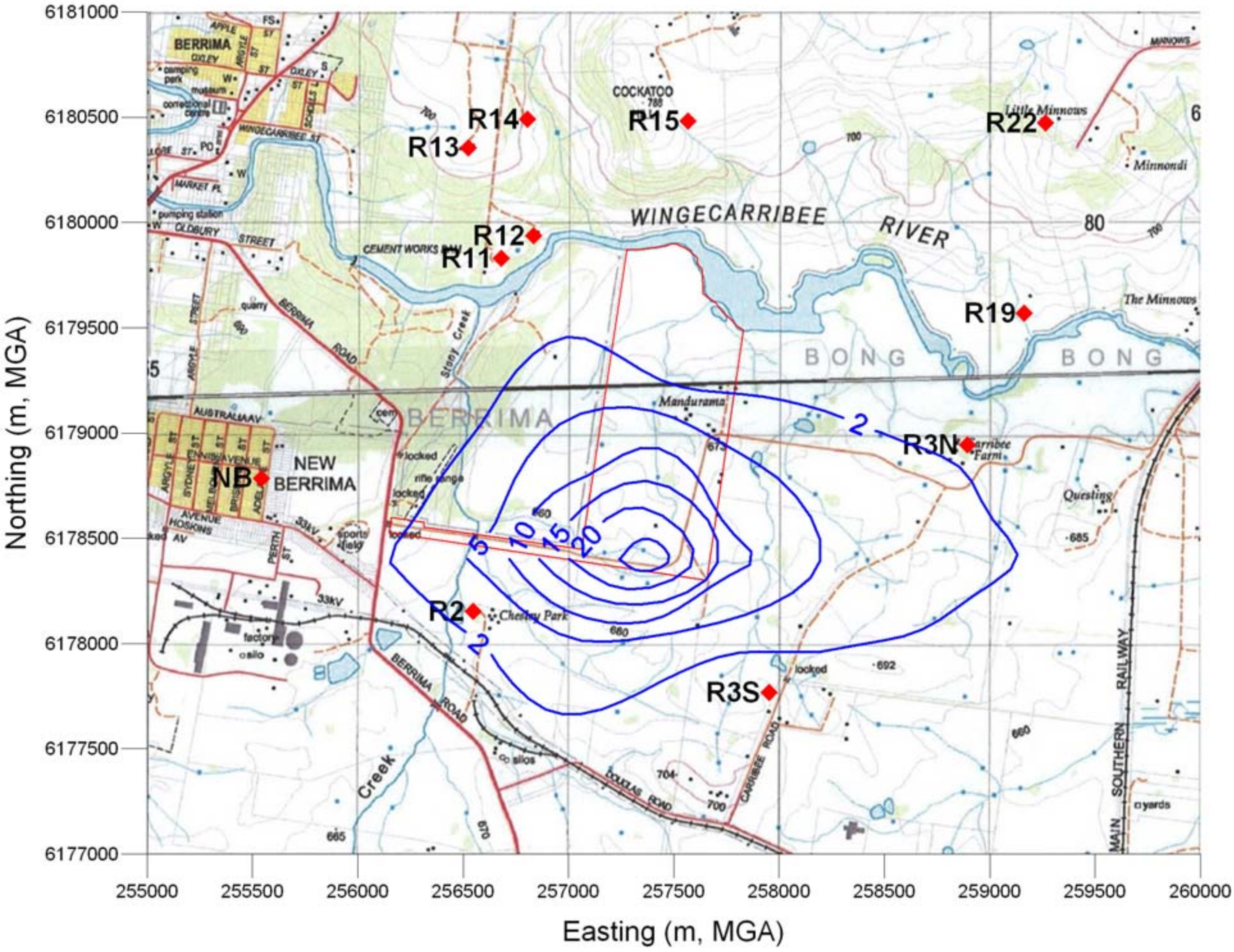
**$PM_{10}$ Annual Average Predicted Incremental Contours (µg/m$^3$)**



