

# **Tarrawonga Coal Mine Modification**

## **Appendix C**

### **Air Quality Impact Assessment**





**HEGGIES**

REPORT 10-8480-R2

Revision 4

**Tarrawonga Coal Mine  
Section 75W Modification  
Air Quality Impact Assessment**

PREPARED FOR

**Tarrawonga Coal Pty Ltd  
PO Box 600  
Gunnedah NSW 2380**

9 APRIL 2010

**HEGGIES PTY LTD**  
ABN 29 001 584 612



# Tarrawonga Coal Mine

## Section 75W Modification

### Air Quality Impact Assessment

#### PREPARED BY:

Heggies Pty Ltd  
2 Lincoln Street Lane Cove NSW 2066 Australia  
(PO Box 176 Lane Cove NSW 1595 Australia)  
Telephone 61 2 9427 8100 Facsimile 61 2 9427 8200  
Email sydney@heggies.com Web www.heggies.com

#### DISCLAIMER

Reports produced by Heggies Pty Ltd are prepared for a particular Client's objective and are based on a specific scope, conditions and limitations, as agreed between Heggies and the Client. Information and/or report(s) prepared by Heggies may not be suitable for uses other than the original intended objective. No parties other than the Client should use any information and/or report(s) without first conferring with Heggies.

The information and/or report(s) prepared by Heggies should not be reproduced, presented or reviewed except in full. Before passing on to a third party any information and/or report(s) prepared by Heggies, the Client is to fully inform the third party of the objective and scope and any limitations and conditions, including any other relevant information which applies to the material prepared by Heggies. It is the responsibility of any third party to confirm whether information and/or report(s) prepared for others by Heggies are suitable for their specific objectives.



Heggies Pty Ltd is a Member Firm of the Association of Australian Acoustical Consultants.



Heggies Pty Ltd operates under a Quality System which has been certified by SAI Global Pty Limited to comply with all the requirements of ISO 9001:2008 "Quality management systems - Requirements" (Licence No 3236).

This document has been prepared in accordance with the requirements of that System.

#### DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
10-8480-R2	Revision 4	9 April 2010	Martin Doyle	Gary Graham	Martin Doyle
10-8480-R2	Revision 3	7 April 2010	Martin Doyle	Gary Graham	
10-8480-R2	Revision 2	1 April 2010	Martin Doyle	Gary Graham	
10-8480-R2	Revision 1	24 March 2010	Martin Doyle	Gary Graham	
10-8480-R2	Revision 0	23 March 2010	Martin Doyle	Gary Graham	



## TABLE OF CONTENTS

1	INTRODUCTION	6
1.1	Report Structure	7
2	TCM OVERVIEW	8
2.1	Approved TCM Operations	8
2.2	Proposed Modification	11
2.3	Summary of Previous Air Quality Impact Assessment	14
2.4	Particulate Sources and Emissions from the TCM	14
2.5	Existing Air Quality Mitigation and Management Measures	15
2.6	Air Quality Complaints	16
3	PROJECT SETTING	17
3.1	Local Topography	17
3.2	Sensitive Receptors	17
3.3	Neighbouring Pollutant Sources	21
3.3.1	Local Sources	21
3.3.2	Regional Sources	21
4	AMBIENT AIR QUALITY CRITERIA	22
4.1	Particulate Matter	22
4.1.1	Goals Applicable to PM <sub>10</sub>	22
4.1.2	Goal Applicable to TSP	22
4.2	Nuisance Impacts of Fugitive Emissions	22
4.3	Air Quality Goals	22
5	PREVAILING DISPERSION METEOROLOGY	24
5.1	Meteorological Data Availability	24
5.2	Meteorological Conditions	26
5.2.1	Wind Regime	26
5.2.2	Temperature	28
5.2.3	Rainfall	29
5.2.4	Relative Humidity	29
5.3	Meteorological Modelling	29
5.3.1	Atmospheric Stability and Mixing Depth	30
6	BASELINE AIR QUALITY	33
6.1	TCM Air Quality Monitoring Network	33
6.2	Particulate Matter	35
6.3	Dust Deposition	39
6.4	Background Air Quality for Assessment Purposes	41
7	AIR QUALITY MODELLING METHODOLOGY	42



## TABLE OF CONTENTS

7.1	Emissions Inventory	42
7.1.1	Wind Erosion Estimation	43
7.2	Atmospheric Dispersion Modelling	43
8	AIR QUALITY MODELLING RESULTS	44
8.1	CALPUFF Modelling Results	44
8.1.1	Dust Deposition	44
8.1.2	TSP	44
8.1.3	Particulate Matter (PM <sub>10</sub> )	45
8.2	Assessment of the Transportation of Product Coal	49
8.3	Air Quality Mitigation, Management and Monitoring Measures	50
9	GREENHOUSE GAS ASSESSMENT	51
9.1	Direct and Indirect Emissions (Emission Scopes)	51
9.2	Greenhouse Gas Calculation Methodology	51
9.3	Greenhouse Gas Calculation Results	54
9.4	Greenhouse Gas Mitigation Measures	56
10	CONCLUSIONS	57
11	REFERENCES	58
12	GLOSSARY AND TERMS	60
	D1 Dust Deposition	1
	D2 TSP	1
	D3 Particulate Matter less than 10 microns in size (PM <sub>10</sub> )	2

## LIST OF TABLES

Table 1	Summary Comparison of the Approved TCM and the Modified TCM	11
Table 2	Particulate Generating Activities Occurring at the TCM	15
Table 3	Surrounding Properties	17
Table 4	DECCW Goals for Allowable Dust Deposition	22
Table 5	TCM Air Quality Goals	23
Table 6	Meteorological Parameters used for this Study	30
Table 7	Description of Atmospheric Stability Classes	30
Table 8	Annual Average Dust Deposition Levels – TCM Network -2006 to 2009	40
Table 9	Background Air Quality Levels used for Assessment Purposes	41
Table 10	Emissions Inventory Summary	42
Table 11	Predicted Incremental and Cumulative Dust Deposition at Nearest Receptors	44
Table 12	Predicted Incremental and Cumulative Annual Average TSP Concentrations at Nearest Receptors	45
Table 13	Predicted Incremental and Cumulative Annual Average PM <sub>10</sub> Concentrations at Nearest Receptors	45
Table 14	Predicted Incremental 24-hour PM <sub>10</sub> Concentrations at Nearest Receptors	46
Table 15	Predicted Cumulative 24-hour PM <sub>10</sub> Concentrations at Nearest Receptors	47
Table 16	Detailed Breakdown of Incremental and Background PM <sub>10</sub> Concentrations on Days of 24-hour PM <sub>10</sub> Exceedances	48
Table 17	Summary of Potential Modified TCM Greenhouse Gas Emissions	52



## TABLE OF CONTENTS

Table 18	Vegetation Clearance Areas and Emission Factor Details	53
Table 19	Scope 1 Greenhouse Gas Emissions from the Modified TCM (2 Mtpa Coal Extraction)	55
Table 20	Scope 3 Greenhouse Gas Emissions from the Modified TCM (2 Mtpa Coal Extraction)	55
Table 21	Scope 1 and 3 Greenhouse Gas Emissions Attributable to the Modified TCM (t CO <sub>2-e</sub> /annum)	55

## LIST OF FIGURES

Figure 1	Regional Location	9
Figure 2	Originally Proposed Project Layout as provided in the 2005 EIS	10
Figure 3	Proposed Modification to the Tarrawonga Coal Mine	13
Figure 4	Receivers Surrounding the Tarrawonga Coal Mine	19
Figure 5	Location of Surrounding Sensitive Receptors (Assessed within Dispersion Modelling Exercise)	20
Figure 6	Location of TCM Meteorological Station	24
Figure 7	15-Minute Annual Wind Rose Comparison – TCM Weather Station – January 2007 to October 2009	26
Figure 8	Annual Wind Rose for TCM Site - 2007	27
Figure 9	Monthly Temperature Variance at the TCM during 2007 and Regional Historic Data	28
Figure 10	Total Monthly Rainfall for the TCM during 2007 and Historic Annual Mean Rainfall from Gunnedah Pool	29
Figure 11	Calculated Annual Stability Class Distributions for the TCM during 2007	31
Figure 12	TAPM-Predicted Diurnal Variation in Mixing Depth for the TCM during 2007	32
Figure 13	TCM Air Quality Monitoring Network	34
Figure 14	24-hour Average PM <sub>10</sub> Concentrations – December 2006 to October 2009 – TCM Air Quality Monitoring Network	35
Figure 15	Paired and Combined 24-hour Average PM <sub>10</sub> Concentrations - December 2006 to October 2009 – “Merriown” and “Templemore” HVAS	36
Figure 16	DECCW Tamworth PM <sub>10</sub> Concentrations with TCM HVAS Data	37
Figure 17	24-hour Average PM <sub>10</sub> Concentration Distribution – Tamworth and TCM HVAS – December 2006 to October 2009	38
Figure 18	DECCW PM <sub>10</sub> (24-Hour Average) Monitoring Results for Tamworth, 2007	38
Figure 19	Annual Average Dust Deposition Levels – TCM Network – 2006 to 2009	40
Figure 20	Frequency Distribution of Incremental 24-hour Average PM <sub>10</sub> Concentrations at Nearest Receptors	46
Figure 21	Frequency Distribution of Cumulative 24-hour Average PM <sub>10</sub> Concentrations at Nearest Receptors	48

## LIST OF ATTACHMENTS

Attachment A	Seasonal Wind Roses –Tarrawonga Coal Mine - 2007
Attachment B	Calculated Seasonal Variation in Atmospheric Stability Class
Attachment C	Emissions Inventory for Site Operations
Attachment D	Dispersion Modelling Results for Mine-Related Receptors
Attachment E	Contour Plots of Incremental Pollutant Increases Predicted from the Modified Tarrawonga Coal Mine



## 1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been commissioned by Tarrawonga Coal Pty Ltd (TCPL) to undertake an Air Quality Impact Assessment (AQIA) for a proposed modification to the approved Tarrawonga Coal Mine (TCM) (herein referred to as the Modification) in the Gunnedah Basin of New South Wales (NSW). Changes implemented to the approved TCM by the Modification would result in the modified TCM. TCPL is a joint venture between Whitehaven Coal Mining Pty Ltd (Whitehaven) (70%) and Idemitsu Boggabri Coal Limited (IBC) (30%).

This AQIA has been prepared in accordance with the NSW Department of Environment, Climate Change and Water's (DECCW) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (NSW Department of Environment and Conservation [DEC], 2005) (hereafter the Approved Methods). The Approved Methods outline the requirements for conducting an AQIA, as follows:

- Description of local topographic features and sensitive receptor locations.
- Establishment of air quality assessment criteria.
- Analysis of climate and dispersion meteorology for the region.
- Description of the existing air quality environment.
- Compilation of a comprehensive emissions inventory for proposed operations.
- Completion of atmospheric dispersion modelling and analysis of results.

This report also includes a quantitative Greenhouse Gas Assessment which examines the potential scope 1, 2 and 3 greenhouse gas emissions of the modified TCM.

Additional policies, guidelines and plans referenced within this assessment are the *Protection of the Environment Operations (Clean Air) Regulation, 2002*, the "*Approved Methods for the Sampling and Analysis of Air Pollutants in NSW*" (DEC, 2007), and the "*National Greenhouse Accounts (NGA) Factors*" (hereafter the NGA Factors) (Commonwealth Department of Climate Change [DCC], 2009).



## 1.1 Report Structure

This AQIA is structured as follows:

<b>Section 1</b>	Introduction and report structure.
<b>Section 2</b>	A description of the existing and proposed modified TCM including: <ul style="list-style-type: none"><li>• overview of approved TCM operations;</li><li>• a description of the Modification;</li><li>• particulate sources and emissions;</li><li>• existing mitigation and management measures; and</li><li>• complaints history.</li></ul>
<b>Section 3</b>	Description of the study area including: <ul style="list-style-type: none"><li>• local topography;</li><li>• receptor details;</li><li>• neighbouring emission sources; and</li><li>• regional emission sources.</li></ul>
<b>Section 4</b>	Ambient air quality criteria including: <ul style="list-style-type: none"><li>• goals applicable to particulate matter less than 10 microns in size (PM<sub>10</sub>);</li><li>• goal applicable to total suspended particulates (TSP);</li><li>• nuisance impacts of fugitive emissions; and</li><li>• air quality goals.</li></ul>
<b>Section 5</b>	A description of the prevailing dispersion meteorology including: <ul style="list-style-type: none"><li>• meteorological conditions; and</li><li>• meteorological modelling.</li></ul>
<b>Section 6</b>	A description of the baseline air quality in the region.
<b>Section 7</b>	A description of the air quality modelling methodology including: <ul style="list-style-type: none"><li>• emissions parameters and calculations.</li></ul>
<b>Section 8</b>	Dispersion modelling results.
<b>Section 9</b>	Greenhouse gas assessment.
<b>Section 10</b>	Conclusions.
<b>Section 11</b>	Lists the reports and other material cited in this document.
<b>Section 12</b>	Provides a glossary of terms used in this document.



## 2 TCM OVERVIEW

### 2.1 Approved TCM Operations

The TCM is located approximately 15 kilometres (km) north-east of Boggabri, 42 km north-northwest of Gunnedah in the Gunnedah Basin of NSW. **Figure 1** illustrates the local setting of the TCM.

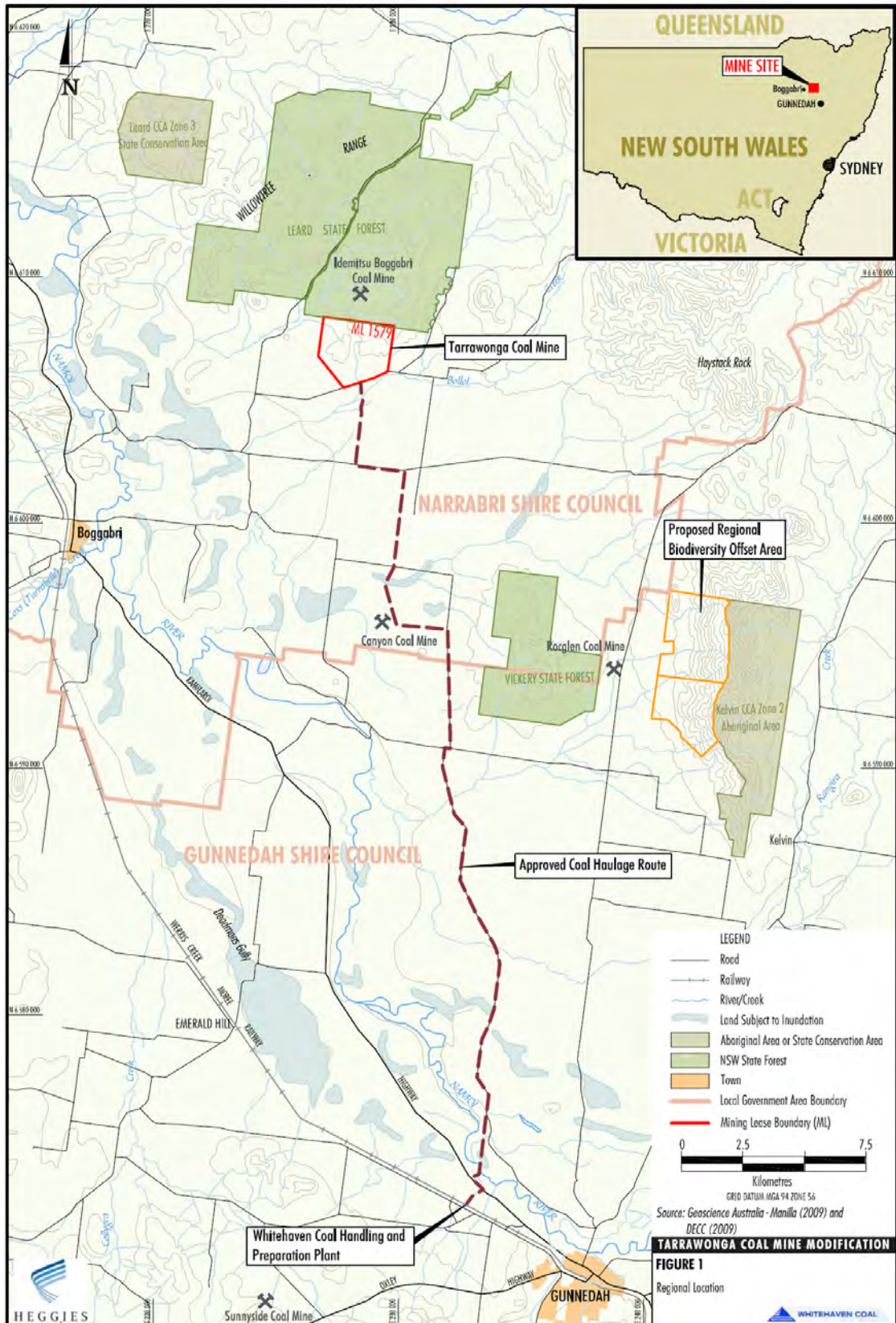
The approved TCM involves construction and operation of an open cut coal mine over an 8 to 10 year period to extract approximately 12.4 million tonnes (Mt) of coal at a maximum rate of 2 Mt a year. Waste rock generated from the open cut is placed in two adjoining out-of-pit emplacements, and as infill in the mine void. The coal is crushed and screened on-site to a nominal 50 to 150 millimetre (mm) size, and then transported via road to Whitehaven's Coal Handling and Preparation Plant (CHPP), which is located approximately 35 km to the south of the approved TCM on the outskirts of Gunnedah (**Figure 1**). At the Whitehaven CHPP the coal is further crushed, screened and washed before being loaded on to trains for dispatch and sale to customers as a low ash, thermal and/or semi-soft coking coal. **Figure 2** shows the proposed layout as assessed in the *East Boggabri Joint Venture Environmental Impact Statement (2005 EIS)* (TCPL, 2005a).

The TCM was approved via Development Consent (DA-88-4-2005) by the NSW Minister for Planning in November 2005 under Part 4 of the *Environmental Planning and Assessment Act, 1979* (EP&A Act). The potential environmental impacts of the TCM were assessed in the 2005 EIS (TCPL, 2005a). Operations at the TCM are approved for the following hours of operation:

- Open cut mining activities occur between the hours of 7.00 am and midnight Monday to Friday, between midnight and 3.30 am Tuesday to Saturday, and 7.00 am to 6.00 pm Saturdays.
- Coal processing activities are permitted between 7.00 am and 10.00 pm Monday to Friday, and 7.00 am to 6.00 pm Saturdays, excluding public holidays.
- Coal transportation from the mine site is permitted between the hours of 7.00 am to 9.15 pm Monday to Friday and 7.00 am to 5.15 pm on Saturdays. These times ensure that all coal trucks are off the public road network by 10.00 pm Monday to Friday and 6.00 pm Saturdays.
- General maintenance activities are permitted any time Monday to Sunday.



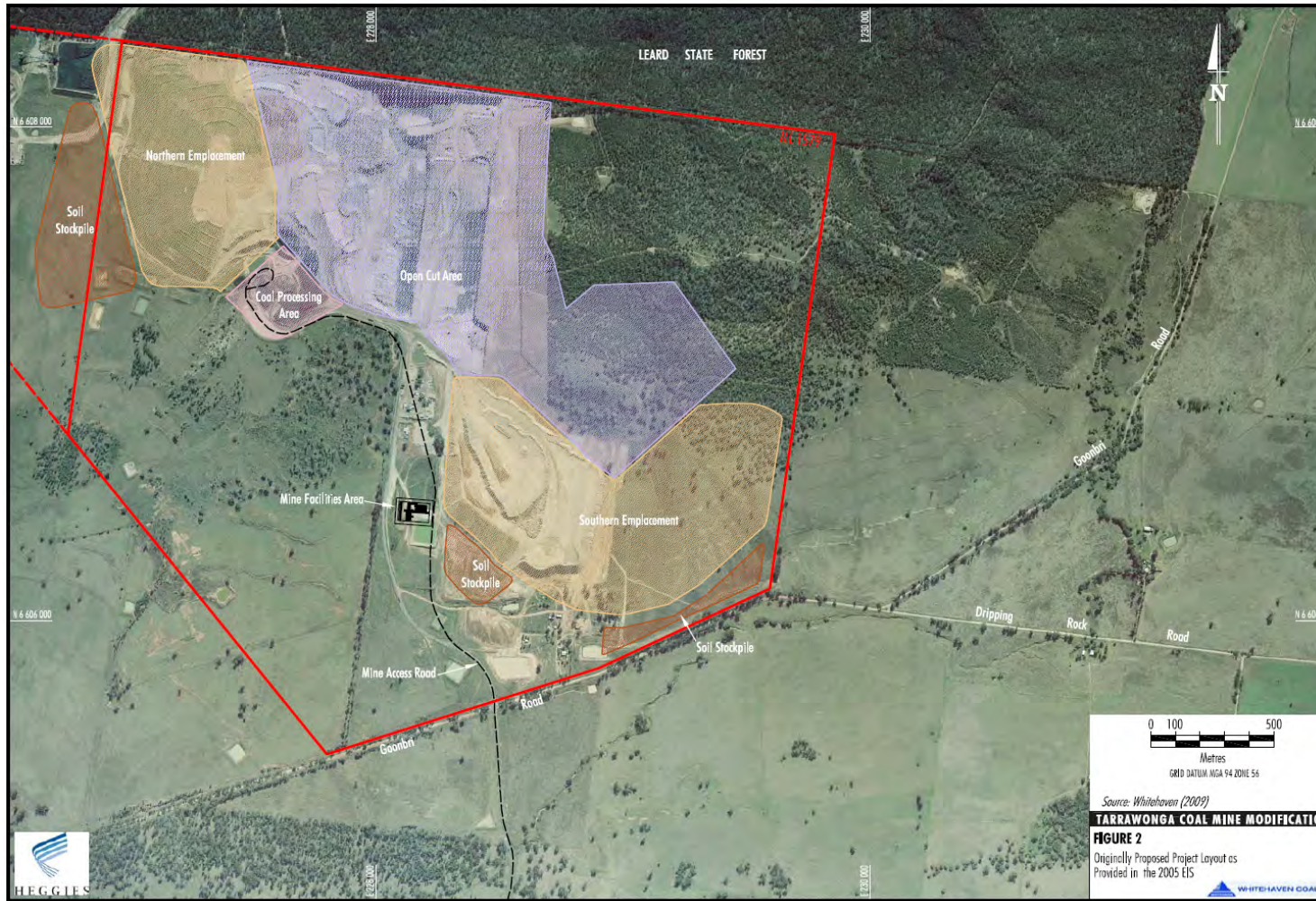
Figure 1 Regional Location



Source: TCPL (2010)



Figure 2 Originally Proposed Project Layout as provided in the 2005 EIS



Source: TCPL (2010)



## 2.2 Proposed Modification

The key aspects of the Modification include:

- extension of the open cut to the east, but no change to the depth of the open cut;
- no change to the life of mine;
- increased total coal production from approximately 12.4 Mt to approximately 16.4 Mt;
- no change to maximum annual coal production rate (i.e. average of 2 Mt over the life of the mine);
- increased total waste rock production from approximately 88.5 million bank cubic metres (Mbcm) to approximately 123.3 Mbcm;
- increased heights and areas of waste rock emplacements;
- increased topsoil and subsoil stockpiles areas;
- addition of two small hardstand/infrastructure areas;
- construction and use of additional water storages;
- increased hours of operation (i.e. processing hours to be the same as open cut mining hours);
- no change to employment; and
- no change to transport arrangements (including transport route and trucking hours).

**Table 1** provides a summary comparison of the approved TCM and the modified TCM.

**Table 1 Summary Comparison of the Approved TCM and the Modified TCM**

Development Component	Summary of the Existing TCM	Summary of the Modified TCM
Mine Life	8 to 10 years.	No change.
Mining Method	Conventional open cut involving sequential removal of topsoil, waste rock, coal extraction, progressive backfilling and rehabilitation.	No change.
Annual Coal Production Rate	Maximum 2 million tonnes per annum (Mtpa).	No change.
Open Cut Operating Hours	7.00 am to 12.00 am Monday to Friday, 12.00 am to 3.30 am Tuesday to Saturday, and 7.00 am to 6.00 pm Saturdays.	No change.
Life of Mine Coal Quantity	Approximately 12.4 Mt.	Approximately 16.4 Mt.
Open Cut Disturbance Area	Approximately 160 hectares (ha).	Approximately 198 ha.
Life of Mine Waste Rock Quantity	Approximately 88.5 Mbcm.	Approximately 123.3 Mbcm.
Out-of-pit Waste Rock Storage Areas	Northern Emplacement: maximum height of 330 metres (m) Australian Height Datum (AHD). Southern Emplacement: maximum height of 340 m AHD.	Maximum height increase to 370 m AHD. No change.
Blasting Hours	9:00am to 5:00pm, Monday to Friday.	No change.