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# Appendix 6

## TSP Annual Average Predicted Incremental Contour Plot

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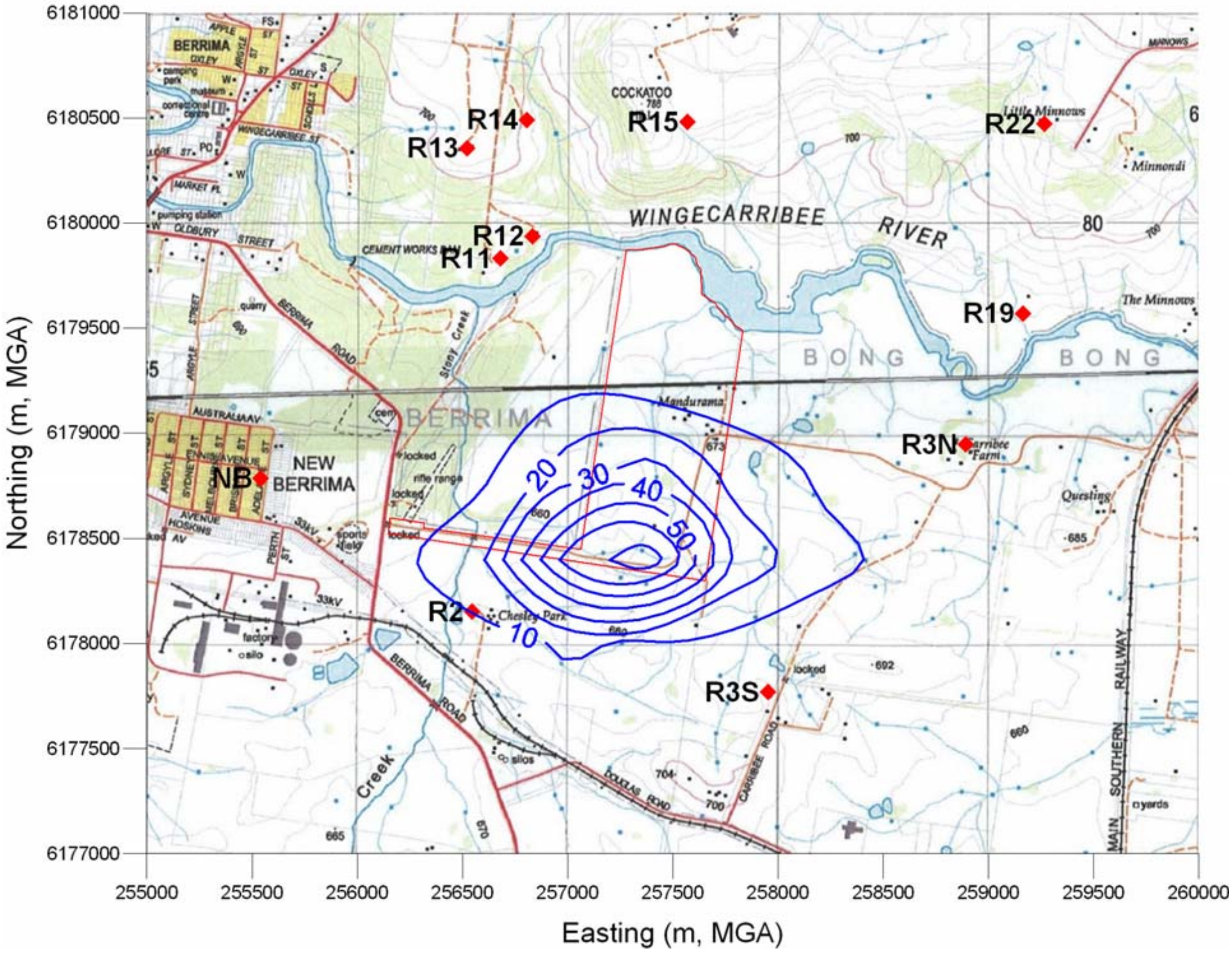
**TSP Annual Average Predicted Incremental Contours (µg/m³)**