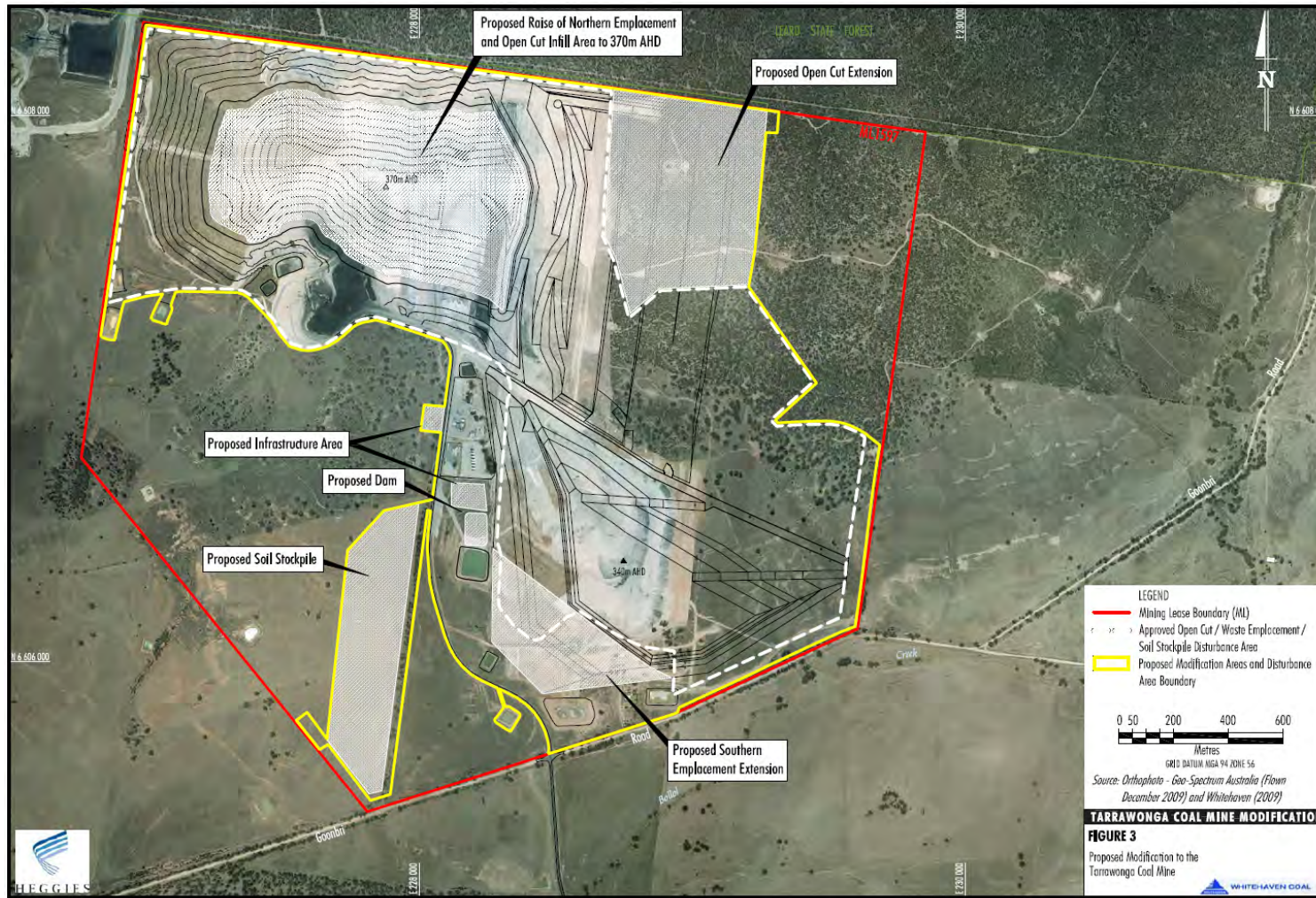


<b>Development Component</b>	<b>Summary of the Existing TCM</b>	<b>Summary of the Modified TCM</b>
Run-of-Mine (ROM) Coal Stockpile	Approximately 150,000 tonnes (t).	No change.
On-site Coal Crushing and Screening	Loaded onto conveyor via hopper and crushed to 150 mm by the primary crusher. Coal requiring further beneficiation sent to product bin and the remainder crushed to 50 mm in secondary crusher before truck loading.	No change.
On-site Coal Crushing and Screening Operating Hours	Coal processing permitted 7.00 am to 10.00 pm Monday to Friday, and 7.00 am to 6.00 pm Saturdays, excluding public holidays.	Changed to be the same as the open cut mining hours.
Product Coal Stockpile	Product coal stockpile area with a capacity of 35,000 to 50,000 t.	No change.
Water Supply	Approximately 118 megalitres (ML) per annum used for dust suppression at mine site and coal crushing and screening facility. Approximately 45 ML obtained from surface inflows to open cut area and 73 ML from surface inflows to sediment basins and storage dams.	No change.
Electricity Supply	On-site diesel-powered generators, consisting of a single 600 kilovolt ampere (kVA) generator, one 100 kVA generator, and a system of integrated 7.5 kVA generators for lighting movable light plants.	No change.
Road Transport Requirements	Construction and use of internal haul roads and main Mine Access road.  Use of public roads for transport of coal by truck to the Whitehaven CHPP at Gunnedah.  Coal transportation permitted between 7.00 am to 9.15 pm Monday to Friday, and 7.00 am to 5.15 pm Saturdays.	No change.
Mine infrastructure and service facilities	Crib hut, offices, hardstand, first aid building, maintenance workshop, toilets, wash bay, and light vehicle parking area.	Additional 0.6 ha and 0.7 ha areas to the west and south-east of the existing administration building  Additional 21.2 ha soil stockpile.
Workforce	67 full-time on-site personnel plus additional contract personnel employed on an as-needs-basis.	No change.

The modified TCM layout is presented on **Figure 3**.



Figure 3 Proposed Modification to the Tarrawonga Coal Mine



Source: TCPL (2010)



## 2.3 Summary of Previous Air Quality Impact Assessment

As part of the 2005 EIS compiled for the TCM Development Application (TCPL, 2005a), an AQIA was conducted by Heggies, then Richard Heggies Associates Pty Ltd, in May 2005.

Emissions from the following operational activities for each project stage were calculated and input into the dispersion model Ausplume:

- Excavation activities (excavators, dozers, scrapers and graders).
- Blasting activities.
- Placement of materials within the site (i.e. topsoil, subsoil, waste rock, mined coal).
- Coal processing area activities (front-end loader, primary crusher, secondary crusher, handling/transfer/conveying, product bin loading to trucks).
- Wind erosion of open cut area, soil stockpiles (topsoil and subsoil), out-of-pit waste rock emplacement areas (northern and southern), in-pit waste rock emplacement and coal stockpiles.
- General movement of heavy vehicles on unsealed roads within the site (haul truck wheel dust).

Pollutants that were assessed through the dispersion modelling process included emissions of particulate matter ( $PM_{10}$ <sup>1</sup>, TSP<sup>2</sup> and deposited dust). Cumulative impacts associated with emissions from the nearby Boggabri Coal Project were addressed through the coarse inclusion of these operations within the TCM model. Existing air quality conditions were assessed through the analysis and application of air quality monitoring data acquired at the nearby Whitehaven (now Canyon) Coal Mine (for dust deposition) and DECCW recorded data from Tamworth (for  $PM_{10}$ ).

The results of the modelling assessment indicated that the potential for exceedance of the 24-hour average criterion for  $PM_{10}$  (50 micrograms per cubic metre [ $\mu\text{g}/\text{m}^3$ ]) existed at “Bollol Creek Station” residence during Year 8 operations when cumulative impacts (TCM plus background plus Boggabri Coal Project) were considered. However, the conservative nature of the dispersion modelling indicated that only during the coincidence of absolute maximum operations at both the TCM and Boggabri Coal Project would such an exceedance occur. Consequently, the likelihood of adverse impacts upon the surrounding region was considered to be low. It is noted that the “Bollol Creek Station” is now mine-related.

Annual greenhouse gas emissions from the TCM were also calculated during the original AQIA conducted for the approved TCM. Total annual emissions were calculated to be approximately 154,000 t of carbon dioxide equivalent ( $\text{CO}_2\text{-e}$ ), which stood as a potential increase of 0.039% on Australia’s 1990 greenhouse gas emissions<sup>3</sup>.

## 2.4 Particulate Sources and Emissions from the TCM

Atmospheric pollutants generated by activities occurring at the TCM include fugitive emissions of particulates ( $PM_{10}$ , TSP and deposited dust) in addition to those generated through the combustion of fuel in vehicles (nitrogen oxide, sulphur dioxide, volatile organic compounds, carbon monoxide and  $PM_{10}$ ).

---

<sup>1</sup>  $PM_{10}$  is used to describe particulate matter with an aerodynamic diameter of 10 microns ( $\mu\text{m}$ ) or less.

<sup>2</sup> TSP (Total Suspended Particulate) describes particulate matter which is less than 50 microns in diameter.

<sup>3</sup> It is noted that the published specialist consultant study for air quality contained an erroneous annual  $\text{CO}_2\text{-e}$  emission of 30,000 tonnes. Subsequent analysis has shown this figure to be 154,322 t of  $\text{CO}_2\text{-e}$ . This typographical error does not affect the calculated potential increase on Australia’s 1990 emissions of 0.039%.



It is considered that background concentrations of combustion-related pollutants in the local area are low, due to the absence of significant combustion sources within the immediate region. Additionally, the emissions of these pollutants from mine sources would be relatively minor (taking into account the plant and equipment used at the TCM and the low sulphur content of diesel used in Australia), with resulting concentrations at the nearest receptors negligible. Consequently, the focus of this assessment will be fugitive emissions of dust and particulate.

**Table 2** presents a summary of particulate generating activities at the TCM.

**Table 2 Particulate Generating Activities Occurring at the TCM**

<b>Activity</b>	<b>Particulate Emission Source</b>
Soil Stripping	Soil removal
	Transport of soil to stockpiles by scraper
	Dumping of soil to stockpiles
Blasting	Drilling of blast holes
	Blasting events
Waste Rock Management	Excavation and placement of waste rock in haul trucks via excavator
	Transport of waste rock to the waste rock emplacement by haul truck
	Dumping of waste rock on the waste rock emplacement
	Waste rock management by dozer
Coal Handling	Coal ripping by dozer
	ROM coal to haul truck by excavator
	Transport to the ROM coal stockpile or coal loader
	Dumping of coal to the ROM coal stockpile/coal hopper
	Rehandling of coal from the ROM coal stockpile to loader by front-end loader
	Crusher on ROM coal
Haul Route Management	Grader on haul routes
Stockpiles/Open Areas	Wind erosion of stockpiles and open areas

## 2.5 Existing Air Quality Mitigation and Management Measures

Air quality management at the TCM is described in the Air Quality Monitoring Program (TCM, 2005b). Current air quality mitigation and management measures employed at the TCM are provided below (TCPL, 2009a):

- use of trunks, branches and litter from clearing for mine site rehabilitation. No materials are burnt;
- limiting groundcover removal in advance of mining consistent with operational requirements. Under normal operational circumstances, a maximum of 100 m is prepared in advance of mining;
- groundcover removal as part of the topsoil removal activities, rather than prior to topsoil removal;
- where practicable, limiting soil stripping activities to periods when there is sufficient soil moisture to prevent significant dust lift-off and avoiding periods of high winds;
- soil stripping using open bowl scrapers, thereby eliminating the dust generated from elevated scrapers;



- application of water to exposed surfaces, with emphasis on those areas subject to frequent vehicle/equipment movements which may cause dust generation and subsequent dispersion;
- use of water injection on the drilling rig;
- use of imported aggregates for blast hole stemming;
- water application at the crusher and on the conveyor discharge point to the coal bin;
- cessation of coal processing activities during periods of concurrent high winds and temperatures which cause coal dust dispersal, independent of water applications. (TCPL noted that such conditions occurred during 2008 to 2009);
- ROM coal pad watering;
- progressive shaping and rehabilitation of areas once they are no longer required for mining purposes;
- speed limit restrictions on all vehicles and equipment on the mine site;
- equipment exhaust positioning to avoid exhausts impinging on the ground and causing dust lift-off; and
- use of covers on all product coal trucks. Toll is the principal contractor engaged in the haulage of coal from the TCM to the Whitehaven CHPP. All Toll vehicles and those operated by its contractors are fitted with roll-over tarpaulins.

## 2.6 Air Quality Complaints

Examination of the Annual Environmental Management Report (AEMR) for 2006/2007, 2007/2008 and 2008/2009 (TCPL, 2007, 2008, 2009b) indicates that six complaints pertaining to air quality issues have been received and were recorded in the complaints register between May 2006 and April 2009. It is noted that of the six complaints received between May 2006 and April 2009, five were received from the “Bollol Creek” residence, which was the location of the highest predicted dust levels in the 2005 EIS AQIA (**Section 2.3**). “Bollol Creek Station” has subsequently become a mine-related residence. Therefore, the AQIA criteria have not been applied in relation to “Bollol Creek Station” in this assessment.

No complaints regarding air quality were received by TCPL during the 2008/2009 reporting period.



### 3 PROJECT SETTING

#### 3.1 Local Topography

The land to the south of the TCM is predominately flat, ranging between 240 m AHD and 280 m AHD. To the north of the TCM, the topography is more undulating, with a number of scattered small peaks and ridgelines associated with Leard State Forest ranging approximately between 280 m AHD and 540 m AHD.

The TCM site has an altitudinal range of approximately 90 m, increasing gradually from approximately 280 m AHD at the southwestern boundary to approximately 370 m AHD at the north-eastern boundary, a distance of approximately 3 km.

The topography of the local region surrounding the TCM is presented on **Figure 4** and **Figure 5**.

#### 3.2 Sensitive Receptors

A number of privately-owned and mine-related dwellings are situated in the area surrounding the TCM. Receptors surrounding the TCM are shown on **Figure 4** and **Figure 5**. Those properties located in closest proximity to the TCM which have been taken forward within the dispersion modelling exercise are shown on **Figure 5**. Details relating to each property's location in relation to the TCM, altitude and mine-related status are provided in **Table 3**.

It is considered that the properties selected for quantitative assessment of air quality impacts from the modified TCM will adequately reflect the expected air quality impacts across the local area and will be representative of impacts expected at all other property locations (**Figure 4**).

**Table 3 Surrounding Properties**

Receptor ID	Receptor Name	Location (m, MGA56)		Distance (km) / Direction from Mining Lease (ML) Boundary	Elevation (m, AHD)
		Easting	Northing		
<b>Privately-Owned Properties</b>					
R1	<i>Tarrowonga</i>	226669	6603865	2.0/SSW	260
R2	<i>Jeralong</i>	224395	6604430	3.3/SW	260
R3	<i>Green Hills</i>	232101	6609253	2.6/NE	303
R4	<i>Pine Grove</i>	230424	6601952	4.2/SSE	272
R5	<i>Ambardo</i>	229134	6603150	2.5/S	267
R6	<i>Kyalla</i>	229066	6602024	3.7/S	265
<b>Mine-Related Properties<sup>1</sup></b>					
P1	<i>Merriown</i>	224467	6607855	2.4/W	267
P2	<i>Nagero</i>	225989	6607844	0.9/W	270
P3	<i>Thuin</i>	228747	6605891	Inside ML	275
P4	<i>Bollol Creek Station</i>	231041	6606127	1.4/E	282
P5	<i>Templemore</i>	230897	6605835	1.3/ESE	278
P6	<i>'Unnamed'</i>	223629	6606602	3.0/E	254
P7	<i>Blair Athol School House</i>	231877	6605687	2.3/ESE	285

<sup>1</sup>: Includes properties owned by one of TCPL's joint venture parent companies (IBC).

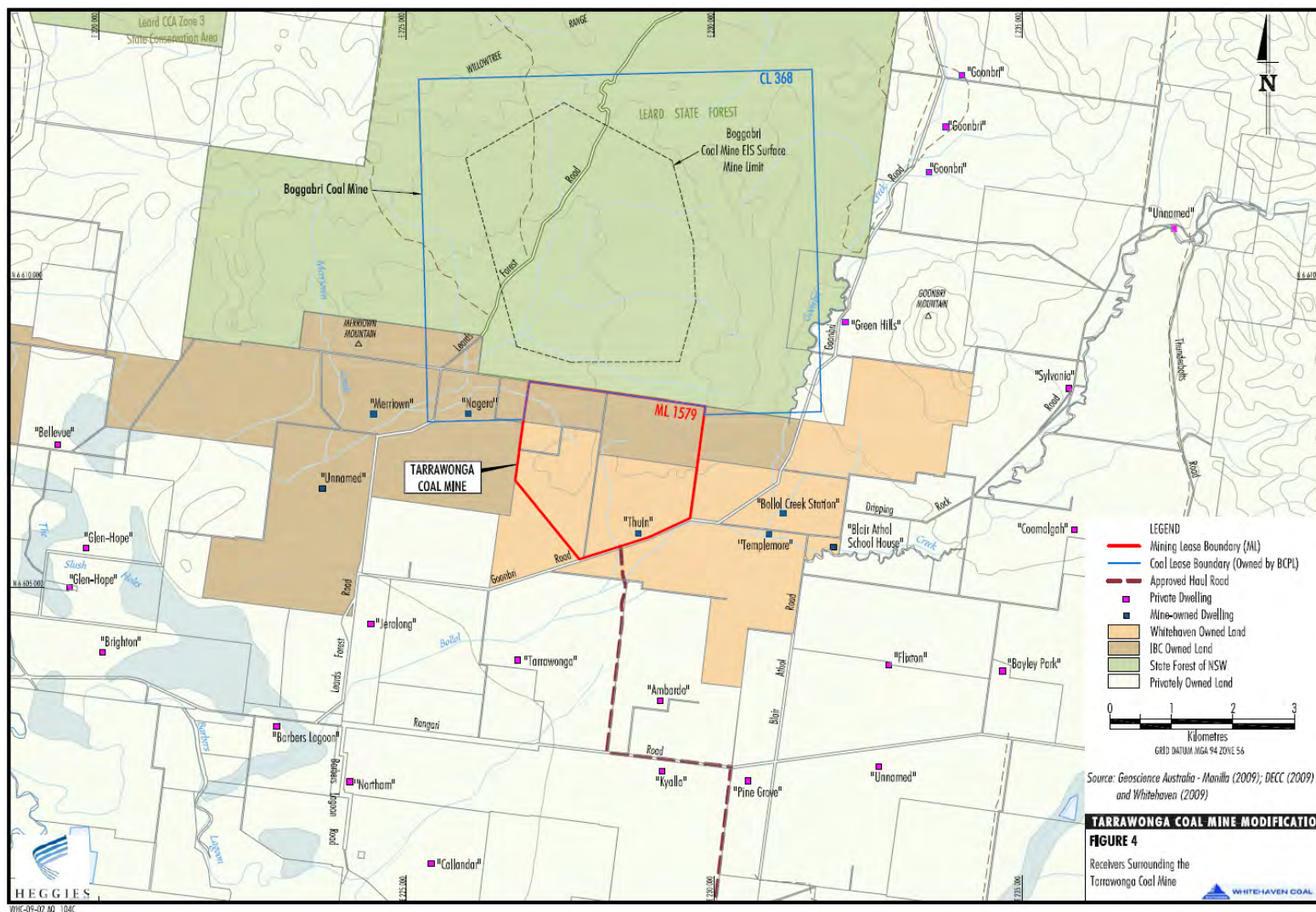
MGA = Map Grid of Australia



It can be seen from **Table 3** that all surrounding receptors are at an altitude at or below that of the TCM (280 m AHD to 370 m AHD). The privately-owned receptors presented in **Table 3** will be used as assessment locations within the dispersion modelling study for the TCM to determine compliance with air quality regulations.



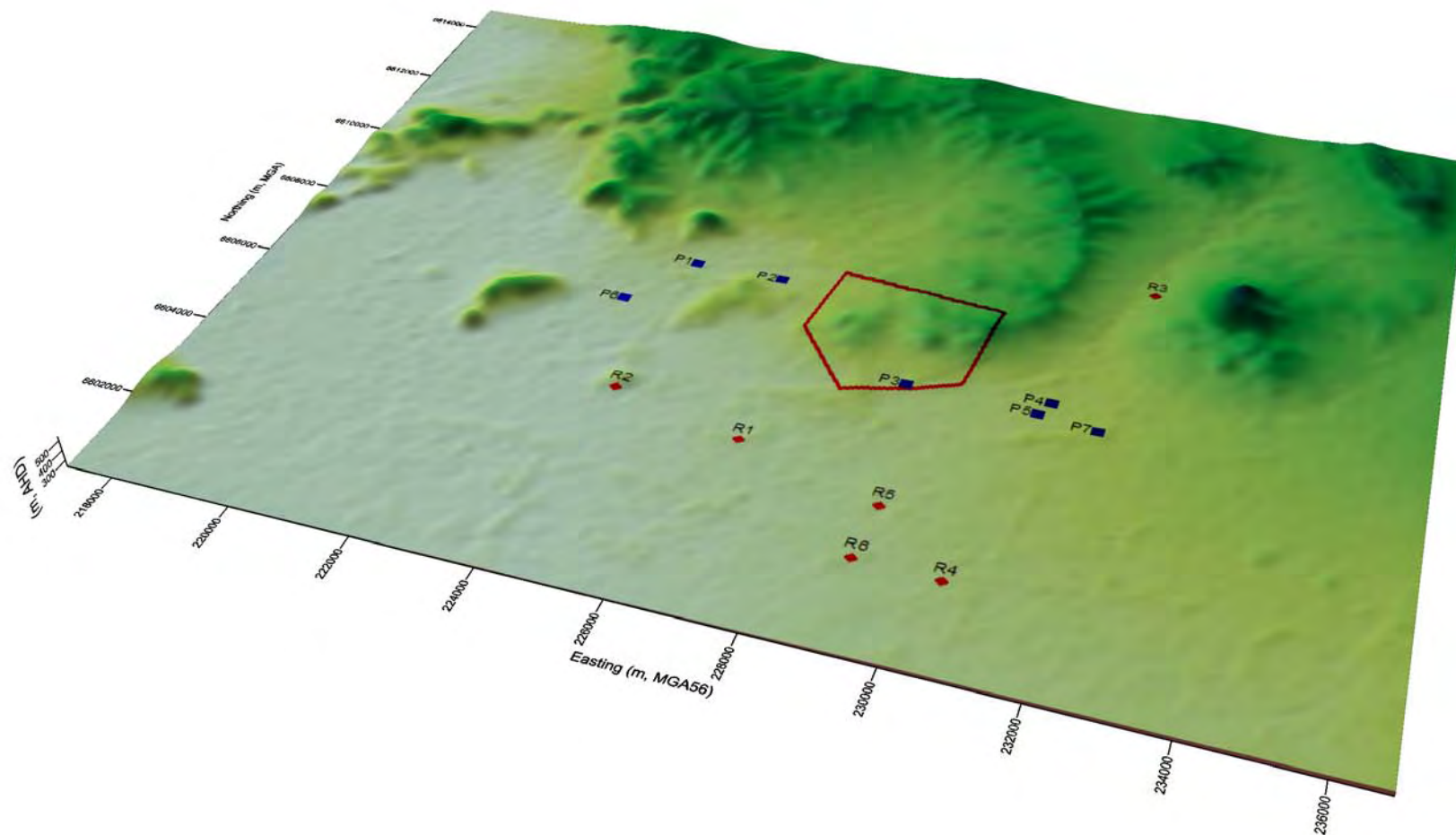
Figure 4 Receivers Surrounding the Tarrawonga Coal Mine



Source: TCPL (2010)



Figure 5 Location of Surrounding Sensitive Receptors (Assessed within Dispersion Modelling Exercise)



NOTE: Vertical Exaggeration of 2 Applied



### 3.3 Neighbouring Pollutant Sources

#### 3.3.1 Local Sources

As stated in **Section 2.3**, the Boggabri Coal Project (owned by IBC) is situated in close proximity to the north of the TCM site, with the associated ROM pad located adjacent to the ML western boundary. Given the proximity of the Boggabri Coal Project to the TCM, it is likely that cumulative impacts associated with emissions from both operations would be experienced in the local surrounding region and reflected in collected monitoring data (see **Section 6**).

Further afield within the Gunnedah Basin, there are a number of additional coal mining-related operations. Of note are the following Whitehaven affiliated operations:

- Narrabri Underground Coal Project – located approximately 26 km to the north-west;
- Canyon (formerly Whitehaven) Coal Mine – located approximately 10 km to the south;
- Rocglen (formerly Belmont) Coal Mine – located approximately 20 km to the south-east;
- Sunnyside Coal Mine – located approximately 40 km to the south; and
- Whitehaven CHPP – located approximately 35 km to the south.

It is considered that the surrounding coal mining operations, with the exception of the Boggabri Coal Project, do not have the potential to cause cumulative impacts upon receptors surrounding the TCM due to the large distances between the TCM and these other sources.

#### 3.3.2 Regional Sources

Concentrations of pollutants can be elevated under certain conditions, such as bushfires or dust storms. Although these events are relatively unusual, they do occur and can result in elevated concentrations of particulates over several days in some instances. These events can be identified through the use of a network of air quality monitors as simultaneous elevations of particulate will be noted across an area (refer **Section 6.1**).



## 4 AMBIENT AIR QUALITY CRITERIA

### 4.1 Particulate Matter

#### 4.1.1 Goals Applicable to PM<sub>10</sub>

PM<sub>10</sub> is considered to be an important pollutant in terms of potential impact due to its ability to penetrate into the respiratory system.

The DECCW PM<sub>10</sub> assessment goals as expressed in the Approved Methods are:

- a 24-hour maximum of 50 µg/m<sup>3</sup>;
- a 24-hour maximum of 150 µg/m<sup>3</sup> (project and other sources); and
- an annual average of 30 µg/m<sup>3</sup> (project and other sources).

The 24-hour PM<sub>10</sub> reporting standard of 50 µg/m<sup>3</sup> is numerically identical to the “*Ambient Air Quality National Environment Protection Measure*” (NEPM) (National Environmental Protection Council, 1998) reporting standard except that the NEPM reporting standard allows for five exceedances per year.

In general accordance with the TCM Development Consent (DA 88-4-2005), the 24-hour PM<sub>10</sub> criteria are taken to be 50 µg/m<sup>3</sup> for the TCM alone (for determining the requirement for acquisition of properties) and also for the TCM and other sources for the purposes of best-practice air quality management.

#### 4.1.2 Goal Applicable to TSP

The annual goal for TSP is given as 90 µg/m<sup>3</sup> (TCM and other sources), as recommended by the National Health and Medical Research Council (NHMRC) at their 92<sup>nd</sup> session in October 1981. This goal has also been adopted in the Approved Methods.

### 4.2 Nuisance Impacts of Fugitive Emissions

The preceding sections are concerned 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 4 grams per square metre per month (g/m<sup>2</sup>/month).

**Table 4** presents the DECCW impact assessment goals for dust deposition, showing the allowable increase in dust deposition level over the ambient (background) level which would be acceptable so that dust nuisance could be avoided.

**Table 4 DECCW Goals for Allowable Dust Deposition**

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m <sup>2</sup> /month	4 g/m <sup>2</sup> /month

Source: DEC (2005).

### 4.3 Air Quality Goals

In view of the foregoing, the air quality goals to be adopted for this assessment, which conform to current DECCW and federal air quality criteria, are summarised in **Table 5**.



**Table 5 TCM Air Quality Goals**

<b>Pollutant</b>	<b>Averaging Time</b>	<b>Goal</b>
TSP	Annual	90 µg/m <sup>3</sup> (TCM and other sources)
	24-hours	50 µg/m <sup>3</sup> (TCM)
PM <sub>10</sub>		50 µg/m <sup>3</sup> (TCM and other sources – for determining best practice air quality management)
		150 µg/m <sup>3</sup> (TCM and other sources)
	Annual	30 µg/m <sup>3</sup> (TCM and other sources)
Dust Deposition	Annual	Maximum incremental (TCM only) increase of 2 g/m <sup>2</sup> /month Maximum Total of 4 g/m <sup>2</sup> /month (TCM and other sources)



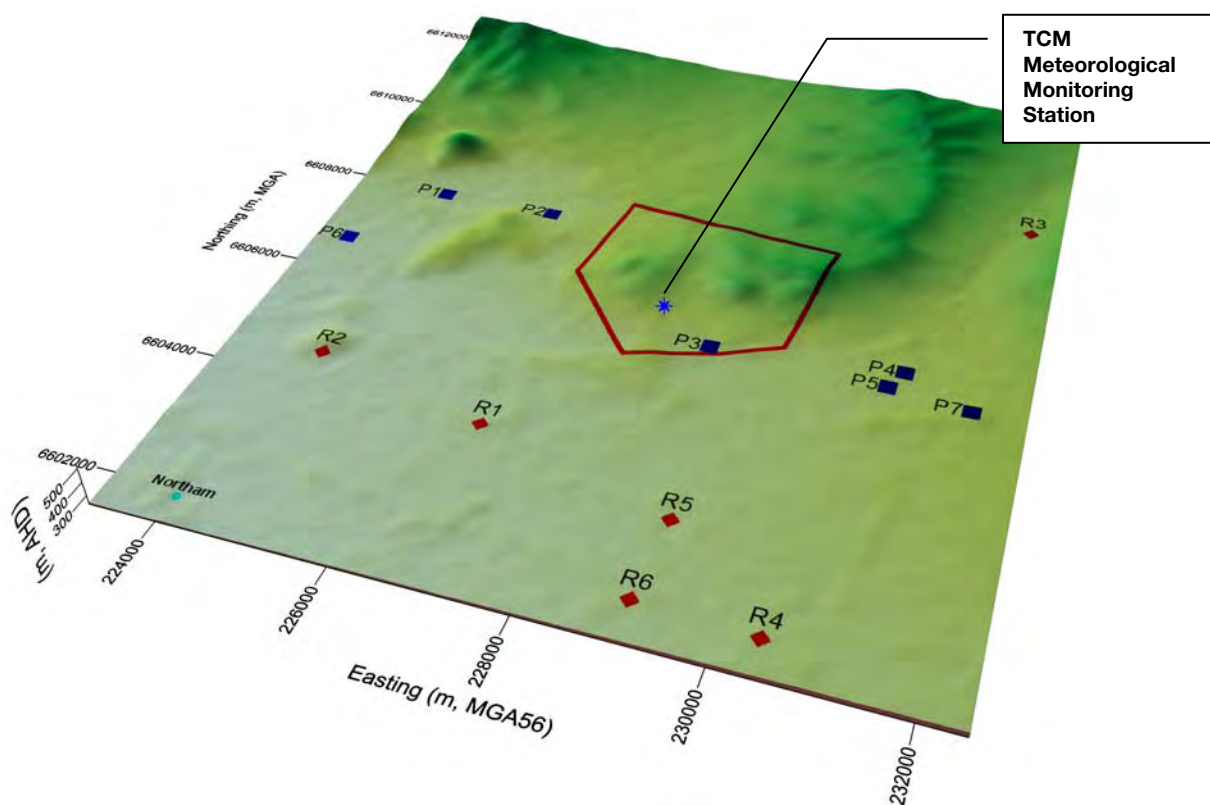
## 5 PREVAILING DISPERSION METEOROLOGY

### 5.1 Meteorological Data Availability

To adequately characterise the dispersion meteorology of the TCM region, monitoring data from the on-site meteorological station located at the mine site office (refer **Figure 6**) was sourced from the TCPL (TCPL, 2009a). The data from this monitoring station was used to characterise the local meteorology and provide the input datasets for the meteorological modelling undertaken. The following parameters, recorded at 15-minute intervals, were available from this station.

- wind speed;
- wind direction;
- temperature;
- relative humidity;
- dew point temperature;
- solar radiation; and
- precipitation.

**Figure 6** Location of TCM Meteorological Station



Note: Also shown are properties within the modelling domain at which no single point predictions have been made. These are presented for information only

15-minute data recorded between December 2006 and October 2009 was provided by TCPL. The wind speed and direction profile of the calendar years of 2007, 2008 and partial (January to October) 2009 is shown on **Figure 7**.



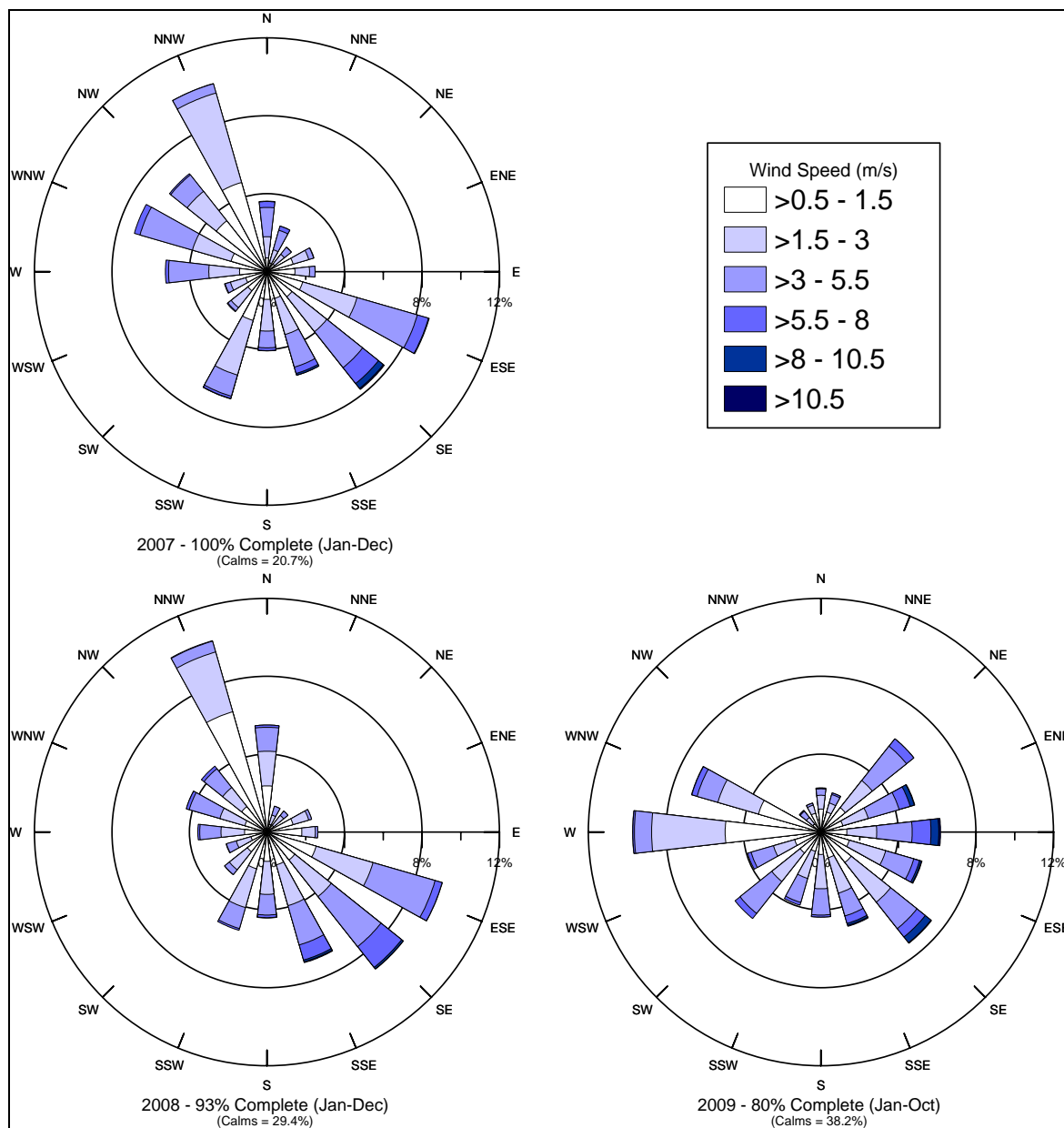
Section 4.1 of the Approved Methods (DEC, 2005) states that for Level 2 air quality impact assessments (of which this assessment is), a site-specific meteorological dataset with at least 90% complete hourly observational data for a one year period must be used (i.e. for 8760 hours, maximum of 876 missing).

As shown on **Figure 7**, the 2007 calendar year represented the most complete dataset recorded by the TCM weather station, with a total percentage complete data of approximately 100% (1-hour missing for the entire year). 2008 showed a similar wind speed and direction pattern to 2007 however, the percentage completeness is slightly lower at approximately 93%. The 2009 dataset was not a complete year and exhibited a higher frequency of westerly and easterly flow than the preceding two years.

The 15-minute recorded data during 2007 has been used to develop an hourly-varying meteorological dataset for use in the dispersion modelling process, as per the requirements of the Approved Methods. Where insufficient data is available for certain parameters, meteorological modelling has been conducted.



Figure 7 15-Minute Annual Wind Rose Comparison - TCM Weather Station - January 2007 to October 2009



## 5.2 Meteorological Conditions

### 5.2.1 Wind Regime

A summary of the annual wind behaviour experienced at the TCM site during 2007 based on hourly-varying measurements is presented as a wind rose on **Figure 8**. This wind rose displays occurrences of winds from all quadrants.

Hourly-average wind speed and direction were derived from the provided 15-minute average dataset using the United States Environmental Protection Agency (US EPA) (2000) approach for calculating scalar wind speed and direction.

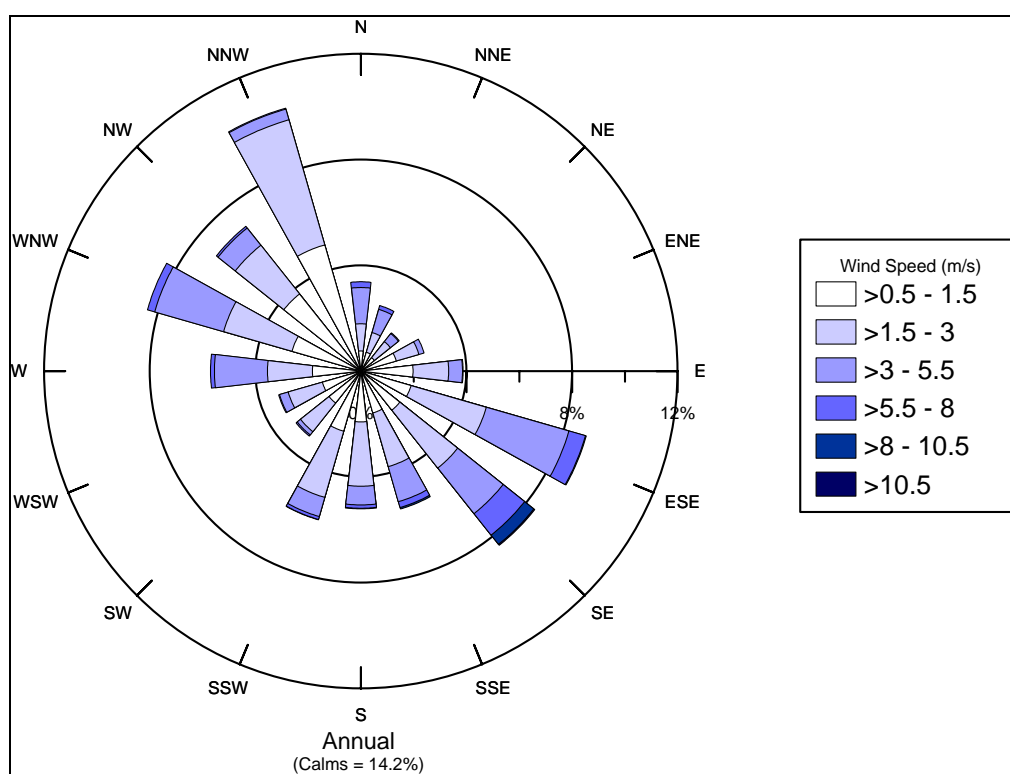


**Figure 8** indicates that winds experienced at the TCM are predominately light to moderate (between 1.5 metres per second (m/s) and 8 m/s) from the north-western quadrant (approximately 30% combined) and light to fresh (between 1.5 m/s and 10.5 m/s) from the south-eastern quadrant (approximately 30% combined). Calm wind conditions (wind speed less than 0.5 m/s) were observed to occur 14.2% of the time throughout 2007. It is noted that this percentage is lower than the quoted 20.7% presented on **Figure 8** for the 2007 15-minute average wind rose. This difference is attributable to the calculation process of hourly-average wind speed.

The seasonal variation in predicted wind behaviour at the TCM is presented in **Attachment A**. The seasonal wind roses indicate that:

- In spring, light to moderate from the north-western quadrant (approximately 36% combined) and light to fresh from the south-eastern quadrant (approximately 28% combined).
- In summer, light to fresh winds are experienced predominantly from the east to southeast (approximately 30% combined).
- In autumn, light to fresh winds are experienced predominantly from the east-southeast to south-southwest (approximately 40% combined).
- In winter, light to moderate winds are experienced predominantly from the west to north-northwest (approximately 46% combined).

**Figure 8 Annual Wind Rose for TCM Site - 2007**



Note: Difference in % calms with **Figure 7** attributable to the calculation process of hourly-average wind speed as discussed in text of **Section 5.2.1**.



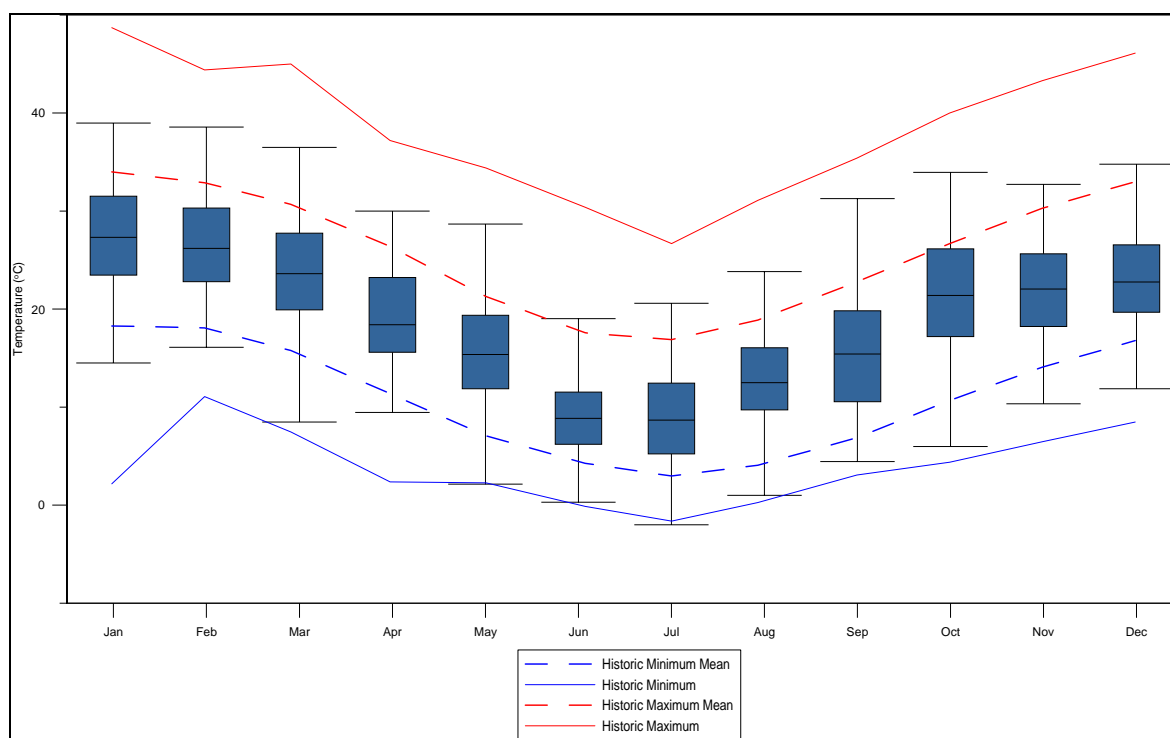
## 5.2.2 Temperature

Recorded monthly temperature variance at the TCM during 2007 is illustrated on **Figure 9**. Also overlaid on **Figure 9** are the historic maximum/minimum and mean maximum/minimum temperatures recorded at the Bureau of Meteorology's (BoM) climate station at Gunnedah Pool between 1876 and 2009 (BoM, 2009). This climate station, located approximately 40 km south-southeast of the TCM, provides the most complete historic climate dataset in the local region and is considered representative of the greater region.

It can be seen that the recorded temperature at the TCM during 2007 matches well with the historical measurements at Gunnedah Pool. On this basis, it is considered that the 2007 dataset is representative of the temperature likely to be experienced within the region.

From analysis of the recorded historic data at Gunnedah Pool, the daytime temperature of the greater region surrounding the TCM may be described as cool to hot, with average air temperatures during the day varying between 16.9 degrees Celcius (°C) and 18.9°C in winter and 32.9°C and 34.0°C in summer at the Gunnedah Pool and TCM, respectively. Average air temperatures during the night tend to be cold to mild, varying between 3.0°C and 4.3°C in winter and between 16.8°C and 18.3°C in summer at the Gunnedah Pool and TCM, respectively.

**Figure 9 Monthly Temperature Variance at the TCM during 2007 and Regional Historic Data**



Note: TCM data is represented by the box and whisker plots with the maxima and minima represented by the uppermost and lowermost horizontal lines, with the upper and lower bounds of the box representing the 75<sup>th</sup> and 25<sup>th</sup> percentile, respectively. The mean is represented by the horizontal line within each box.

Regional Historic Data sourced from Gunnedah Pool Station (BoM, 2009)



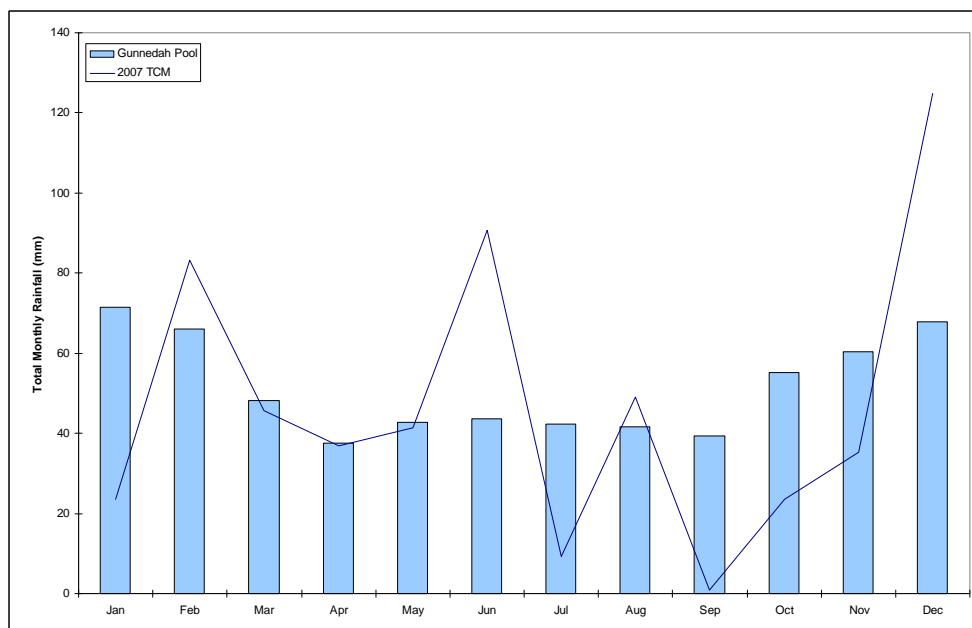
### 5.2.3 Rainfall

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 recorded total monthly rainfall measured at the TCM during 2007 is shown on **Figure 10**. Also shown is the monthly mean rainfall measured at Gunnedah Pool between 1876 and 2009 (BoM, 2009).

Rainfall experienced in the greater region surrounding the TCM can be described as low to moderate, with the historic annual average rainfall recorded at Gunnedah Pool totalling approximately 615 mm. Review of data recorded at the TCM during 2007 shows that, while some months (notably June and December) were higher than the corresponding regional monthly average, total rainfall recorded during 2007 was approximately 560 mm and therefore lower than regional average

Rainfall in the region surrounding the TCM is typically lower during the winter months with maxima generally experienced during the summer months.

**Figure 10 Total Monthly Rainfall for the TCM during 2007 and Historic Annual Mean Rainfall from Gunnedah Pool**



Note: Regional Historic Data sourced from Gunnedah Pool Station (BoM, 2009)

### 5.2.4 Relative Humidity

The relative humidity in the region surrounding the TCM can be described as moderate. The mean 9.00 am relative humidity at Gunnedah Pool was between 58% to 78%, while the 3.00 pm relative humidity varies between 40% and 55% throughout the year (BoM, 2009). This is in general agreement with relative humidity data collected at the TCM, with a 9.00 am and 3.00 pm annual average relative humidity of 61% and 41% respectively recorded throughout 2007.

## 5.3 Meteorological Modelling

In order to calculate all required meteorological parameters required by the dispersion modelling process, meteorological modelling using The Air Pollution Model (TAPM) meteorological model (Version 3) has been implemented.



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 site-specific hourly meteorological observations at user-defined levels within the atmosphere.

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 at the TCM on-site weather station was input into the TAPM simulations to provide realignment to local conditions.

**Table 6** details the parameters used in the TAPM meteorological modelling for this assessment.

**Table 6 Meteorological Parameters used for this Study**

<b>TAPM (v 3.0)</b>	
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	226248 m East, 6607844 m South
Data assimilation	Meteorological data assimilation using wind data from the TCM onsite weather station into lower four levels of model

### 5.3.1 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 7**.

**Table 7 Description of Atmospheric Stability Classes**

<b>Atmospheric Stability Class</b>	<b>Category</b>	<b>Description</b>
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



Atmospheric stability class has been derived using the US EPA (2000) Sigma Theta method, as prescribed within Section 4.4.1 of the Approved Methods (DEC 2005). 15-minute average wind direction data was used to derive hourly standard deviation throughout 2007. The Sigma Theta method utilises this standard deviation as a measure of hourly wind direction variability and, following combination with corresponding hourly-average wind speed, estimates hourly atmospheric stability. The calculated frequency of each stability class at the TCM during 2007 is shown on **Figure 11**. The calculated seasonal stability class distribution for the TCM are included in **Attachment B**.

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. Furthermore, a high frequency of Stability Class “F” has been calculated, suggesting that night-time atmospheric conditions are often very stable, with a low dispersion potential.

Diurnal variations in maximum and average mixing depths predicted by TAPM at the TCM during 2007 are illustrated on **Figure 12**. 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 the convective mixing layer.