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# Appendix 7

## Dust Deposition Monthly Average Predicted Incremental Contour Plot

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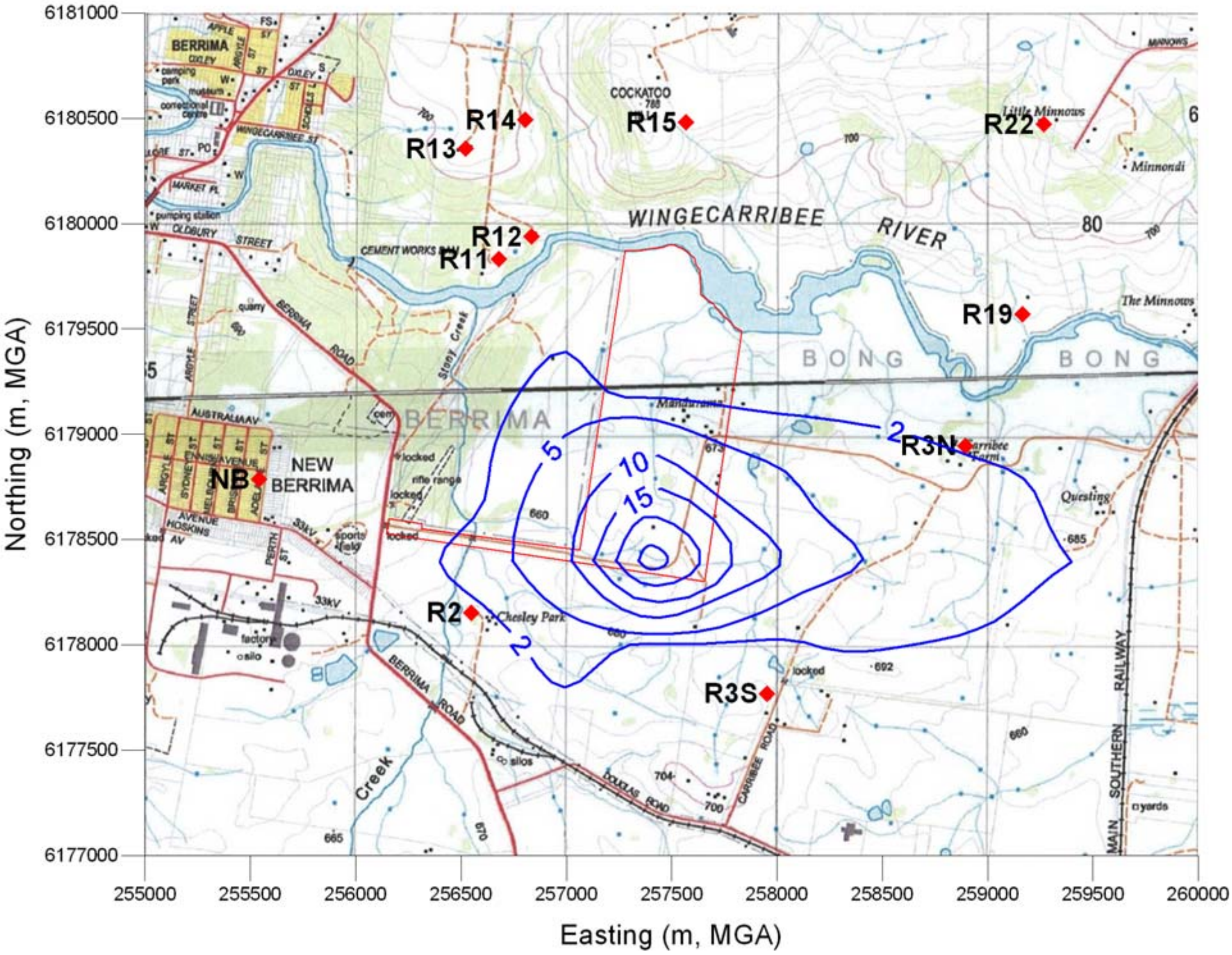
**Dust Deposition Monthly Average Predicted Incremental Contours (g/m²/month)**



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