**Figure 11 Calculated Annual Stability Class Distributions for the TCM during 2007**

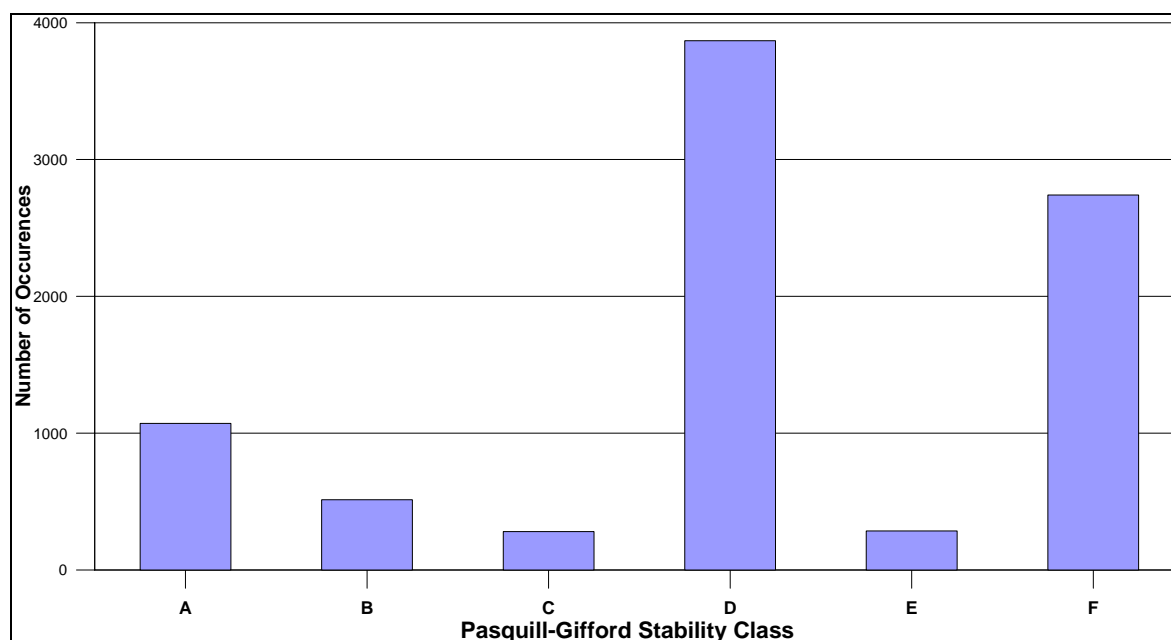
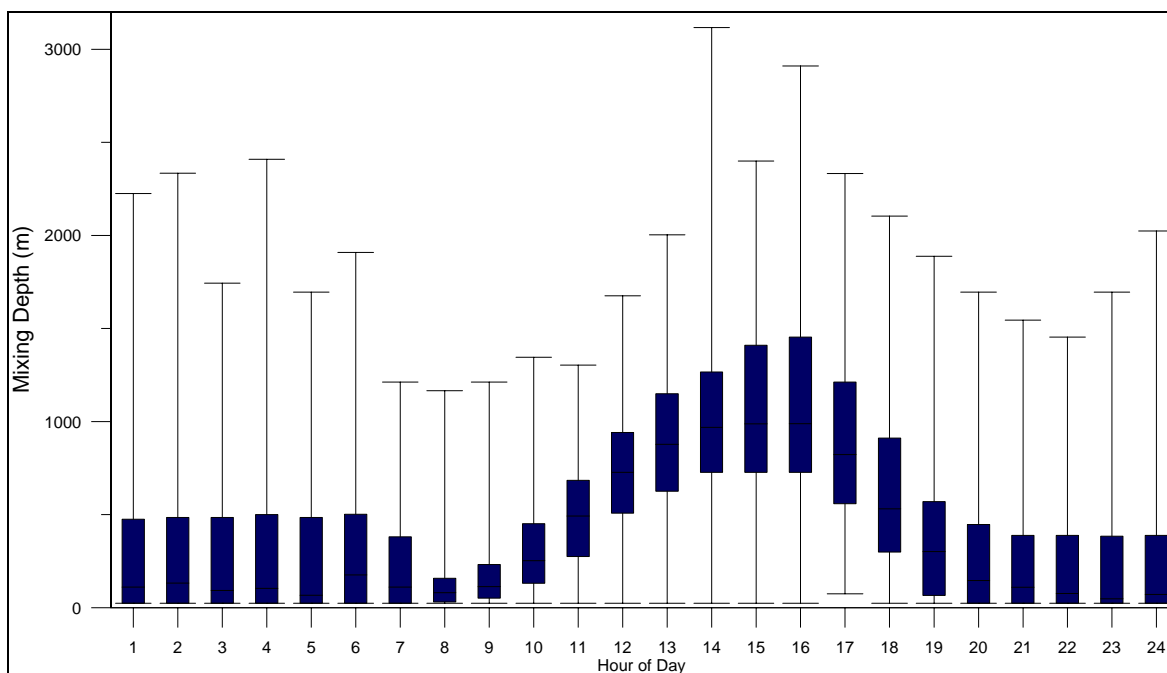




Figure 12 TAPM-Predicted Diurnal Variation in Mixing Depth for the TCM during 2007





## 6 BASELINE AIR QUALITY

### 6.1 TCM Air Quality Monitoring Network

For the approved TCM, TCPL are required to maintain a routine air quality monitoring network at the TCM to ensure compliance with the relevant air quality assessment criteria. The TCM air quality monitoring network monitors PM<sub>10</sub> and dust deposition. **Figure 13** illustrates the distribution of the TCM air quality monitoring network.



Figure 13 TCM Air Quality Monitoring Network

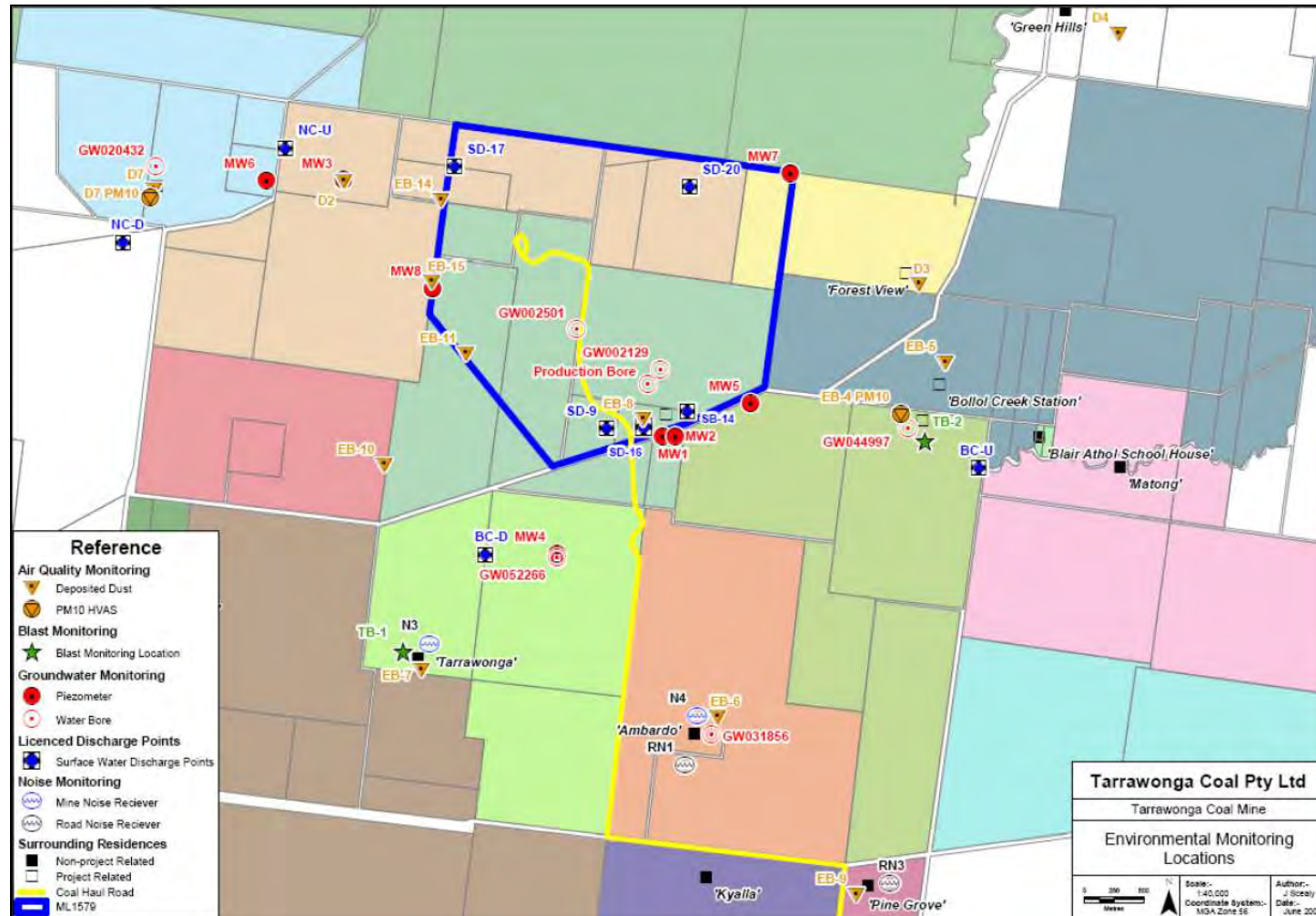


Image Source: TCPL 2008-2009 AEMR, 2009

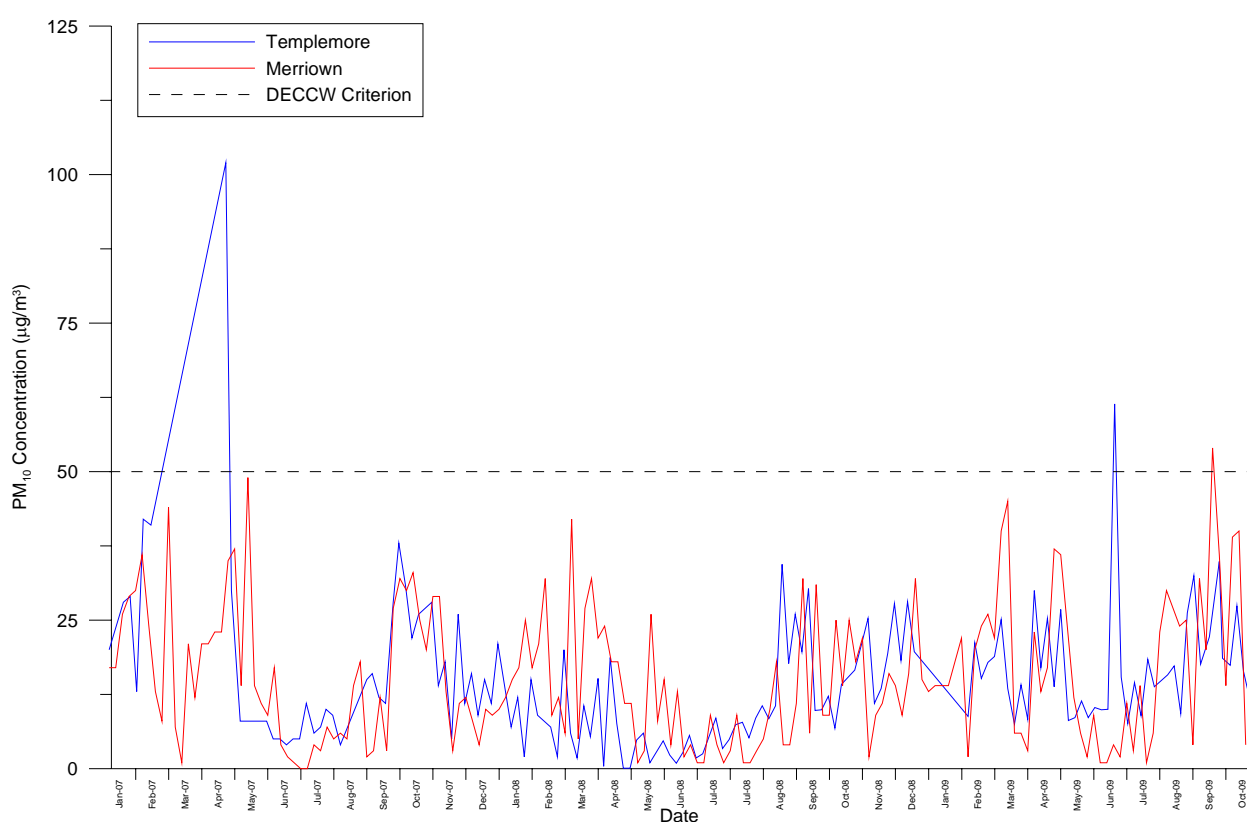


## 6.2 Particulate Matter

PM<sub>10</sub> concentrations (24-hour average, one-in-six day cycle) are measured by High Volume Air Sampler (HVAS) at two locations surrounding the TCM. The HVAS locations are situated at the “Merriown” property (D7 PM<sub>10</sub> on **Figure 13**) to the west and the “Templemore” property (EB-4, PM<sub>10</sub> on **Figure 13**) to the east. It is noted that the “Merriown” HVAS is maintained by Idemitsu Boggabri Coal (IBC) as part of the Boggabri Coal Project, and is used by TCPL to measure cumulative impacts.

In order to analyse 24-hour average PM<sub>10</sub> concentrations for the region surrounding the TCM, data recorded at the “Templemore” and “Merriown” HVAS locations between December 2006 and October 2009 has been sourced from TCPL and presented on **Figure 14**.

**Figure 14 24-hour Average PM<sub>10</sub> Concentrations – December 2006 to October 2009 – TCM Air Quality Monitoring Network**



Source: TCPL, 2009b

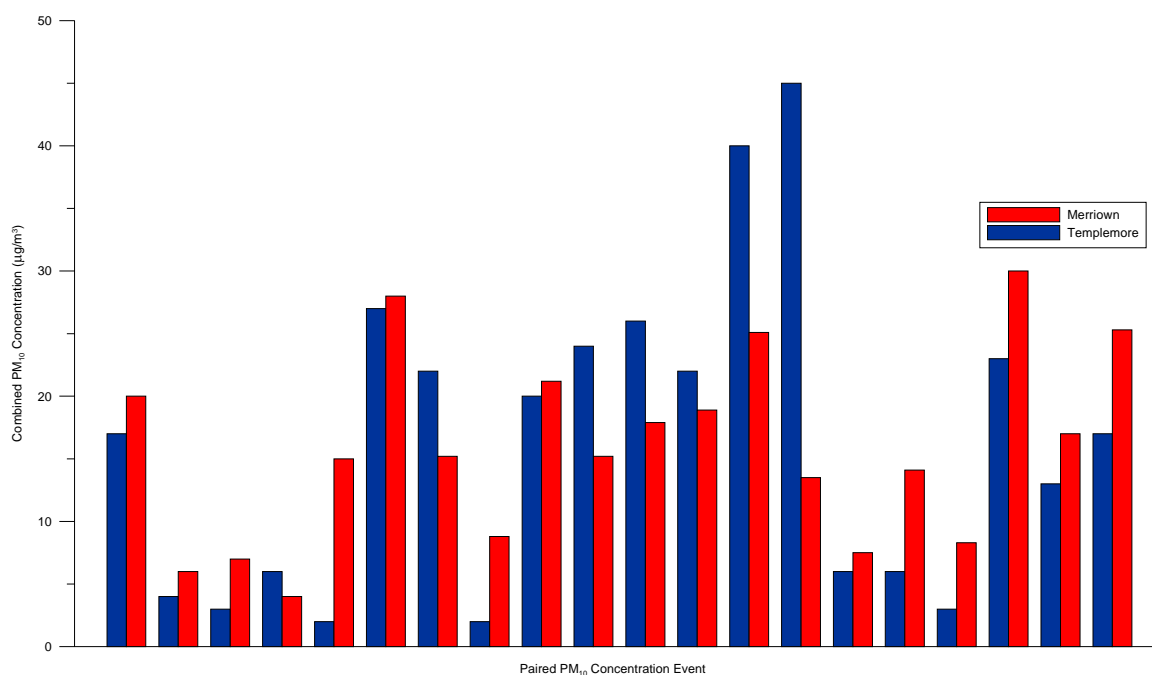
With the exception of three 24-hour periods (two in the “Merriown” dataset (15 April 2007 and 30 June 2009) and one in the “Templemore” dataset (27 September 2009)), all measured concentrations at both HVAS locations between December 2006 and October 2009 were below the DECCW 24-hour average criterion of 50 µg/m<sup>3</sup>. The exact cause of these exceedances is not readily known, however review of the NSW DECCW 2007 Annual NEPM Report (DECCW, 2008) indicated that elevated concentrations were experienced at regional NSW monitoring locations on 15 April 2007, while one “Templemore” exceedance occurred during the September 2009 dust storm event. The average PM<sub>10</sub> concentrations of the “Templemore” and “Merriown” HVAS datasets are 15.5 µg/m<sup>3</sup> and 15.1 µg/m<sup>3</sup> respectively.



As shown on **Figure 14**, concentrations at the two HVAS locations were not always recorded on the same days. In order to provide some comparison between the two datasets, the concentrations recorded concurrently at both HVAS locations between December 2006 and October 2009 (20 in total) were extracted and are presented on **Figure 15**. **Figure 15** illustrates that for 13 of the 20 concurrent samples, the 24-hour average PM<sub>10</sub> concentration at “Merriown” was greater than that recorded at “Templemore”. It is therefore considered that, despite the relatively small dataset of concurrent measurements, the “Merriown” HVAS location may be indicative of cumulative emissions from the TCM and Bogabri Coal Project.

As described above, while substantial PM<sub>10</sub> monitoring data for the TCM area are available as discussed above, it is noted in Section 5.1.1 of the Approved Methods (DEC, 2005) that for a Level 2 air quality assessment (of which this AQIA is), ambient monitoring data for at least one year of continuous measurements should be used in the dispersion modelling process. As discussed, the 24-hour average PM<sub>10</sub> datasets for the TCM area were recorded on one-in-six day cycle. In the absence of continuous site-specific PM<sub>10</sub> monitoring data, the Approved Methods states that site-representative monitoring data can be used as a substitute.

**Figure 15 Paired and Combined 24-hour Average PM<sub>10</sub> Concentrations - December 2006 to October 2009 - “Merriown” and “Templemore” HVAS**



The DECCW maintain a network of continuous air quality monitoring stations across NSW. The closest of these stations is located at Tamworth, approximately 90 km southeast of the TCM. This air quality monitoring site is located in Hyman Park, off Robert Street and Hillvue Road, Tamworth and was established in 2000. The 24-hour average PM<sub>10</sub> concentrations recorded at the DECCW Tamworth monitoring station between December 2006 and October 2009, along with the TCM HVAS data recorded in that period, are presented on **Figure 16**. It is noted that the presented data on **Figure 16** has been capped at 160 µg/m<sup>3</sup> due to the adverse influence graphically of several very high concentrations recorded during the widespread dust storms in September and October 2009. The 2007 average of the Tamworth dataset is 15.8 µg/m<sup>3</sup> and has been adopted for the purposes of this assessment.



In order to illustrate that the data recorded at the DECCW Tamworth monitoring station can be considered site-representative, an analysis of the frequency distribution of recorded concentrations at the Tamworth and TCM monitoring locations is presented on **Figure 17**.

The frequency distribution for each dataset shown on **Figure 17** suggests that, while low level concentrations ( $5 \mu\text{g}/\text{m}^3$  or less) are more frequent at the TCM HVAS locations than at Tamworth, the overall distribution of emissions is quite similar across all three datasets. Indeed, between 80% and 88% of concentrations are less than  $25 \mu\text{g}/\text{m}^3$  for the three monitoring locations. It is therefore considered that in the absence of a continuous site-specific monitoring 24-hour varying  $\text{PM}_{10}$  dataset, data from the DECCW Tamworth monitoring station can be used as a conservatively high site-representative monitoring dataset.

Therefore, in order to meet the requirements of Section 5.1.1 of the Approved Methods (DEC, 2005) regarding continuous monitoring data, the 24-hour average  $\text{PM}_{10}$  concentrations recorded at the DECCW Tamworth monitoring station for the period 1 January 2007 to 31 December 2007, presented on **Figure 18**, will be drawn upon in conjunction with the TCM  $\text{PM}_{10}$  HVAS data to estimate existing levels of  $\text{PM}_{10}$ . This 2007 dataset is concurrent with the meteorological data set to be used in the atmospheric dispersion modelling process (as discussed in **Section 5**).

**Figure 16 DECCW Tamworth  $\text{PM}_{10}$  Concentrations with TCM HVAS Data**

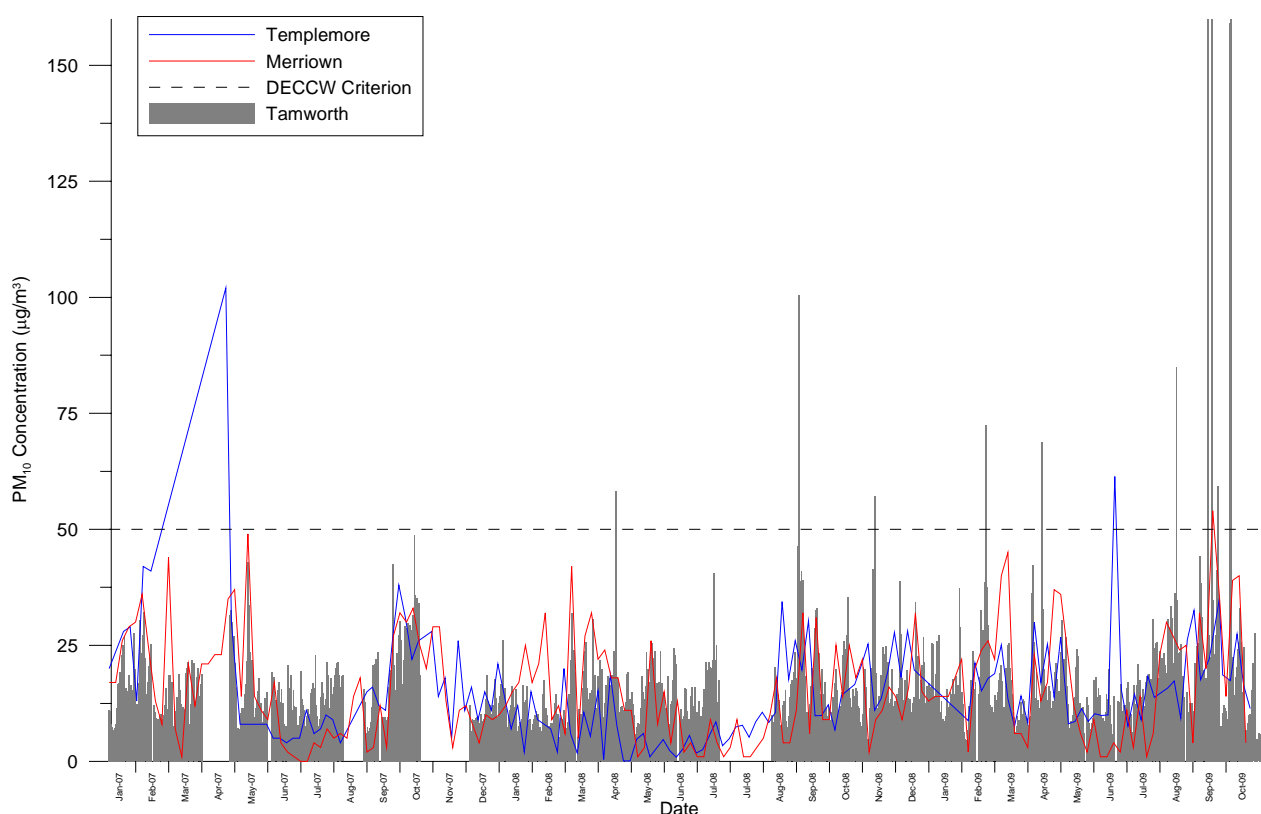




Figure 17 24-hour Average PM<sub>10</sub> Concentration Distribution – Tamworth and TCM HVAS – December 2006 to October 2009

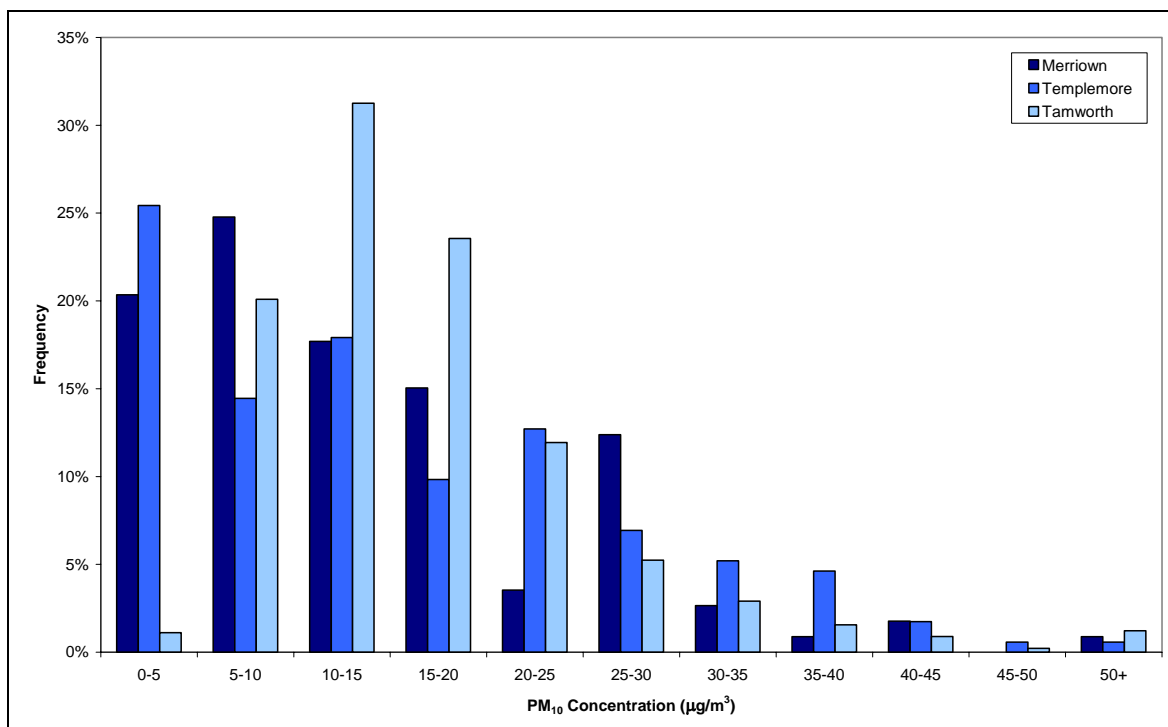
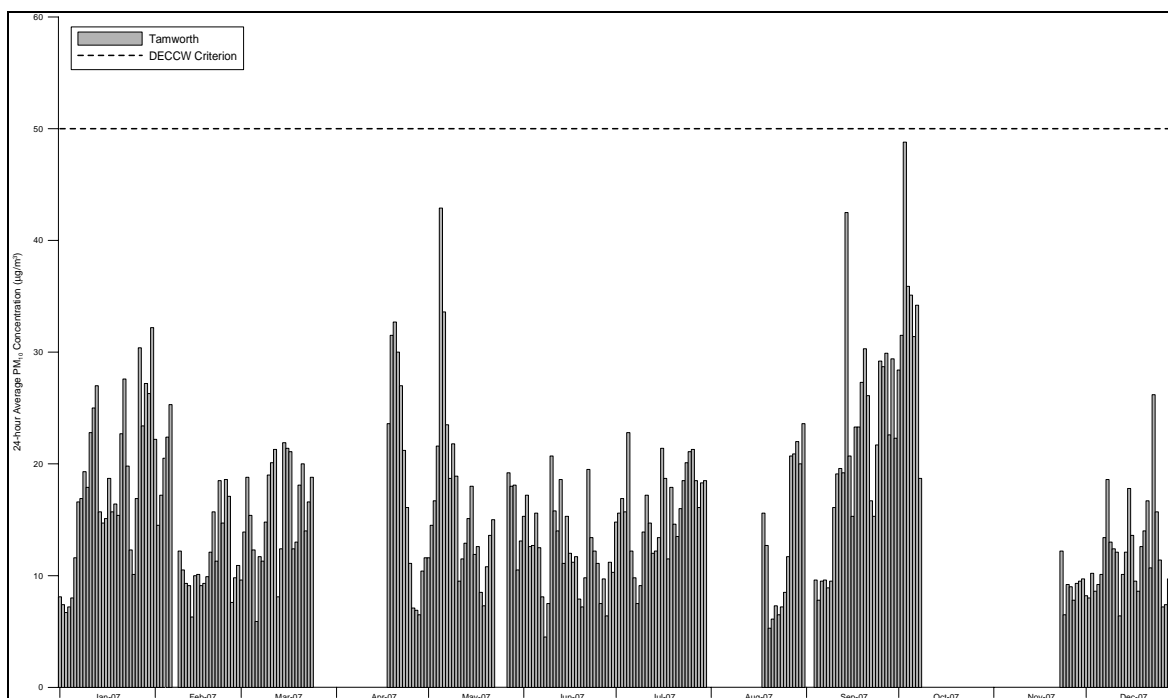


Figure 18 DECCW PM<sub>10</sub> (24-Hour Average) Monitoring Results for Tamworth, 2007



Note: Where gaps in data exist, an annual average will be substituted for the purposes of dispersion modelling



### 6.3 Dust Deposition

Ambient dust deposition levels have historically been measured by TCPL at thirteen separate locations surrounding the TCM since 2005, with twelve locations currently active. Additionally, IBC currently maintains four locations in the local region. The location of these dust deposition gauges are illustrated on **Figure 13**, with TCPL and IBC locations prefixed by “EB” and “D”, respectively.

Dust deposition gauges EB-6, EB-9 (and EB-12) and EB-10 are located at non-mine related residential properties “Ambardo”, “Pine Grove” and “Tarrowonga” respectively. EB-3 was located at “Jeralong” but was decommissioned in June 2008. Other sites are located at EB-4 (“Templemore”), EB-5 and EB-13 (“Bollol Creek”), EB-8 (“Thuin”), D2, D3 (“Forest View”), D4 (“Green Hills”) and D-7 (IBC), EB-10, EB-11, EB-14 and EB-15 (TCM Site).

Dust deposition monitoring results from the TCPL dust deposition network has been sourced and analysed (TCPL, 2008, 2009a, 2009b). The results from 2006 to 2009 for all thirteen TCPL locations are presented in **Table 8** and **Figure 19**.

As shown in **Table 8** and **Figure 19**, the recorded annual average dust deposition levels vary across all monitoring sites, with elevated levels recorded at locations closer to the TCM site boundary. It is noted that, with the exception of EB-13, dust deposition levels in 2009 are the highest throughout (**Table 8**). It is likely that this is attributable to the fact that 2009 is an incomplete calendar year and the occurrence of significant regional-scale events in September 2009.

Dust deposition levels at the four dust deposition monitoring locations situated at privately-owned properties (EB-3, EB-6, EB-9) and mine-related located EB-10 are below the project assessment goal of 4 g/m<sup>2</sup>/month for each monitoring year, with the exception of EB-3 in 2008 (incomplete year as stated above) (**Table 8**).

Dust deposition monitoring from the Boggabri Coal Project has been sourced and provided by TCPL for the period December 2008 to December 2009. Dust deposition monitoring at the Boggabri Coal Project occurs at four locations that also serve as cumulative impact monitors with the TCM:

- D2 and D7 to the west of the TCM;
- D4 at “Green Hills” a privately-owned property to the north of the TCM; and
- D3 at “Forest View” a mine-related property to the east of the TCM.

Annual average dust deposition levels at each monitoring location (excluding a dust storm event in October 2009) were 1.1 g/m<sup>2</sup>/month (D7), 1.5 g/m<sup>2</sup>/month (D2), 1.8 g/m<sup>2</sup>/month (D4, “Green Hills”) and 4.2 g/m<sup>2</sup>/month (mine-related D3 “Forest View”).

Taking into account the large number and geographical spread of dust deposition monitoring undertaken around the TCM; given the distance of the EB-9 monitoring location from TCM operations, it is likely that this location best provides a measure of ambient dust deposition levels without the influence of local mining operations.

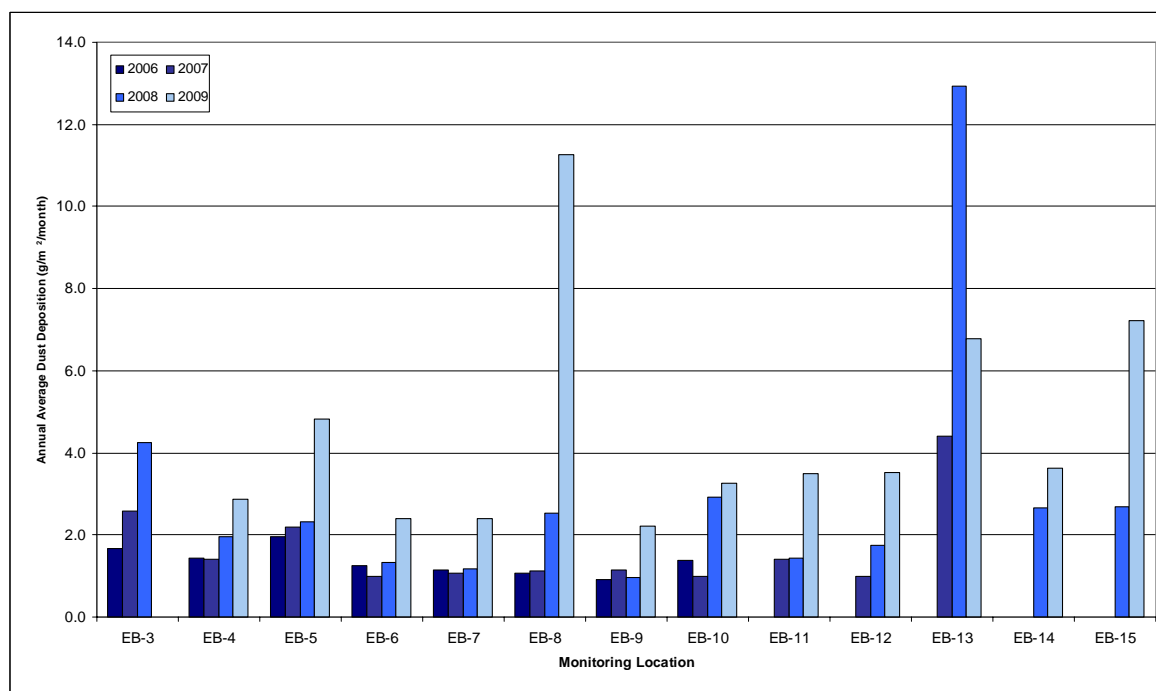


**Table 8 Annual Average Dust Deposition Levels – TCM Network -2006 to 2009**

Monitoring Location	Annual Average Dust Deposition Levels (g/m <sup>2</sup> /month)				Site Average
	2006	2007	2008	2009	
EB-3	1.7	2.6	4.2	N/A	<b>2.8</b>
EB-4	1.4	1.4	2.0	2.9	<b>1.9</b>
EB-5	2.0	2.2	2.3	4.8	<b>2.8</b>
EB-6	1.2	1.0	1.3	2.4	<b>1.5</b>
EB-7	1.2	1.1	1.2	2.4	<b>1.5</b>
EB-8	1.1	1.1	2.5	11.3	<b>4.0</b>
EB-9	0.9	1.2	1.0	2.2	<b>1.3</b>
EB-10	1.4	1.0	2.9	3.3	<b>2.1</b>
EB-11	N/A	1.4	1.4	3.5	<b>2.1</b>
EB-12	N/A	1.0	1.7	3.5	<b>2.1</b>
EB-13	N/A	4.4	12.9	6.8	<b>8.0</b>
EB-14	N/A	N/A	2.7	3.6	<b>3.1</b>
EB-15	N/A	N/A	2.7	7.2	<b>4.9</b>
<b>Annual Average</b>	<b>1.4</b>	<b>1.7</b>	<b>3.0</b>	<b>4.5</b>	

N/A: No data available

**Figure 19 Annual Average Dust Deposition Levels – TCM Network – 2006 to 2009**





## 6.4 Background Air Quality for Assessment Purposes

For the purposes of undertaking a cumulative assessment of air pollutants within this assessment (project-related plus background) background air quality concentrations/levels as presented **Table 9** have been adopted. The maximum monitored values from site-specific data have been adopted where appropriate. Daily varying background 24-hour PM<sub>10</sub> concentrations from the DECCW Tamworth monitoring site have been adopted where appropriate.

No monitoring data are available for TSP. PM<sub>10</sub> can account for between 24% and 52% of TSP, as detailed within the “*National Pollutant Inventory Emission Estimation Techniques Manual for Mining, Version 2.3*” [EETM] (Commonwealth of Australia, 2001), depending on the source of the particulate (wind erosion, crushing, etc.). Monitoring data from coal mining areas in the Hunter Valley where co-located TSP and PM<sub>10</sub> monitors have been operated indicate that long-term average PM<sub>10</sub> concentrations represent approximately 40% of the corresponding long-term TSP concentration (NSW Minerals Council, 2000). This relationship has been adopted for this study.

**Table 9 Background Air Quality Levels used for Assessment Purposes**

Air Quality Parameter	Concentration/Level
PM <sub>10</sub>	Daily varying (24-hour)
	15.8 µg/m <sup>3</sup> (annual average)
TSP	30.5 µg/m <sup>3</sup> (annual average)
Dust Deposition	1.2 g/m <sup>2</sup> /month (annual average)



## 7 AIR QUALITY MODELLING METHODOLOGY

Activities associated with the approved TCM with the potential to generate particulates have been identified in **Section 2.3** of this report. As the modified TCM is proposed to be a continuation of approved TCM operations, potential sources of dust are considered to be the same. However the locations of mining activities would be altered as a result of the proposed Modification.

The dust generating activities identified in **Section 2.3** have been quantified for the modified TCM as outlined in **Section 7.1**.

### 7.1 Emissions Inventory

The quantities of particulate emissions from the modified TCM have been estimated using various factors developed in the NPI EETM (Commonwealth of Australia, 2001). Where appropriate EETM factors are not available, factors developed by the US EPA have been used when EETM factors are not available or are deemed to be more appropriate. **Table 10** presents the emissions inventory for the modified TCM. The modified TCM activity data, emissions estimate assumptions and details of the emissions inventory calculations are presented as **Attachment C**.

**Table 10 Emissions Inventory Summary**

Development Component	TSP (t/yr)	PM <sub>10</sub> (t/yr)
<b>Preparation Activities</b>		
Topsoil Stripped for Open Cut	17.0	4.7
Topsoil stripped for Out of Pit Waste Rock Emplacement	17.0	4.7
Subsoil stripped for Out of Pit Waste Rock Emplacement	17.0	4.7
Dumping of Topsoil	0.08	0.04
Clearing Waste Rock by Dozer	2.4	0.6
Waste Rock Excavation	5.7	5.1
Waste Rock Loading to Trucks	5.7	5.1
Dumping of Waste Rock at NE	2.6	1.2
Dumping of Waste Rock at SE	6.2	2.9
Dumping of Waste Rock in open cut	1.3	1.2
<b>Product Removal Activities</b>		
Drilling	4.4	4.4
Blasting	88.6	87.5
Coal Ripping/Pushing by Dozer	24.9	10.0
Coal Loading to truck by Excavator	22.4	20.5
Dumping of coal at ROM	0.3	0.2
<b>Coal Processing Activities</b>		
Loading Crusher	44.9	21.6
Primary Crushing	11.2	4.5
Secondary Crushing	33.6	13.4
Misc Conveying	0.6	0.3
Loading to trucks	44.9	21.6
<b>Vehicle Movement</b>		
Movement of Waste Rock to SE Waste Rock Emplacement	276.9	58.0



Development Component	TSP (t/yr)	PM <sub>10</sub> (t/yr)
Movement of waste rock to north-east Waste Rock Emplacement	153.8	32.2
Movement of waste rock as in-pit fill	21.9	8.7
Movement of topsoil to stockpiles	0.4	0.1
Movement of coal to ROM	19.9	4.2
<b>Ancillary Activities</b>		
Waste Rock Emplacement maintenance by dozer	4.9	0.6
<b>TOTAL</b>	<b>828.6</b>	<b>318.0</b>

t/yr = tonnes per year

### 7.1.1 Wind Erosion Estimation

Details of the estimation of wind erosion are provided in **Attachment C**. Areas of wind erosion included in the modelling exercise have been selected based on the assumption that exposed areas of material such as topsoil stockpiles and waste rock emplacements are managed as per **Section 2.5**. Two areas have been included, active surface disturbance areas and inactive surface disturbance areas.

Active surface disturbance have been estimated by assuming that an area of approximately one eighth of the total area of each identified source is active at any one time. Inactive surface disturbance areas (e.g. areas of the mine site that have been disturbed and are awaiting final landform reshaping and/or rehabilitation, for example portions of the waste emplacements) have been calculated in accordance with the AEMR for 2008/2009 (TCPL, 2009b). Inactive surface disturbance areas are not anticipated to be a significant source of dust because some surface stabilisation and natural surface 'crusting' would occur, which limits the potential for wind-blown emissions. Forty percent of inactive areas are assumed to be available for wind erosion for the purposes of this estimate.

## 7.2 Atmospheric Dispersion Modelling

The particulate dispersion modelling carried out for the modified TCM utilises the DECCW and US EPA approved CALPUFF Dispersion Model software. CALPUFF is a transport and dispersion model that advects (or puffs) material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the meteorological fields generated by CALMET, although can utilise a single station meteorological file generated by for example TAPM, as is the case within this assessment (refer **Section 5.3**). The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST is then used to process these files, producing tabulations that summarise results of the simulation.

The choice of the CALPUFF (Version 6.1) modelling system for the current assessment is based on the high percentage of calm conditions experienced at the site (approximately 14% in 2007). The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as Ausplume) is its ability to handle calm wind speeds (<0.5 m/s).

More advanced dispersion models (such as CALPUFF) are approved for use by the DECCW in situations where these models may be more appropriate than use of the Ausplume model. Such situations include those noted above (i.e. high frequency of calm wind conditions).



## 8 AIR QUALITY MODELLING RESULTS

### 8.1 CALPUFF Modelling Results

Dispersion modelling predictions of dust deposition, TSP and PM<sub>10</sub> concentrations for the privately-owned receptors nominated in **Section 3.2** attributable to the modified TCM operations are presented in **Section 8.1.1** to **Section 8.1.3**.

For completion, the dispersion modelling results for mine-related receptors are provided in **Attachment D**.

#### 8.1.1 Dust Deposition

**Table 11** shows the results of the dispersion modelling for dust deposition from the modified TCM at each of the identified receptors using the emission rates calculated in **Attachment C**.

Contour plots of the incremental increase in dust deposition attributable to each scenario are presented in **Attachment E**. The contour plots are indicative of the levels of dust deposition that could potentially be reached under the meteorological conditions modelled.

**Table 11 Predicted Incremental and Cumulative Dust Deposition at Nearest Receptors**

Receptor ID	Receptor Name	Dust Deposition- Annual Average (g/m <sup>2</sup> /month)		Assessment Criteria (g/m <sup>2</sup> /month)	
		Increment	Cumulative	Increment	Cumulative
R1	<i>Tarrawonga</i>	0.3	1.5	2	4
R2	<i>Jeralong</i>	0.2	1.4	2	4
R3	<i>Green Hills</i>	0.4	1.6	2	4
R4	<i>Pine Grove</i>	0.4	1.6	2	4
R5	<i>Ambarado</i>	0.8	2.0	2	4
R6	<i>Kyalla</i>	0.4	1.6	2	4

The results indicate that annual average dust deposition levels at all receptors surrounding the modified TCM are predicted to be below the relevant criterion of 4 g/m<sup>2</sup>/month (cumulative dust deposition) when using a background deposition level of 1.2 g/m<sup>2</sup>/month.

#### 8.1.2 TSP

**Table 12** shows the results of the dispersion modelling for TSP from the modified TCM at each of the identified receptors using the emission rates calculated in **Attachment C**. As discussed in **Section 6.4**, a conservative background concentration of 30.5 µg/m<sup>3</sup> has been assumed for the TCM area.

Annual average TSP concentrations are well within the criterion of 90 µg/m<sup>3</sup> at all modelled receptors.

A contour plot of the incremental increase in TSP concentrations attributable to the modified TCM is presented in **Attachment E**. The contour plot is indicative of the concentrations of TSP that could potentially be reached under the meteorological conditions modelled.



**Table 12 Predicted Incremental and Cumulative Annual Average TSP Concentrations at Nearest Receptors**

Receptor ID	Receptor Name	TSP Concentrations- Annual Average ( $\mu\text{g}/\text{m}^3$ )		Assessment Criterion ( $\mu\text{g}/\text{m}^3$ )
		Increment	Cumulative	Cumulative
R1	Tarrawonga	2	33	90
R2	Jeralong	1	32	90
R3	Green Hills	2	33	90
R4	Pine Grove	2	33	90
R5	Ambardo	4	35	90
R6	Kyalla	2	33	90

### 8.1.3 Particulate Matter ( $\text{PM}_{10}$ )

#### Annual Average $\text{PM}_{10}$

Presented in **Table 13** are the results of the dispersion modelling for annual average  $\text{PM}_{10}$  from the modified TCM at each of the identified receptors using the emission rates calculated in **Attachment C**.

An annual average background concentration of  $15.8 \mu\text{g}/\text{m}^3$  has been applied to obtain an indication of the potential cumulative impacts associated with the modified TCM and to allow comparison with the annual average  $\text{PM}_{10}$  criterion of  $30 \mu\text{g}/\text{m}^3$ .

**Table 13 Predicted Incremental and Cumulative Annual Average  $\text{PM}_{10}$  Concentrations at Nearest Receptors**

Receptor ID	Receptor Name	$\text{PM}_{10}$ Concentrations- Annual Average ( $\mu\text{g}/\text{m}^3$ )		Assessment Criterion ( $\mu\text{g}/\text{m}^3$ )
		Increment	Cumulative	Cumulative
R1	Tarrawonga	1	17	30
R2	Jeralong	1	17	30
R3	Green Hills	1	17	30
R4	Pine Grove	2	18	30
R5	Ambardo	3	19	30
R6	Kyalla	1	17	30

Annual average  $\text{PM}_{10}$  concentrations are predicted to satisfy the criterion of  $30 \mu\text{g}/\text{m}^3$  at all the modelled receptors. A contour plot of the incremental increase in annual average  $\text{PM}_{10}$  concentrations attributable to the modified TCM is presented in **Attachment E**. The contour plot is indicative of the concentrations of  $\text{PM}_{10}$  that could potentially be reached under the meteorological conditions modelled.

#### Incremental 24-hour Maximum $\text{PM}_{10}$

Presented in **Table 14** are the dispersion modelling predictions of the highest five (incremental) 24-hour maximum  $\text{PM}_{10}$  concentrations from the modified TCM at each of the identified receptors.



**Table 14 Predicted Incremental 24-hour PM<sub>10</sub> Concentrations at Nearest Receptors**

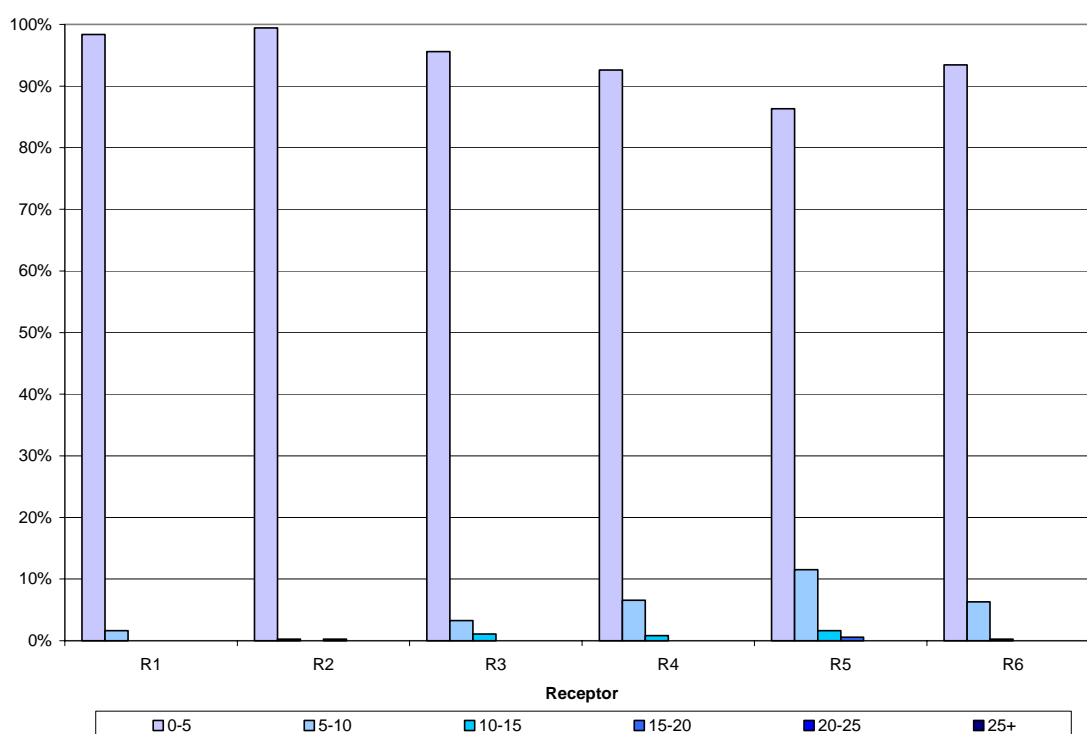
Rank of 24-hour PM <sub>10</sub> Concentration	24-hour PM <sub>10</sub> Concentration (µg/m <sup>3</sup> )						Assessment Criterion (µg/m <sup>3</sup> )
	R1	R2	R3	R4	R5	R6	
	<i>Tarrawonga</i>	<i>Jeralong</i>	<i>Green Hills</i>	<i>Pine Grove</i>	<i>Ambardo</i>	<i>Kyalla</i>	
Maximum	10	19	12	11	20	12	50
2nd	10	6	12	10	16	9	
3rd	9	5	10	10	12	9	
4th	8	4	10	8	11	8	
5th	7	4	10	8	11	8	

It is demonstrated that maximum incremental impacts of PM<sub>10</sub> are experienced at R5 “Ambardo” (20 µg/m<sup>3</sup>) and R2 “Jeralong” (19 µg/m<sup>3</sup>).

Examination of the frequency distribution of incremental 24-hour average PM<sub>10</sub> concentrations at each receptor (presented on **Figure 20**) shows that at all six Receptors, incremental PM<sub>10</sub> concentrations are between 0 and 5 µg/m<sup>3</sup> on over 80% of the modelled 24-hour periods.

Contour plots of the incremental increase in PM<sub>10</sub> concentrations attributable to the modified TCM are presented in **Attachment E**. The contour plots are indicative of the concentrations of PM<sub>10</sub> that could potentially be reached under the conditions modelled.

**Figure 20 Frequency Distribution of Incremental 24-hour Average PM<sub>10</sub> Concentrations at Nearest Receptors**



Note: Incremental bands in units of µg/m<sup>3</sup>

Note: Bars indicate frequency of occurrence (of 365 predictions) of each band of PM<sub>10</sub> concentration



## Cumulative 24-hour Maximum PM<sub>10</sub>

Predictions of incremental PM<sub>10</sub> concentrations on each modelled day have been paired with the corresponding background concentration monitored at the NSW DECCW Tamworth monitoring site. This allows an examination of the maximum predicted cumulative concentration (modified TCM plus background) which could potentially be experienced under the worst case operating conditions modelled.

Presented in **Table 15** are the dispersion modelling predictions of the highest five cumulative (modified TCM plus background) 24-hour maximum PM<sub>10</sub> concentrations at each of the identified receptors.

**Table 15 Predicted Cumulative 24-hour PM<sub>10</sub> Concentrations at Nearest Receptors**

Rank of 24-hour PM <sub>10</sub> Concentration	24-hour PM <sub>10</sub> Concentration (µg/m <sup>3</sup> )						Assessment Criterion (µg/m <sup>3</sup> )
	R1	R2	R3	R4	R5	R6	
	<i>Tarrawonga</i>	<i>Jeralong</i>	<i>Green Hills</i>	<i>Pine Grove</i>	<i>Ambardo</i>	<i>Kyalla</i>	
Maximum	50	49	53	49	50	50	50 (TCM and other sources – for determining best practice air quality management) 150 (TCM and other sources – for acquisition)
2nd	45	43	52	46	50	48	
3rd	43	43	45	44	47	45	
4th	36	37	41	42	45	42	
5th							
	36	36	38	38	40	41	

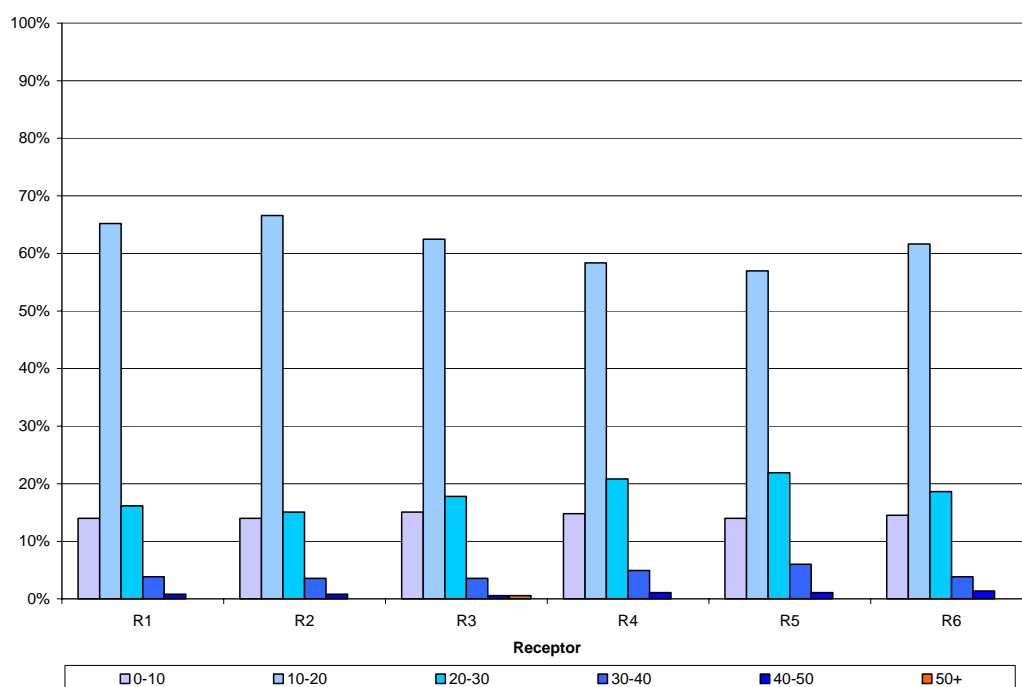
The modelling indicates that at one of the six modelled receptors (Receptor R3 “Green Hills”) exceedances of the 50 µg/m<sup>3</sup> 24-hour PM<sub>10</sub> best practice air quality management criterion are predicted to occur on two occasions. It is noted that no exceedances of the 150 µg/m<sup>3</sup> 24-hour PM<sub>10</sub> (acquisition) criterion are predicted at any receptor.

Examination of the frequency distribution of cumulative 24-hour average PM<sub>10</sub> concentrations at each receptor (presented on **Figure 21**) shows that at all six receptors, incremental PM<sub>10</sub> concentrations are between 10 and 20 µg/m<sup>3</sup> on over 58% of the modelled 24-hour periods.

Further examination of the days on which exceedances of the 24-hour maximum PM<sub>10</sub> criterion are observed is warranted.



**Figure 21 Frequency Distribution of Cumulative 24-hour Average PM<sub>10</sub> Concentrations at Nearest Receptors**



Note: Incremental bands in units of  $\mu\text{g}/\text{m}^3$

Note: Bars indicate frequency of occurrence (of 365 predictions) of each band of PM<sub>10</sub> concentration

**Table 16** provides a detailed breakdown of each exceedance of the maximum 24-hour PM<sub>10</sub> criterion at each receptor, which identifies the predicted cumulative concentration (Modified TCM plus background) and the individual incremental and background concentrations. Also shown is the day on which the exceedance occurred. **Table 16** demonstrates that the cumulative concentrations modelled at all receptors are highly background driven. That is, exceedances can be observed at the nearest receptors even when increments from the modified TCM are predicted to be small.

**Table 16 Detailed Breakdown of Incremental and Background PM<sub>10</sub> Concentrations on Days of 24-hour PM<sub>10</sub> Exceedances**

Receptor ID	Receptor Name	PM <sub>10</sub> Concentration ( $\mu\text{g}/\text{m}^3$ )			Date
		Cumulative	Incremental	Background	
R3	Green Hills	53	10	42.9	5 May 2007
		52	3	48.8	3 October 2007

It is shown that all exceedances (two in total) were experienced on only two days, 5 May 2007 and 3 October 2007 when background PM<sub>10</sub> concentrations were  $42.9 \mu\text{g}/\text{m}^3$  and  $48.8 \mu\text{g}/\text{m}^3$  respectively. On these days, incremental contributions of PM<sub>10</sub> from modified TCM sources would only be required to be  $7.1 \mu\text{g}/\text{m}^3$  and  $1.2 \mu\text{g}/\text{m}^3$  respectively to cause an exceedance of the criterion.

Examination of the “National Environmental Protection (Ambient Air Quality) Measure New South Wales Annual Compliance Report for 2007” (DECC, 2008) indicates that on 2 October 2007 and 3 October 2007, exceedances of the NEPM PM<sub>10</sub> standard were observed at Bathurst, Beresfield and Wagga Wagga with the exceedance at Bathurst being attributed to a dust storm and smoke.



With Tamworth being located approximately 300 km north of Bathurst, it is difficult to ascertain whether the high background concentration monitored on 3 October 2007 at Tamworth is also attributable to the regional dust storms. It is noted that no PM<sub>10</sub> monitoring was undertaken at either the “Templemore” or “Merriown” mine-related monitoring sites on 3 October 2007.

The NEPM Annual Compliance Report for 2007 also indicates that several monitoring stations experienced exceedances of the PM<sub>10</sub> standard on 4 May 2007 and 5 May 2007 (Rozelle, Beresfield, Liverpool, Chullora, Newcastle and Macarthur). Although these stations are mainly located in the Sydney Metropolitan area, it is noted that exceedances were experienced to the north of Sydney over the two day period.

PM<sub>10</sub> measurements from the mine-related “Templemore” HVAS monitoring site show concentrations of 49 µg/m<sup>3</sup> on 5 May 2007. In conjunction with a monitored PM<sub>10</sub> concentration of 42.9 µg/m<sup>3</sup> at the Tamworth monitoring site approximately 80 km to the southeast of the TCM site, and the exceedances in Sydney and Newcastle, it can be assumed that the particulate elevations were of a regional and non-anthropogenic nature.

Exceedances of the 24-hour PM<sub>10</sub> criterion at Receptors R3 ‘Green Hills’ can be attributed to an elevated background particulate concentration which has been shown to be likely due to regional particulate events, rather than mine-related particulate emissions. As discussed in Section 4.1, the purpose of the cumulative 50 µg/m<sup>3</sup> 24-hour PM<sub>10</sub> criterion is to assist with best practice air quality management.

**Section 2.5** describes the existing air quality management measures employed at the TCM, which are considered to be generally best-practice. Given that the exceedances are background driven rather than resulting from emissions from the modified TCM, no additional air quality mitigation measures are considered to be necessary to control the modified TCM’s relatively small contribution to these exceedances.

## Cumulative Impacts with Surrounding Sources

The Boggabri Coal Project lies in an area approximately 0.5 km north of the TCM. Approval was granted for the Boggabri Coal Project in 1989 and operations commenced in 2006. Approved operations at the Boggabri Coal Project are of a similar nature and scale to those occurring at the TCM (i.e. conventional open cut coal mining).

Due to the similar nature of operations at the Boggabri Coal Project and TCM, it might be expected that incremental concentrations of PM<sub>10</sub> experienced at the nearest receptors to the TCM may be similar to those modelled above. Richard Heggie Associates (2005) original report included in the 2005 EIS AQIA undertook dispersion modelling of similar operations to the TCM at the Boggabri Coal Project. Incremental PM<sub>10</sub> concentrations of up to 13 µg/m<sup>3</sup> as a 24-hour maximum were predicted from the Boggabri Coal Project operations. It is noted that these estimations were highly conservative.

Given the close proximity of the Boggabri Coal Project to the TCM, the network of monitoring sites surrounding the TCM, cumulative impacts would be observed in the monitoring data. As discussed in **Section 6.2**, with the exception of three 24-hour periods and one “Templemore” dataset, all measured concentrations between December 2006 and October 2009 were below the DECCW 24-hour average criterion of 50 µg/m<sup>3</sup> indicating that although cumulative impacts may exist, they do not result in exceedances of the criteria.

## 8.2 Assessment of the Transportation of Product Coal

The 2005 EIS AQIA (Richard Heggie Associates, 2005) provided an assessment of the potential air quality impacts associated with the transportation of product coal from the TCM to the Whitehaven CHPP. This assessment is reproduced below:



*An estimated maximum 99,600 truck movements to and from the Project Site would be required per year to despatch the coal mine products during peak production. This equates to maximum of 332 movements per day, Monday to Saturday.*

*The low background concentrations of relevant pollutants, including NO<sub>2</sub>, SO<sub>2</sub> and particulate matter (refer Section 2), are indicative of the local airshed's high capacity to assimilate these pollutants. In view of the expected magnitude of vehicle traffic, it is expected that the local airshed will have the capacity to assimilate emissions from this source and easily meet the relevant air quality goals.*

*It is not anticipated that particulate emissions from vehicle exhausts would significantly contribute to dust deposition rates in the area immediately adjacent to the Project Site. In addition to the comparatively low magnitude of heavy vehicle traffic required for product transportation, all roads from the Project Site boundary to the Whitehaven CHPP and rail loading facility would be sealed, therefore wheel-generated dust emissions would be minimal. As such, vehicles travelling from the Project Site are not anticipated to adversely impact upon nearby residences from an air quality perspective.*

Given that the proposed Modification would not change the maximum production rate (2 Mtpa), the number of product coal truck movements would not change and the conclusions in Richard Heggie Associates (2005) above would remain unchanged.

### **8.3 Air Quality Mitigation, Management and Monitoring Measures**

As discussed in **Section 2.5**, TCPL currently employs air quality mitigation and management measures at the TCM which are considered to be generally best practice. These measures are described in the Air Quality Monitoring Program and the 2008/2009 AEMR (TCPL, 2009b).

It is recommended that the existing "Tarrawonga Coal Mine Air Quality Monitoring Program" (TCPL, 2005b) be continued with PM<sub>10</sub> concentrations measured at two locations ("Templemore" and "Merriown") and dust deposition monitored at six locations.



## 9 GREENHOUSE GAS ASSESSMENT

A quantitative greenhouse gas assessment has been undertaken to estimate potential greenhouse gas emissions associated with the modified TCM.

### 9.1 Direct and Indirect Emissions (Emission Scopes)

The NGA Factors (DCC, 2009) defines two types of greenhouse gas emissions:

*Direct emissions are produced from sources within the boundary of an organisation and as a result of the organisation's activities.*

...

*Indirect emissions are emission generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation.*

The NGA Factors identifies three 'scopes' of emissions for greenhouse gas accounting and reporting purposes, defined as follows:

- *Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO<sub>2</sub>-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate scope 1 emissions.*
- *Indirect emission factors are used to calculate scope 2 emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO<sub>2</sub>-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.*
- *Various emission factors can be used to calculate scope 3 emissions. For ease of use, this workbook reports specific 'scope 3' emission factors for organisations that:*
  - (a) *burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or*
  - (b) *consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the T&D network.*

### 9.2 Greenhouse Gas Calculation Methodology

Quantification of potential emissions from the modified TCM has been undertaken in relation to both carbon dioxide (CO<sub>2</sub>) and other non-CO<sub>2</sub> greenhouse gas emissions.

For comparative purposes, non-CO<sub>2</sub> greenhouse gases are awarded a "CO<sub>2</sub>-equivalence" (CO<sub>2</sub>-e) based on their contribution to the enhancement of the greenhouse effect. The CO<sub>2</sub>-e of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO<sub>2</sub> greenhouse gases are contained within the Intergovernmental Panel on Climate Change (IPCC), (1996) document "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories".

The GWPs of relevance to this assessment are:

- methane (CH<sub>4</sub>): GWP of 21 (21 times more effective as a greenhouse gas than CO<sub>2</sub>); and
- nitrous oxide (N<sub>2</sub>O): GWP of 310 (310 times more effective as a greenhouse gas than CO<sub>2</sub>).

The short-lived gases such as carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), and non-methane volatile organic compounds (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.



The greenhouse gas emissions associated with the modified TCM have been assessed in terms of direct (Scope 1) emission potential, indirect (Scope 2) emission potential and significant upstream/downstream (Scope 3) emission potential.

A summary of the potential modified TCM greenhouse gas emission sources is provided in **Table 17**.

**Table 17 Summary of Potential Modified TCM Greenhouse Gas Emissions**

Project Component	Direct Emissions	Indirect Emissions	
	Scope 1	Scope 2	Scope 3
Fugitive Emissions	Emissions from the release of coal bed methane and CO <sub>2</sub> as a result of the Modified TCM.	N/A	N/A
Diesel	Emissions from the combustion of diesel at the Modified TCM (stationary energy and transport purposes).	N/A	Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Modified TCM.
Explosives	Emissions from explosives used at the Modified TCM.	N/A	N/A
Combustion of Coal	N/A	N/A	Emissions from the combustion of coal from the Modified TCM.
Vegetation Clearance	Emissions from vegetation clearance associated with the Modified TCM.	N/A	N/A

Note: Electricity is not consumed at the modified TCM as all power is generated using diesel generators, therefore, no indirect Scope 2 emissions are assessed.

N/A = Not applicable

### ***Fugitive emissions - Coal Bed Methane and Carbon Dioxide***

The process of coal formation creates significant amounts of methane. Some of this methane remains trapped in the coal until the pressure on the coal is reduced, which occurs during the coal mining process. The stored methane is then released to the atmosphere.

The NGA Factors provides default emission factors for CO<sub>2</sub>-e (as methane) resulting from fugitive emissions at open-cut coal mines. These emission factors are provided on a State and Territory specific basis, based on the variation in coal-bed methane content. Table 8 of the NGA Factors (DCC, 2009) provides a default figure for NSW open-cut coal mines of 0.045 t CO<sub>2</sub>-e per t of raw coal (t CO<sub>2</sub>-e/t raw coal).

### ***Diesel Usage***

Scope 1 greenhouse gas emissions attributable to diesel relate to the use of on-site machinery and on-site power generation.

The primary fuel source for the vehicles, plant and equipment operating at the modified TCM would be diesel. Diesel consumption for all mobile and fixed equipment is estimated as 312 kilolitres (kL) per annum for stationary energy purposes and 13,070 kL for on-site transport fuel purposes.

The annual emissions of CO<sub>2</sub> and other greenhouse gas from this source have been estimated using emission factors contained in Tables 3 and 4 of the NGA Factors (DCC, 2009). It has been assumed that the energy content of diesel is 38.6 megajoules per litre (MJ/L) (DCC, 2009).



## Explosives

The use of explosives in mining leads to the release of greenhouse gases. The activity level is the mass of explosive used (in tonnes). Emissions factors are available for the two main types of explosives (Ammonium Nitrate Fuel Oil [ANFO] and emulsion). For the purposes of this assessment, it is assumed that ANFO and Emulsion explosives would be used in a ratio of 9:1 as part of the Modified TCM as detailed within the 2005 EIS (TCPL, 2005a). It is assumed that no increase in blasting frequency would be experienced as part of the modified TCM over and above that currently undertaken. The quantity of explosives used as part of the modified TCM detailed within the 2008/2009 TCM AEMR are 7,227 t (TCPL, 2009b).

The current edition of the NGA Factors (DCC, 2009) does not include emission factors for CO<sub>2</sub>-e resulting from the use of ANFO or emulsion explosives. However, an emission factor of 0.17 t CO<sub>2</sub>-e per t of explosive (t CO<sub>2</sub>-e/t explosive) has been sourced from the February 2008 edition of the NGA Factors for use in this assessment.

## Vegetation Clearance

Vegetation clearance for the modified TCM would result in the release of greenhouse gas emissions. **Table 18** summarises the types and amount of vegetation cleared over the life of the TCM.

**Table 18 Vegetation Clearance Areas and Emission Factor Details**

Vegetation	Total Area Cleared (ha)	Biomass# (t/ha)	Carbon* (t/ha)	Total Carbon (t)	Emission Factor (t CO <sub>2</sub> -e/t carbon)
White Cypress Pine - Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion	36.8	272	136	5,010	3.67
White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions	22.3	272	136	3,033	3.67

# Derived from Australian Greenhouse Office (AGO) (2000).

\* Assuming 50% of biomass is carbon.

t/ha = tonnes per hectare.

t CO<sub>2</sub>-e/t carbon = tonnes of carbon dioxide equivalent per tonne of carbon.

Greenhouse gas emissions from vegetation clearance have been calculated on a per hectare basis adopting the methodology used by PAE Holmes (2009a, 2009b). The PAE Holmes methodology is based on various technical reports (AGO, 1999, 2000, 2002, 2003).

## Scope 3: Other Indirect Emissions

### Combustion of Product Coal

Indirect emissions of greenhouse gas from the combustion of product coal are expected "downstream" due to the combustion of coal produced by the modified TCM. Up to 2 Mtpa of ROM coal is to be produced by the modified TCM, with the majority destined for international markets.



From review of the 2008/2009 AEMR, this calculation assumes that 50% of ROM coal produced by the TCM is sold and combusted by third parties. The other 50% is assumed to be washed (ie. at the Whitehaven CHPP), of which 87% of this coal is product coal. All combusted coal is assumed to consist of 100% coking coal to be conservative.

The greenhouse gas emissions from combustion of product coal by other (non-TCPL) entities have been based on a coal energy content of 30 gigajoules per tonne (GJ/t) for coking coal (Thermal (black) has an energy content of 27 GJ/t) (Table 1 of the NGA Factors [DCC, 2009]). Standard emission factors for Scope 1<sup>4</sup> emissions from coal combustion have been taken from Table 1 of the NGA Factors.

### ***Transport via Road***

Indirect emissions of greenhouse gas would occur from the transportation of product coal from the TCM to the Whitehaven CHPP. The annual consumption of diesel associated with this activity has been estimated at 3,065 kL.

The annual emissions of CO<sub>2</sub> and other greenhouse gas from this source have been estimated using emission factors contained in Tables 3 and 4 of the NGA Factors (DCC, 2009). It has been assumed that the energy content of diesel is 38.6 megajoules per litre (MJ/L) (DCC, 2009).

### ***Transport via Rail***

Based on data provided for a previous study undertaken by Heggies for a coal mine near Gunnedah, product trains to Newcastle consume 0.015 litres of diesel per tonne of coal transported each kilometer (Whitehaven, pers comm., 2008). The distance between the Whitehaven CHPP and the Newcastle Port is approximately 300 km.

The annual emissions of CO<sub>2</sub> and other greenhouse gases from this source have been estimated using Table 4 of the NGA Factors (DCC, 2009). It has been assumed that the energy content of diesel is 38.6 MJ/L (DCC, 2009).

### ***Extraction, Production and Transport of Diesel Consumed at the Modified TCM***

Scope 3 greenhouse gas emissions attributable to diesel used at the modified TCM relate to its extraction, production and transport.

The annual emissions of CO<sub>2</sub> and other greenhouse gases from this source have been estimated using Table 38 of the NGA Factors (DCC, 2009).

## **9.3 Greenhouse Gas Calculation Results**

Calculated Scope 1 and Scope 3 emissions of greenhouse gas resulting from the emissions sources outlined above for the Modified TCM (**Table 17**) are presented in **Table 19** and **Table 20**, respectively. It is noted that no Scope 2 emissions are generated as part of the modified TCM. Total annual modified TCM emissions have been calculated and are presented in **Table 21**.

The most significant direct emissions are associated with fugitive emissions of methane resulting from coal extraction and the combustion of diesel in site vehicles.

The total direct (Scope 1) emissions from the modified TCM are estimated to be approximately 0.14 Mt CO<sub>2</sub>-e per annum.

---

<sup>4</sup> Note Scope 1 emission factor is used to account for combustion of coal, however these emissions are reported here as Scope 3 emissions as they are produced by third parties.



Indirect (Scope 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total indirect emissions (Scope 3) from the transport and end use of the coal are estimated to be 5.1 Mt CO<sub>2</sub>-e per annum.

A comparison of the predicted direct (Scope 1) emissions against Australia's 2007 net emissions of 597 Mt CO<sub>2</sub>-e demonstrates the Modified TCM would represent approximately 0.02 % of the total annual Australian emissions (DCC, 2008). A comparison of the predicted Scope 1 emissions against NSW emissions in 2007 (162.7 Mt CO<sub>2</sub>-e) demonstrates that the modified TCM would represent approximately 0.08% of NSW emissions (DCC, 2007).

**Table 19 Scope 1 Greenhouse Gas Emissions from the Modified TCM (2 Mtpa Coal Extraction)**

Emissions Source	Activity Rate / annum	Calculated Emissions t CO <sub>2</sub> -e /annum
<b>Fugitive Emissions</b>	-	90,000
<b>Diesel Consumption (Stationary Energy)</b>	312 kL	837
<b>Diesel Consumption (Transport Fuel)</b>	13,070 kL	35,219
<b>Explosive Usage</b>	7,227 tonnes	1,276
<b>Vegetation Clearance</b>	59.14 ha	8,043
<b>TOTAL</b>	-	<b>135,375</b>

**Table 20 Scope 3 Greenhouse Gas Emissions from the Modified TCM (2 Mtpa Coal Extraction)**

Emissions Source	Activity Rate / annum	Calculated Emissions t CO <sub>2</sub> -e /annum
<b>Rail Diesel Consumption</b>	9,000 kL	24,040
<b>Diesel Consumption (Stationary Energy)</b>	312 kL	171
<b>Diesel Consumption (On-site Transport Fuel)</b>	13,070 kL	7,205
<b>Diesel Consumption (Off-site Transport Fuel)</b>	3,065 kL	8,259
<b>Coking Coal Combustion (50% directly sold and combusted by third parties)</b>	1 Mt	2,706,600
<b>Coking Coal Combustion (50% washed at the Whitehaven CHPP – 87% of which combusted)</b>	0.87 Mt	2,354,742
<b>TOTAL</b>	-	<b>5,101,017</b>

**Table 21 Scope 1 and 3 Greenhouse Gas Emissions Attributable to the Modified TCM (t CO<sub>2</sub>-e/annum)**

Scope 1	Scope 3	Total
135,375	5,101,017	5,236,392



## 9.4 Greenhouse Gas Mitigation Measures

TCPL is committed to reducing greenhouse gas emissions. The following is taken from the 2008/2009 AEMR (TCPL, 2009b):

*The potential for reducing greenhouse gas emissions at Tarrawonga is related predominantly to consumption of diesel use by plant and equipment. Methods are in place at site to maximise efficiency from the mining fleet through regular maintenance scheduling and, where possible, minimising the gradient and length of loaded haul runs for the operating dump trucks. Tarrawonga Coal remains committed to a reduction in emission levels as a result of operations at the mine site. As part of this process, Tarrawonga Coal continues to run a fleet of Terex dump trucks (electric drive) which have proven to burn less diesel fuel as compared to the standard mechanical drive fleet at our Canyon site. Initial comparisons indicate a diesel saving of 0.23 litres/bcm/truck using the Terex partial electric drive, which, whilst only a modest saving, does represent real savings in terms of fuel burn and emission levels. Fuel burn has improved from 6.45 litres/tonne ROM coal (2007/2008 AEMR reporting period) to 5.43 litres/tonne ROM coal (2008/2009 AEMR reporting period).*

*In addition to this, the coal haulage contractor, Toll Resources continues to utilise a fleet of purpose built B-Doubles with the Prime Mover's specifically engineered to comply with emission and noise criteria. This includes being speed limited to 93 km/hr which has been determined as the optimum operating speed in terms of operational and fuel efficiency. A number of sub-contract trucks are also currently being used however Toll has indicated that these will be replaced with the purpose build B-Doubles in the future.*

*Tarrawonga Coal is also a member of the Federal Governments Greenhouse Challenge Plus Program which will be used as a guide to improving efficiencies across the site wherever possible. It is also noted that fugitive emissions have been based on the default factors for mines in NSW. This default factor is likely to be above actual emission levels from the Tarrawonga site. Tarrawonga Coal is currently investigating undertaking its own sampling to determine an appropriate emissions factor applicable to the Tarrawonga operation.*



## 10 CONCLUSIONS

Modelling of potential mining fugitive dust, PM<sub>10</sub> and TSP emissions was undertaken using the CALPUFF Dispersion Model software approved by the DECCW.

A scenario was constructed to represent potential emissions due to the proposed TCM.

The findings of the modelling exercise indicate that the modified TCM would comply with the relevant criteria. In summary:

- Dust deposition levels are predicted to be below the modified TCM air quality criteria at all surrounding dwellings.
- Cumulative annual average TSP concentrations are predicted to satisfy the modified TCM criterion at all surrounding dwellings.
- Cumulative annual average PM<sub>10</sub> concentrations are predicted to be below the modified TCM air quality goal at all surrounding dwellings.
- Incremental maximum 24-hour PM<sub>10</sub> concentrations attributable to the modified TCM are predicted to be well below the 50 µg/m<sup>3</sup> air quality criteria at all surrounding dwellings.
- Cumulative maximum 24-hour PM<sub>10</sub> concentrations attributable to the modified TCM are predicted to be well below the 150 µg/m<sup>3</sup> air quality criteria at all surrounding dwellings.
- Cumulative maximum 24-hour PM<sub>10</sub> concentrations attributable to the modified TCM plus background concentrations are predicted to be well below the 50 µg/m<sup>3</sup> air quality criteria for best practice air quality management at the majority of surrounding dwellings. However, exceedances are predicted at the following near-by receptor, during the identified modelled Scenario:
  - Receptor 3 (“Green Hills”) on two occasions.

Detailed examination of these exceedances has shown that each one occurs when background concentrations are greater than 42 µg/m<sup>3</sup> and on days when a regional particulate episode is likely to have occurred. Given that the exceedances are background driven rather than mine-related, no additional air quality mitigation measures are considered to be necessary to control the modified TCM’s small contribution to these exceedances.

It is concluded that, based on the conservative modelling scenario, relatively low predicted incremental PM<sub>10</sub> concentrations and the conservative background concentrations adopted as part of this assessment, the likelihood of exceedances of the 24-hour PM<sub>10</sub> 50 µg/m<sup>3</sup> criterion being experienced during actual operations of the modified TCM is small.

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 conservative, with levels expected to be lower than those modelled during standard operations.

This assessment also considers emissions of methane and CO<sub>2</sub> from the modified TCM and includes estimates of direct and indirect greenhouse gas emissions.

Indirect (Scope 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total indirect emissions (Scope 3) from mining transport and end use of the coal are estimated to be 5.2 Mt CO<sub>2</sub>-e per annum.

A comparison of the predicted direct (Scope 1) emissions against Australia’s 2007 net emissions of 597 Mt CO<sub>2</sub>-e demonstrates the Modified TCM would represent approximately 0.02 % of the total annual Australian emissions (DCC, 2008). A comparison of the predicted Scope 1 emissions against NSW emissions in 2007 (162.7 Mt CO<sub>2</sub>-e) demonstrates that the Modified TCM would represent approximately 0.08% of NSW emissions (DCC, 2007).



## 11 REFERENCES

The following material has been referenced within this report:

- Australian Greenhouse Office (1999) “Woody Biomass: Methods for Estimating Change”, National Carbon Accounting System Technical Report No. 3 August 1999.
- Australian Greenhouse Office (2000) “Synthesis of Allometrics, Review of Root Biomass and Design of Future Woody Biomass Sampling Strategies”, National Carbon Accounting System Technical Report No. 17 September 2000.
- Australian Greenhouse Office (2002) “Greenhouse Gas Emissions from Land Use Change in Australia: An Integrated Application of the National Carbon Accounting System”, May 2002.
- Australian Greenhouse Office (2003) “Spatial Estimates of Biomass in ‘Mature’ Native Vegetation”, National Carbon Accounting System Technical Report No. 44 November 2003.
- Bureau of Meteorology (2009), “Historic Climate Data from Gunnedah Pool Climate Station”
- Commonwealth of Australia (2001) “National Pollutant Inventory, Emission Estimation Technique Manual for Mining, Version 2.3, December 2001”.
- Department of Climate Change (2007) “Australia’s National Greenhouse Accounts, State and Territory Greenhouse Gas Inventories”.
- Department of Climate Change (2008) “Australia’s National Greenhouse Accounts”, The Australian Government’s Initial Report under the Kyoto Protocol.
- Department of Climate Change (2009) “National Greenhouse Accounts (NGA) Factors Workbook”.
- Department of Environment and Climate Change (2008) “National Environment Protection (Ambient Air Quality) Measure New South Wales Annual Compliance Report 2007”.
- Department of Environment and Conservation (2005), “Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales”.
- Department of Environment and Conservation (2007) “Approved Methods for the Sampling and Analysis of Air Pollutants in NSW”.
- Department of Environment, Climate Change and Water (2008), National Environmental Protection (Ambient Air Quality) Measure, New South Wales Annual Compliance Report 2007, December 2008
- Department of Environment, Climate Change and Water (2009), PM<sub>10</sub> data from the DECCW’s Tamworth monitoring site for December 2006 to November 2009
- Intergovernmental Panel on Climate Change (1996) “Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories”.
- National Environmental Protection Council (1998) “Ambient Air Quality National Environment Protection Measure”.
- NSW Minerals Council (2000) “Technical Paper - Particulate Matter and Mining Interim Report”.
- PAE Holmes (2009a) “Air Quality Impact Assessment: Cadia East Project”.
- PAE Holmes (2009b) “Air Quality Impact Assessment: Bulli Seam Operations”.
- Richard Heggies Associates (2005) “East Boggabri Coal Mine Air Quality Impact Assessment”
- Scire, J., Strimaitis, D. and Yamartino, R. (2000) “A User’s Guide for the CALPUFF Dispersion Model”.



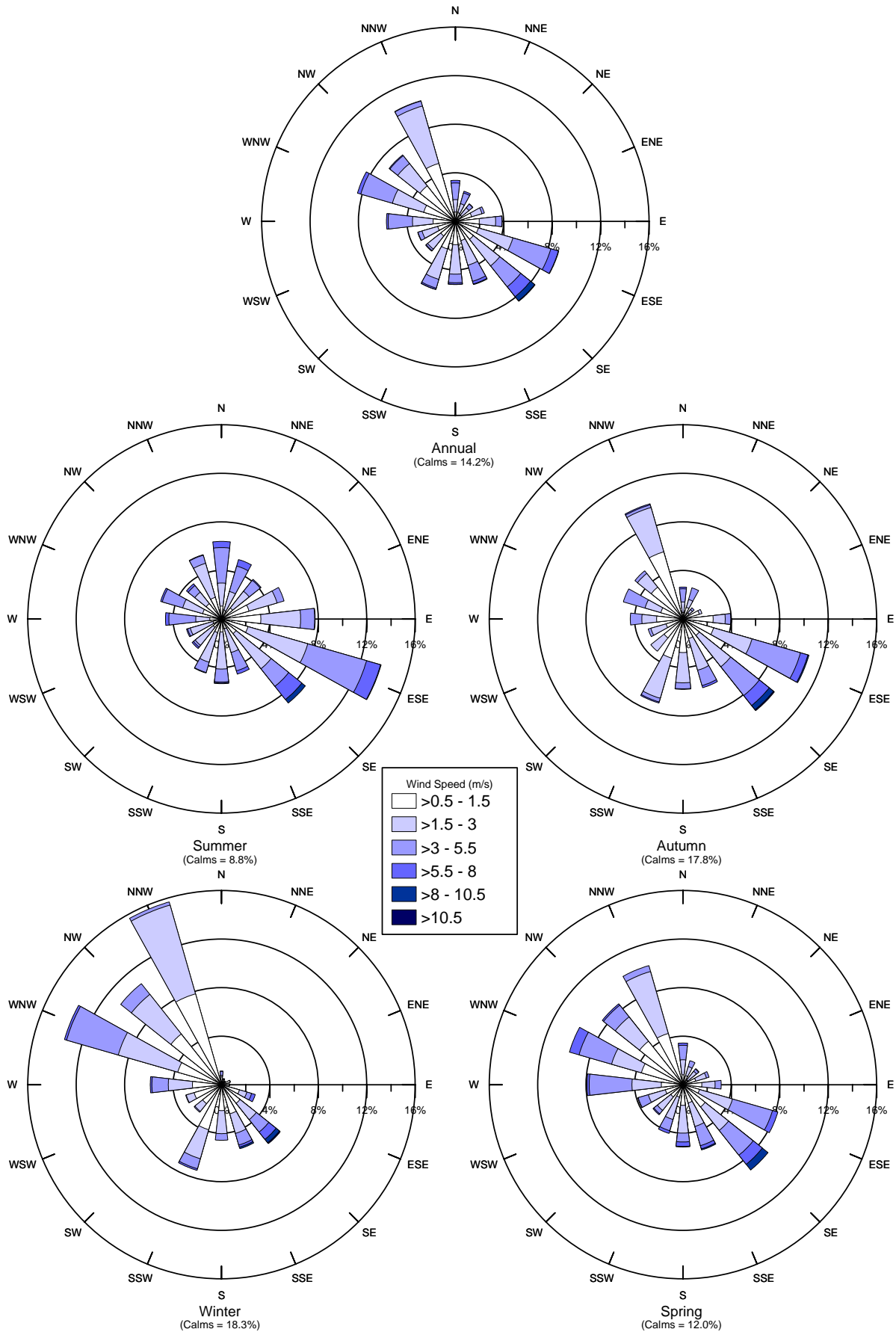
- Tarrawonga Coal Pty Ltd (2005a) “East Boggabri Joint Venture Environmental Impact Statement”, prepared by R.W. Corkery & Co. Pty Limited.
- Tarrawonga Coal Pty Ltd (2005b) “Tarrawonga Coal Mine Air Quality Monitoring Program”.
- Tarrawonga Coal Pty Ltd (2007) “Annual Environmental Monitoring Report – 2006-2007”.
- Tarrawonga Coal Pty Ltd (2008) “Annual Environmental Monitoring Report – 2007-2008”.
- Tarrawonga Coal Pty Ltd (2009a) “Meteorological and Air Quality Collected at TCM Site”.
- Tarrawonga Coal Pty Ltd (2009b) “Annual Environmental Monitoring Report – 2008-2009”.
- Tarrawonga Coal Pty Ltd (2010) Proponent provided figures for reporting purposes Figures 1 to 5).
- United States Environmental Protection Agency (2000), Meteorological Monitoring Guidance for Regulatory Modeling Applications.



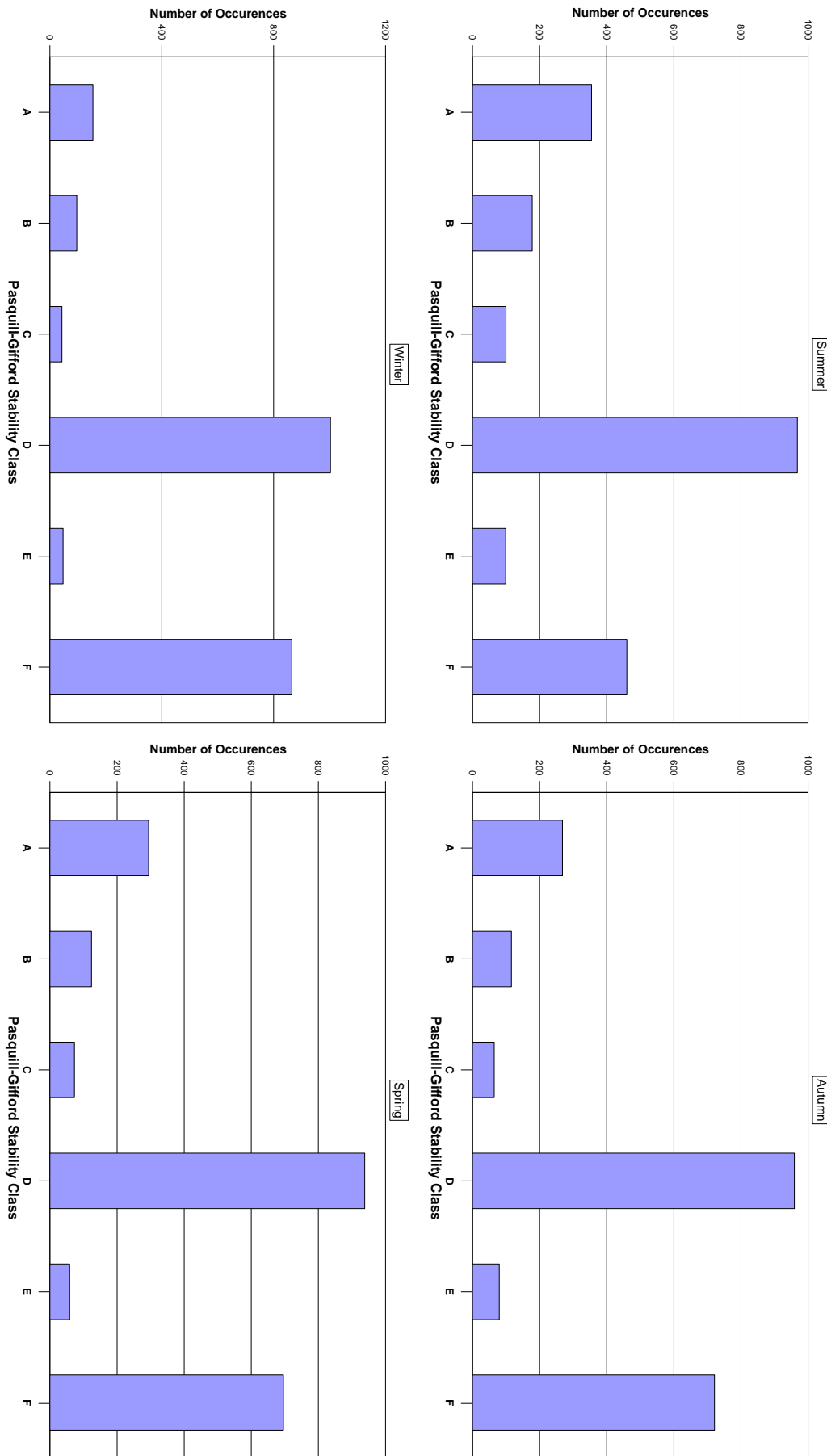
## 12 GLOSSARY AND TERMS

AHD	Australian Height Datum
AEMR	Annual Environmental Management Report
Approved Methods NSW	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
CHPP	Coal Handling and Preparation Plant
CO <sub>2</sub> -e	Carbon Dioxide Equivalent
DECCW	NSW Department of the Environment, Climate Change and Water
g/m <sup>2</sup> /month	Grams per square metre per month
Heggies	Heggies Pty Ltd
HVAS	High Volume Air Sampler
IBC	Idemitsu Boggabri Coal
µg	microgram (g x 10 <sup>-6</sup> )
µm	micrometre or micron (metre x 10 <sup>-6</sup> )
m <sup>3</sup>	cubic metre
MGA	Map Grid of Australia
Mtpa	Million tonnes per annum
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
PM <sub>10</sub>	particulate matter less than 10 microns in aerodynamic diameter
ROM	run-of-mine
TAPM	The Air Pollution Model
TCPL	Tarrawonga Coal Pty Ltd
TSP	Total Suspended Particulate
USEPA	United States Environmental Protection Agency

SEASONAL WIND ROSES – TARRAWONGA COAL MINE - 2007



## CALCULATED SEASONAL VARIATION IN ATMOSPHERIC STABILITY CLASS



## EMISSIONS INVENTORY FOR SITE OPERATIONS

**Tables C-1 to C-8** below provide information on the raw data used as input to air quality emission factor estimations. These estimations have been derived using emission factors provided primarily within the National Pollutant Inventory (NPI) Emission Estimation Technique Manuals (EETM) (Commonwealth of Australia, 2001). The EETM of relevance to this assessment is the EETM for Mining (Version 2.3).

Where emission factors are not available within the NPI documentation, or alternative emission factors have been deemed to be more appropriate for this study, these have been sourced from the United States Environmental Protection Agency (US EPA) AP 42 emission factor documentation. Where information on emission sources has not been provided within the AP 42 documentation, emission estimates have been sourced from published peer reviewed material.

Emission factor equations used within this assessment are presented in **Table C-9** with relevant control factors presented in **Table C-10**.

The following tables provide information on the raw data used to determine operational characteristics of each modelled scenario and the data used in emission factor equations.

**Table C-1 Mining Related Emissions - Operational Hours**

Scenario	Activity	Hours of Operation
Modified TCM	On-site Coal Crushing and Screening	7.00am to 12.00am Monday to Friday, 12.00am to 3.30am Tuesday to Saturday, and 7.00am to 6.00pm Saturdays
	Open Cut Operations	7.00am to 12.00am Monday to Friday, 12.00am to 3.30am Tuesday to Saturday, and 7.00am to 6.00pm Saturdays

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

## EMISSIONS INVENTORY FOR SITE OPERATIONS

**Table C-2 Coal and Waste Rock Parameters used in Emissions Estimation**

Parameter	Value	Units	Source	Notes
Silt Content	1.8	%	Heggies (2005)	Applied to haul roads and waste rock
Moisture Content	3.5	%	Heggies (2005)	Applied to coal extracted in open cut
	5.5	%		Applied to coal subject to water spraying
	5	%		Applied to Waste Rock
Area Blasted	6,000	square metres (m <sup>2</sup> )	Heggies (2005)	Area blasted per blast (1 per day assumed for 24-hr modelling [PM <sub>10</sub> ])
Blasts per year	72	number of blasts	Heggies (2005)	
Grader mean speed	7.5	kilometres per hour (km/h)	TCPL (2009)	

TCPL = Tarrawonga Coal Pty Ltd

For the modified Tarrawonga Coal Mine (TCM), the figures presented in **Table C-3** have been adjusted where appropriate based on the increases in coal extraction or waste rock removal. Data on hours of activity for certain equipment has also been adjusted based on coal extraction rates.

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd	
	(10-8480R2R4.doc) 9 April 2010	

EMISSIONS INVENTORY FOR SITE OPERATIONS

**Table C-3 Equipment List – Modified TCM**

Item	Number in Operation (Proposed)	Function
O & K RH170 Excavator	3	Waste Rock excavation and loading
Hitachi EX1900 Excavator	1	Waste Rock/Coal loading
Terex MT3300 Dump Truck	7	Waste Rock haulage
CAT Dump Truck 777F	3	Waste Rock/Coal haulage
CAT Dump Truck 785C	4	Waste Rock/Coal haulage
Terex SKF Drill	1	Blasthole drilling
Cubex QXR1320 Gen V Drill	1	Blasthole drilling
CAT D11R Dozer	4	Clearing; Interburden/Coal Ripping/Pushing; Dump Maintenance
CAT D10R Dozer	1	Clearing; Interburden/Coal Ripping/Pushing; Dump Maintenance
Water Cart	2	Dust Suppression
CAT 773 Water Truck	1	Dust Suppression
CAT 16M Grader	2	Road Maintenance
CAT 637-2 Scraper	4	Soil Removal and Stockpiling
Mobile Crusher	1	Coal Crushing
IT38G Loader	2	Loading
CAT 988H Loader	2	Loading

**Table C-4 Area of Active Wind Erosion Sources used in Dispersion Modelling (hectares [ha])<sup>1</sup>**

Area Type	NE Waste Rock Emplacement	SE Waste Rock Emplacement	ROM	Temporary In-Pit ROM	Topsoil Stockpile	Open Cut
Active	5.5	4.8	0.5	0.25	3	25
Inactive	40		N/A	N/A	N/A	N/A

Note <sup>1</sup> Active areas are constantly disturbed – assumed 1/8 of total area of Waste Rock Emplacements and Topsoil Stockpiles assumed to be active, 100% of run of mine (ROM) assumed to be active.  
N/A = Not applicable

**Table C-5 Haulage Parameters used in Emissions Estimation<sup>1</sup>**

Project	Coal		Waste Rock <sup>2</sup>		Topsoil	
	Haul Road Distance (km)	Daily truck movements <sup>1</sup>	Haul Road Distance (km)	Daily truck movements <sup>1</sup>	Haul Road Distance (km)	Daily truck movements <sup>1</sup>
TCM Modification	4.7	46	2.6 (NE Waste Rock Emplacement)	175	2.8	11
			2 (SE Waste Rock Emplacement)	411		

EMISSIONS INVENTORY FOR SITE OPERATIONS

0.7 (In-pit fill) 175

- <sup>1</sup> Assumed capacity of haul trucks 136 tonnes (t) (TEREX MT3300, CAT 785C), 91t (CAT 777F)
- <sup>2</sup>: Assumed 23% of Waste Rock to NE Waste Rock Emplacement, 23% to SE Waste Rock Emplacement and 23% as in pit fill (TCPL pers comm. 2010)
- km = kilometre

**Table C-6 Meteorological data required for Emissions Estimation**

Parameter	Value	Units	Source
Mean wind speed	2.0	m/s	Based on site recorded meteorological data
Percentage of time when wind speed > 5.4 m/s	4.2	%	Based on site recorded meteorological data
Average hourly evaporation rate	4.8	mm/day	Based on long-term average data from BoM Gunnedah Resource Centre AWS 1948 to 2009 (BoM, 2009)
Number of days with rainfall > 0.25 mm	76	days	Based on site recorded meteorological data

BoM = Bureau of Meteorology  
 m/s = metre per second.  
 mm = millimetre.  
 mm/day – millimetre per day.  
 AWS = Automated Weather Station.

**Table C-7 Modified TCM Extraction Rates - Proposed**

Year	Coal (Mtpa)	Waste Rock (Mbcm)	Topsoil (Mtpa)
Year 2	2.0	17.56	0.26

Note: Density of Waste Rock and topsoil assumed to be 2 tonnes per cubic metre (t/m<sup>3</sup>)  
 Mbcm = million bank cubic metres.  
 Mtpa = million tonnes per annum.

**Table C-8 Control Factor Variables**

Parameter	Value	Units	Source
Water application intensity on haul routes	2	L/m <sup>2</sup>	Heggies (2005)
Time between water application on haul routes	1	hours	Heggies (2005)

L/m<sup>2</sup> = litres per square metres

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd	
	(10-8480R2R4.doc) 9 April 2010	

## EMISSIONS INVENTORY FOR SITE OPERATIONS

Table C-9 Emission Factor Equations

Activity	Emission Factor Equation	Units	Source	Variables
Drilling	Default of 0.59 for total suspended particulates (TSP) Default of 0.31 for particulate matter less than 10 microns in size (PM <sub>10</sub> )	kg/hole	NPI EETM v2.3 (p11)	
Blasting	$= 0.00022 \times A^{1.5}$ for TSP As above multiplied by 0.52 for PM <sub>10</sub>	kg/blast	AP42 Western Surface Coal Mining	A = Area Blasted (m <sup>2</sup> ) M = Moisture content (%) D = Depth of blast holes (m)
Excavator on waste rock	$= k \times 0.0016 \times (U / 2.2)^{1.3} \times (M / 2)^{-1.4}$	kg/t	NPI EETM v2.3 (p11)	k = 0.74 (TSP) k = 0.35 (PM <sub>10</sub> ) U = mean wind speed (m/s) M = Moisture content (%)
Excavator on coal	$= k \times 0.00596 \times M^{-0.9}$	kg/t	NPI EETM v2.3 (p11)	k = 1.56 (TSP) k = 0.75 (PM <sub>10</sub> ) M = Moisture content (%)
Haul route wheel dust	$EF = k \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W}{3}\right)^{0.45} \times \left(\frac{281.9}{1000}\right) \times \left(\frac{365 - p}{365}\right)$	kg/vehicle kilometres travelled (VKT)	USEPA AP42 - Wheel Generated Dust from Unpaved Roads (2003)	k = 4.9 (TSP) k = 1.5 (PM <sub>10</sub> ) s = silt content (%), W = vehicle gross mass (tonnes) p = number of days in year with rainfall greater than 0.25mm
Trucks dumping coal	Default of 0.01 for TSP Default of 0.0042 for PM <sub>10</sub>	kg/t	NPI EETM v2.3 (p11)	
Trucks dumping waste rock	Default of 0.012 for TSP Default of 0.0043 for PM <sub>10</sub>	kg/t	NPI EETM v2.3 (p11)	
Dozer on coal	TSP = $35.6 \times s^{1.2} \times M^{-1.4}$ PM <sub>10</sub> = $6.33 \times s^{1.5} \times M^{-1.4}$	kg/hr	NPI EETM v2.3 (p11)	s=silt content (%) M=Moisture content (%)
Dozer on material other than coal	TSP = $2.6 \times s^{1.2} \times M^{-1.3}$ PM <sub>10</sub> = $0.34 \times s^{1.5} \times M^{-1.4}$	kg/hr	NPI EETM v2.3 (p11)	s=silt content (%) M=Moisture content (%)
Grader	TSP = $0.0034 \times S^{2.5}$ PM <sub>10</sub> = $0.0034 \times S^{2.0}$	kg/VKT	NPI EETM v2.3 (p12)	S=mean vehicle speed (km/h)

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment	
	Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010	

## EMISSIONS INVENTORY FOR SITE OPERATIONS

Activity	Emission Factor Equation	Units	Source	Variables
Crusher	Default of 0.01 for TSP (Emission Factor for Primary Crushing, High Moisture Ore)	kg/t	NPI EETM v2.3 (p14)	
	Default of 0.004 for PM <sub>10</sub> (Emission Factor for Primary Crushing, High Moisture Ore)			
Wind Erosion	$TSP = 1.9 \times \left( \frac{s}{1.5} \right) \times 365 \times \left( \frac{365 - p}{235} \right) \times \left( \frac{f}{15} \right)$ <p>PM<sub>10</sub>=As above multiplied by 0.5</p> <p>The suspension of particulate matter typically commences when wind speed approaches 5 m/s (Sinclair Knight Merz [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 5 m/s.</p> <p>CALPUFF (see <b>Section 7</b>) 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.</p> <p>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 0.5 m/s (considered highly conservative as fine coal dust is quoted as 0.54 m/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).</p>	kg/ha/year	NPI EETM v2.3 (p41)	<p>s = silt content (%)</p> <p>p = number of days in year with rainfall greater than 0.25 mm</p> <p>f = percentage of time that wind speed is greater than 5.4 m/s at the mean height of the stockpile</p>

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

EMISSIONS INVENTORY FOR SITE OPERATIONS

**Table C-10 Emission Control Factors**

Mitigation Measure	Applicable to	Value	Units	Source	Variables
Water Spraying	Haul routes <sup>1</sup>	$CF = 100 - \frac{(0.8 \times P \times d \times t)}{I}$	%	Cowherd et al (1988)	P=Potential Average Daytime Evaporation Rate (mm/hr) d = Daily average truck movements I = Water Application Intensity (L/m) <sup>2</sup> t = Time between application (hours).
	Drilling	50	%	NPI EETM v2.3 (p16) – conservatively used	
Open Cut Retention	Activities in-pit: Blasting Drilling Excavator Dozer Haul route (certain sections)	TSP=50 PM <sub>10</sub> =5	%	NPI EETM v2.3 (p16)	

<sup>1</sup>: Control Factor varies by haul route (ROM, Waste Rock Dump and Topsoil).

<sup>2</sup>: Rainfall has been taken into account during the calculation of wind erosion emissions (refer **Table DA-9**).

**REFERENCES**

- Bureau of Meteorology (2009) “Historic Climate Data from Gunnedah Pool Climate Station”.
- Commonwealth of Australia (2001) “National Pollutant Inventory, Emission Estimation Technique Manual for Mining, Version 2.3, December 2001”.
- Cowherd, C. Jr., Muleski, G.E. and Kinsey, J.S. (1988) “Control of Open Fugitive Dust Sources”.
- Heggies Pty Ltd (2005) “East Boggabri Coal Mine Air Quality Impact Assessment”
- Sinclair Knight Merz (2005) “Improvement of NPI Fugitive Particulate Matter Emission Estimation Techniques”.
- Tarrawonga Coal Pty Ltd (2009) Pers. Comm.
- United States Environmental Protection Agency (2003) “Compilation of Air Pollutant Emission Factors AP-42” (Chapter 13, Section 13.2.2 Unpaved Roads)
- United States Environmental Protection Agency (2006) “Compilation of Air Pollutant Emission Factors AP-42” (Chapter 13, Section 13.2.5 Industrial Wind Erosion).

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010	
---	--	--

## DISPERSION MODELLING RESULTS FOR MINE-RELATED RECEPTORS

### D1 Dust Deposition

**Table D-1** shows the results of the dispersion modelling for dust deposition from the modified TCM at each of the relevant receptors using the emission rates calculated in **Attachment C**.

**Table D-1 Predicted Incremental and Cumulative Dust Deposition at Nearest Receptors**

Receptor ID	Receptor Name	Dust Deposition- Annual Average (g/m <sup>2</sup> /month)		Assessment Criteria (g/m <sup>2</sup> /month)	
		Increment	Cumulative	Increment	Cumulative
P1	<i>Merriown</i>	0.8	2.0	2	4
P2	<i>Nagero</i>	1.5	2.7	2	4
P3	<i>Thuin</i>	5.8	7.0	2	4
P4	<i>Bollol Creek Station</i>	1.8	3.0	2	4
P5	<i>Templemore</i>	1.9	3.1	2	4
P6	<i>'Unnamed'</i>	0.3	1.5	2	4
P7	<i>Blair Athol School House</i>	1.1	2.3	2	4

g/m<sup>2</sup>/month = grams per square metre per month.

The results indicate that annual average dust deposition levels at all relevant receptors are predicted to be below the relevant criterion of 4 g/m<sup>2</sup>/month (cumulative dust deposition) when using a background deposition level of 1.2 g/m<sup>2</sup>/month with the exception of Receptor P3 Thuin, which is located within the Tarrawonga Coal Mine (TCM) Mining Lease (ML) 1579.

### D2 TSP

**Table D-2** shows the results of the dispersion modelling for TSP from the modified TCM at each of the relevant receptors for using the emission rates calculated in **Attachment C**. As discussed in **Section 6.4**, a conservative background concentration of 30.5 micrograms per cubic metre (µg/m<sup>3</sup>) has been assumed for the modified TCM.

Annual average total suspended solids (TSP) concentrations are within the criterion of 90 µg/m<sup>3</sup> at all modelled identified receptors.

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

DISPERSION MODELLING RESULTS FOR MINE-RELATED RECEPTORS

**Table D-2 Predicted Incremental and Cumulative Annual Average TSP Concentrations at Nearest Receptors**

Receptor ID	Receptor Name	TSP Concentrations- Annual Average ( $\mu\text{g}/\text{m}^3$ )		Assessment Criterion ( $\mu\text{g}/\text{m}^3$ )
		Increment	Cumulative	Cumulative
P1	<i>Merriown</i>	4	35	90
P2	<i>Nagero</i>	7	38	90
P3	<i>Thuin</i>	29	59	90
P4	<i>Bollol Creek Station</i>	9	39	90
P5	<i>Templemore</i>	9	40	90
P6	<i>'Unnamed'</i>	1	32	90
P7	<i>Blair Athol School House</i>	5	36	90

**D3 Particulate Matter less than 10 microns in size ( $\text{PM}_{10}$ )**

**Annual Average  $\text{PM}_{10}$**

Presented in **Table D-3** are the results of the dispersion modelling for annual average  $\text{PM}_{10}$  from the modified TCM at each of the identified receptors using the emission rates calculated in **Attachment C**.

An annual average background concentration of  $15.8 \mu\text{g}/\text{m}^3$  has been applied to obtain an indication of the potential cumulative impacts associated with the modified TCM and to allow comparison with the annual average  $\text{PM}_{10}$  criterion of  $30 \mu\text{g}/\text{m}^3$ .

**Table D-3 Predicted Incremental and Cumulative Annual Average  $\text{PM}_{10}$  Concentrations at Nearest Receptors**

Receptor ID	Receptor Name	$\text{PM}_{10}$ Concentrations- Annual Average ( $\mu\text{g}/\text{m}^3$ )		Assessment Criterion ( $\mu\text{g}/\text{m}^3$ )
		Increment	Cumulative	Cumulative
P1	<i>Merriown</i>	1	17	30
P2	<i>Nagero</i>	3	19	30
P3	<i>Thuin</i>	8	24	30
P4	<i>Bollol Creek Station</i>	3	19	30
P5	<i>Templemore</i>	4	19	30
P6	<i>'Unnamed'</i>	1	17	30
P7	<i>Blair Athol School House</i>	2	18	30

Annual average  $\text{PM}_{10}$  concentrations are predicted to satisfy the criterion of  $30 \mu\text{g}/\text{m}^3$  at all the modelled receptors.

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

DISPERSION MODELLING RESULTS FOR MINE-RELATED RECEPTORS

**Incremental 24-hour Maximum PM<sub>10</sub>**

Presented in **Table D-4** are the dispersion modelling predictions of the highest five (incremental) 24-hour maximum PM<sub>10</sub> concentrations from the modified TCM at each of the identified receptors.

**Table D-4 Predicted Incremental 24-hour PM<sub>10</sub> Concentrations at Nearest Receptors**

Rank of 24-hour PM <sub>10</sub> Concentration	24-hour PM <sub>10</sub> Concentration (µg/m <sup>3</sup> )							Assessment Criterion (µg/m <sup>3</sup> )
	P1	P2	P3	P4	P5	P6	P7	
	<i>Merriown</i>	<i>Nagero</i>	<i>Thuin</i>	<i>Bollol Creek Station</i>	<i>Templemore</i>	<i>'Unnamed'</i>	<i>Blair Athol School House</i>	
Maximum	16	30	66	19	23	11	18	50
2nd	13	23	35	19	19	8	16	
3rd	13	22	33	17	16	8	15	
4th	13	21	31	17	15	8	13	
5th	13	20	31	16	14	7	12	

**Cumulative 24-hour Maximum PM<sub>10</sub>**

Predictions of incremental PM<sub>10</sub> concentrations on each modelled day have been paired with the corresponding background concentration monitored at the New South Wales Department of Environment, Climate Change and Water (DECCW) Tamworth monitoring site. This allows an examination of the maximum predicted cumulative concentration (modified TCM plus background) which could potentially be experienced under the worst case operating conditions modelled.

Presented in **Table D-5** are the dispersion modelling predictions of the highest five cumulative (modified TCM plus background) 24-hour maximum PM<sub>10</sub> concentrations at each of the identified receptors.

**Table D-5 Predicted Cumulative 24-hour PM<sub>10</sub> Concentrations at Nearest Receptors**

Rank of 24-hour PM <sub>10</sub> Concentration	24-hour PM <sub>10</sub> Concentration (µg/m <sup>3</sup> )							Assessment Criterion (µg/m <sup>3</sup> )
	P1	P2	P3	P4	P5	P6	P7	
	<i>Merriown</i>	<i>Nagero</i>	<i>Thuin</i>	<i>Bollol Creek Station</i>	<i>Templemore</i>	<i>'Unnamed'</i>	<i>Blair Athol School House</i>	
Maximum	49	49	77	55	55	49	53	50 (TCM and other sources – for determining best practice air quality management) 150 (TCM and other sources
2nd	43	46	55	48	47	43	48	
3rd	43	43	53	48	45	43	47	
4th	37	43	53	46	45	37	45	
5th	36	41	51	43	43	36	39	

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

## DISPERSION MODELLING RESULTS FOR MINE-RELATED RECEPTORS

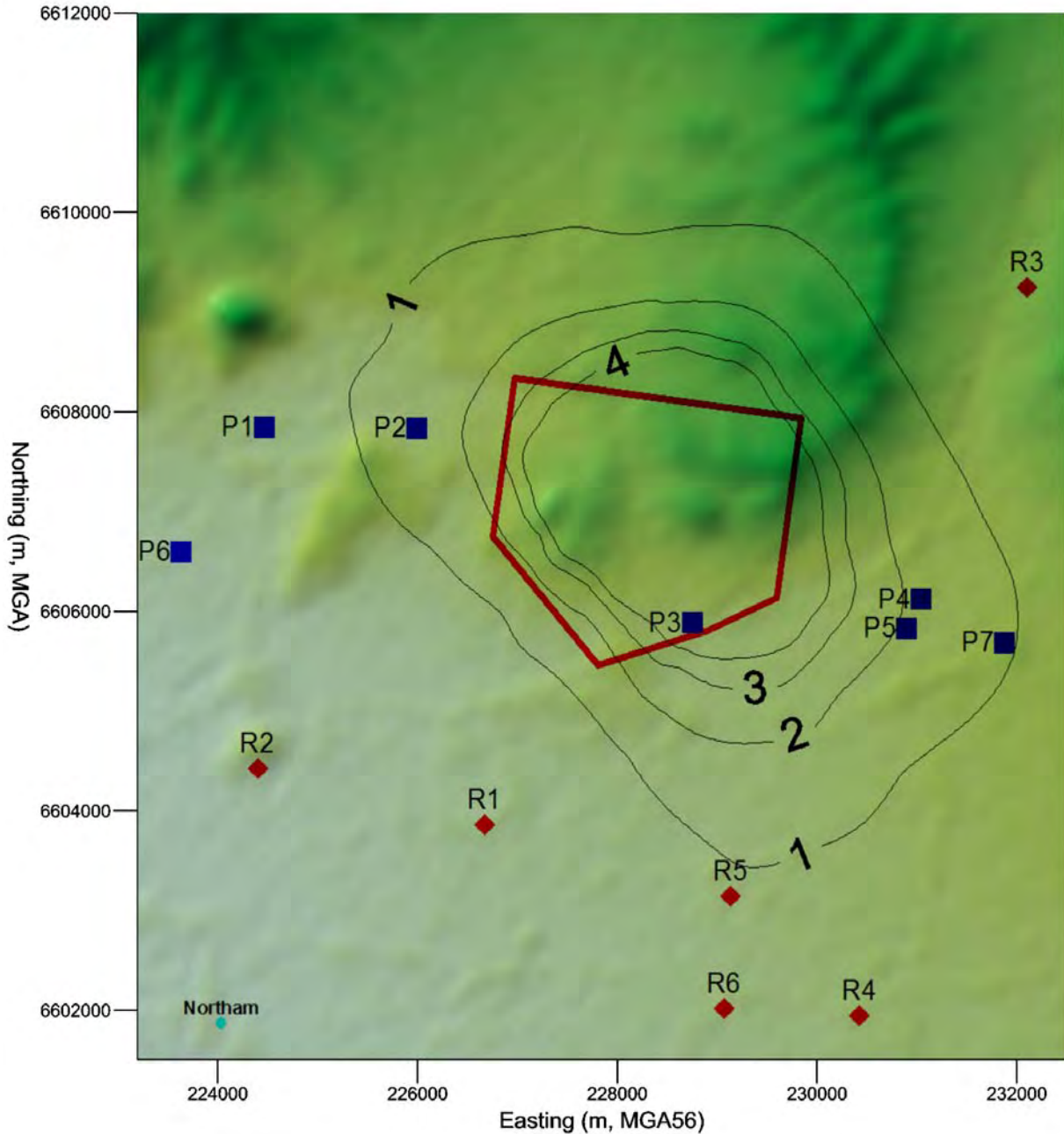
The DECCW 24-hour PM<sub>10</sub> criterion is predicted to be exceeded at Receptor P3 “Thuin” (within ML 1579), without the addition of background concentration. The cumulative assessment indicates that with the exception of Receptors P1 “Merriown”, P2 “Nagero” and P6 ‘Unnamed’, the PM<sub>10</sub> criterion is exceeded at all relevant receptors.

Heggies Pty Ltd Report Number 10- 8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010	
---	--	--

CONTOUR PLOT OF INCREMENTAL POLLUTANT INCREASES PREDICTED FROM MODIFIED TCM OPERATION

Figures E-1 to E-4 are contour plots of the incremental increases in pollutant concentrations predicted due to the modified Tarrawonga Coal Mine (TCM) operations. Pollutant concentrations were predicted on a grid of receptors, in addition to the discrete receptors presented in **Table 3**.

**Figure E-1 Predicted Incremental Increase in Monthly Average Dust Deposition due to Modified TCM Operation (grams per square metre per month [g/m<sup>2</sup>/month])**

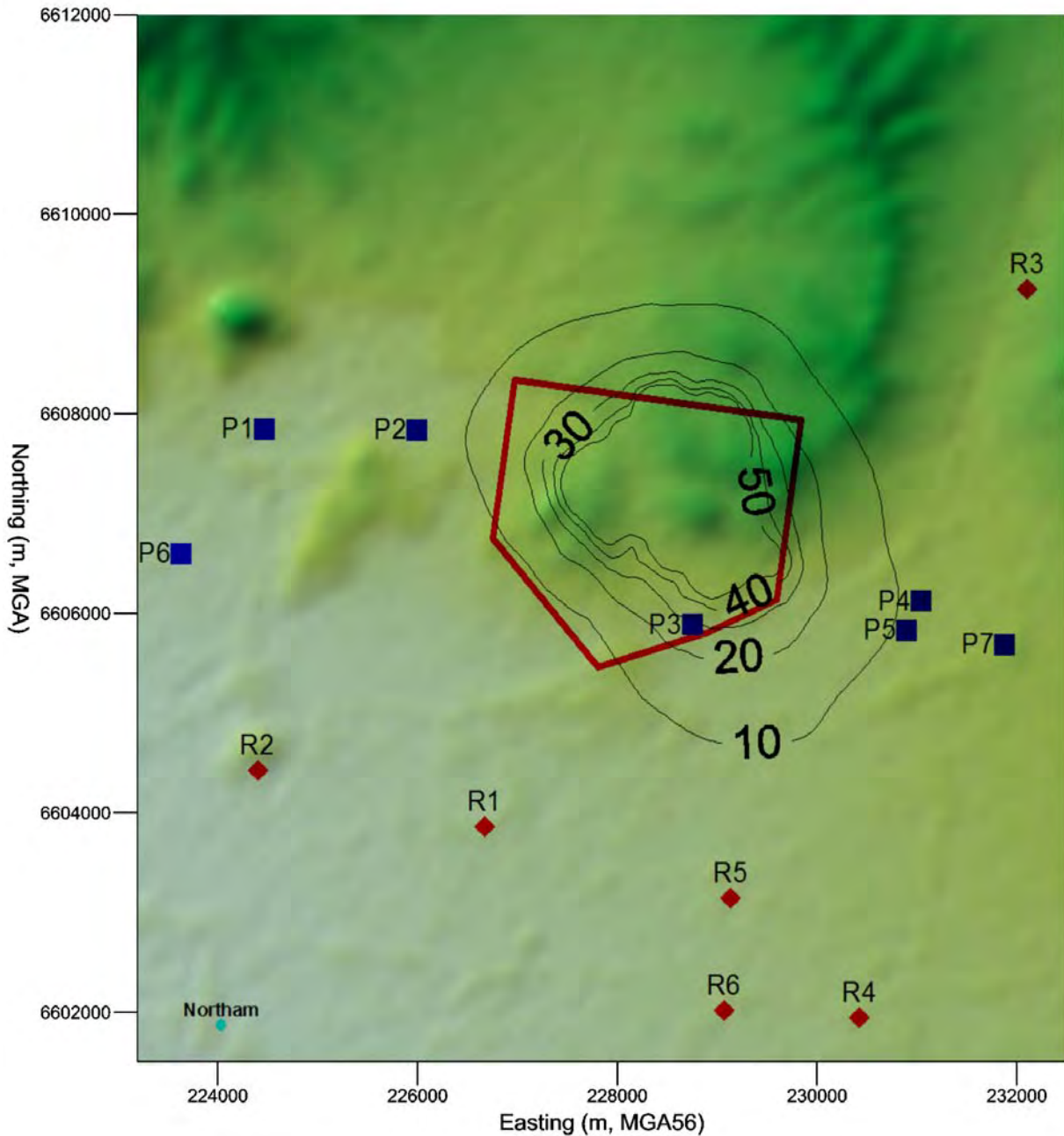


Note: Also shown are Properties within the modelling domain at which no single point predictions have been made. These are presented for information only

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010	
---	--	--

CONTOUR PLOT OF INCREMENTAL POLLUTANT INCREASES PREDICTED FROM MODIFIED TCM OPERATION

**Figure E-2 Predicted Incremental Increase in Annual Average TSP Concentrations due to Modified TCM Operations ( $\mu\text{g}/\text{m}^3$ )**

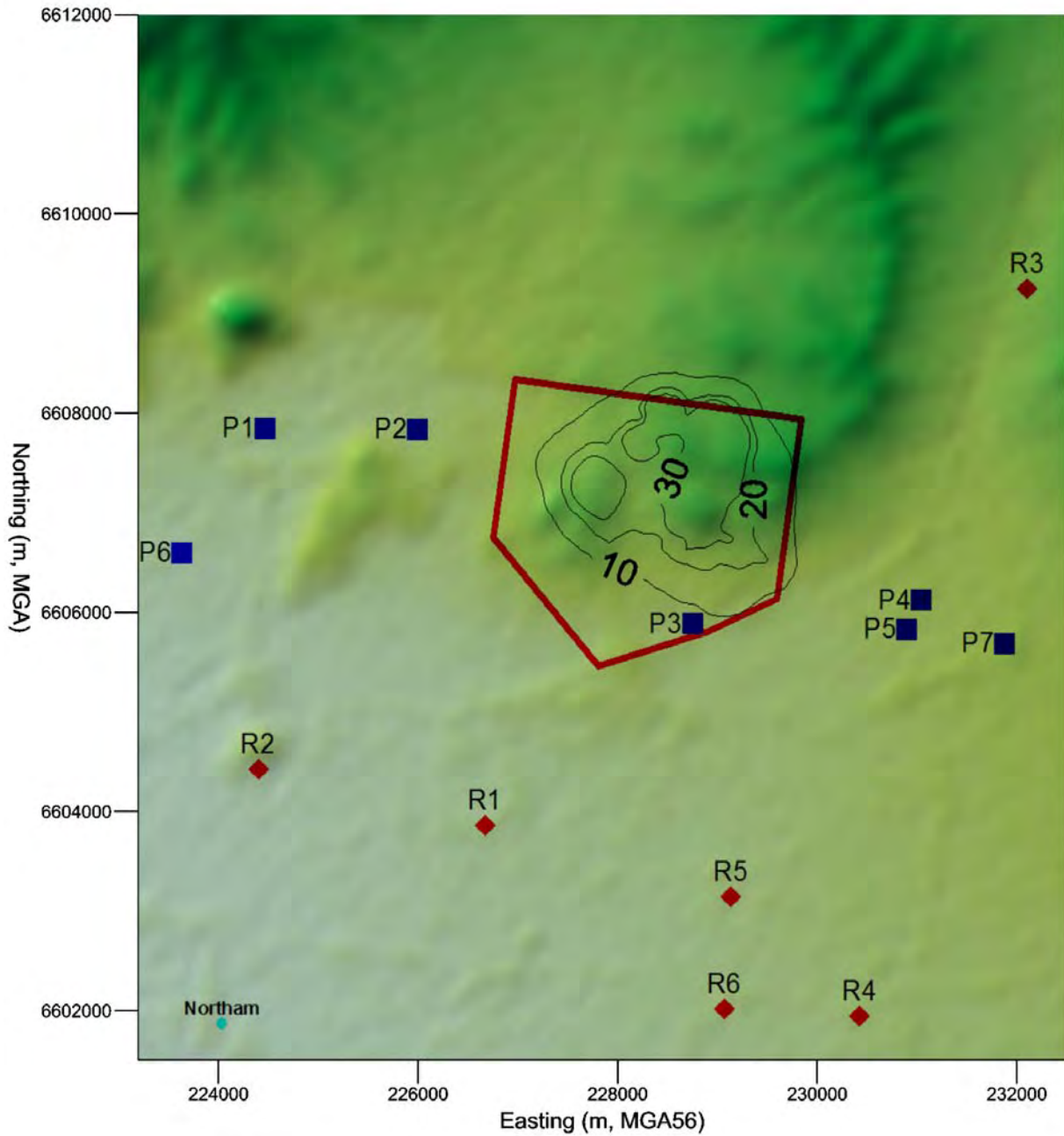


Note: Also shown are Properties within the modelling domain at which no single point predictions have been made. These are presented for information only

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

CONTOUR PLOT OF INCREMENTAL POLLUTANT INCREASES PREDICTED FROM MODIFIED TCM OPERATION

**Figure E-3 Predicted Incremental Increase in Annual Average PM<sub>10</sub> Concentrations due to Modified TCM Operations (µg/m<sup>3</sup>)**

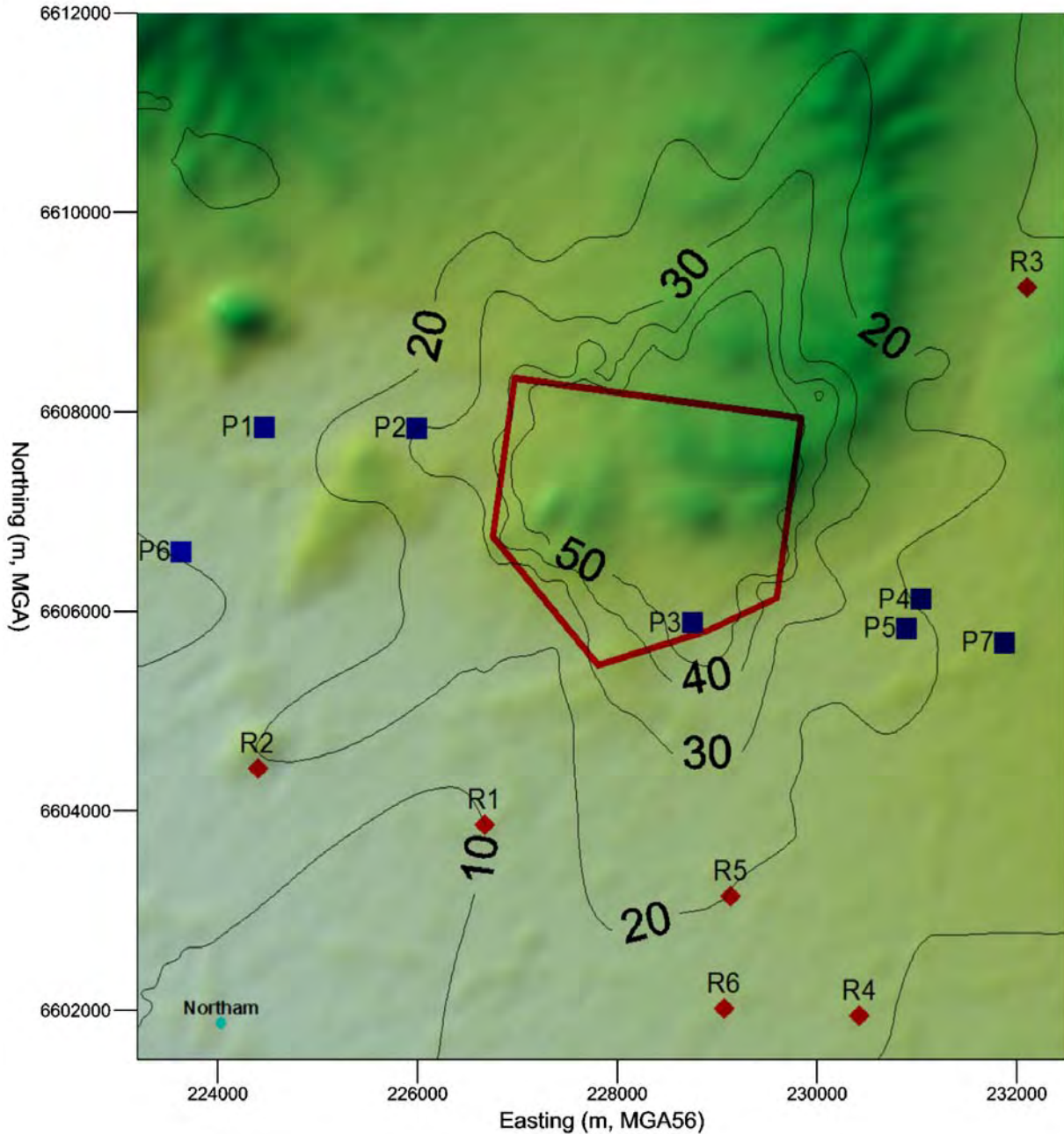


Note: Also shown are Properties within the modelling domain at which no single point predictions have been made. These are presented for information only

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--

CONTOUR PLOT OF INCREMENTAL POLLUTANT INCREASES PREDICTED FROM MODIFIED TCM OPERATION

**Figure E-4 Predicted Incremental Increase in 24-hour Average PM<sub>10</sub> Concentrations due to Modified TCM Operations (µg/m<sup>3</sup>)**



Note: Also shown are Properties within the modelling domain at which no single point predictions have been made. These are presented for information only

Heggies Pty Ltd Report Number 10-8480-R2 Revision 4	Tarrawonga Coal Mine Section 75W Modification Air Quality Impact Assessment Tarrawonga Coal Pty Ltd (10-8480R2R4.doc) 9 April 2010
---	--