ENVIRONMENTAL ASSESSMENT

Duralie Extension Project

APPENDIX D

AIR QUALITY ASSESSMENT

GLOUCESTER COAL

ResourceStrategies

HEGGIES
AUSTRALIA

REPORT 8034-R3

Appendix D
Duralie Extension Project
Air Quality Assessment

PREPARED FOR

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11 NOVEMBER 2009

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Duralie Extension Project

Air Quality Assessment

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF ATTACHMENTS

HEGGIES AUSTRALIA

D1 INTRODUCTION

Heggies Pty Ltd (Heggies) has been commissioned by Duralie Coal Pty Ltd (DCPL) to undertake an Air Quality Assessment (AQA) for a proposed extension to the Duralie Coal Mine (DCM) (i.e. the Duralie Extension Project [the Project]) in the Gloucester Valley, New South Wales (NSW).

This AQA has been prepared in accordance with the NSW Department of Environment and 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 AQA, 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 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 addresses the Director-General's Environmental Assessment Requirements (EARs) for the Project relating to air quality including:

> ***Air Quality*** *– including the potential dust associated with transporting coal to the Stratford mine;*
>
> *…*
>
> ***Greenhouse Gases*** *– including:*
>
> *a quantitative assessment of the potential scope 1, 2 and 3 greenhouse gas emissions of the project …*
>
> *…*
>
> *- a detailed description of the measures that would be implemented on site to minimise the greenhouse gas emissions of the project, ...*

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).

D1.1 Report Structure

This AQA is structured as follows:

Section D1	Introduction and report structure
Section D2	A description of the existing DCM including: • overview of current DCM operations; • particulate sources and emissions; • existing mitigation and management measures; and • complaints history.
Section D3	A description of the Project
Section D4	Description of the study area including: • local topography; • receptor details; • neighbouring emission sources; • local sources; and • regional sources.
Section D5	Ambient Air Quality criteria including: • goals applicable to particulate matter less than 10 microns in size (PM_{10}); • goal applicable to total suspended particulates (TSP); • nuisance impacts of fugitive emissions; and • Project air quality goals.
Section D6	A description of the prevailing dispersion meteorology including: • meteorological conditions; and • meteorological modelling.
Section D7	A description of the baseline air quality in the region
Section D8	Emissions parameters and calculations
Section D9	Dispersion modelling results
Section D10	Greenhouse gas assessment
Section D11	Conclusions
Section D12	Lists the reports cited in this assessment

D2 EXISTING DURALIE COAL MINE

D2.1 Summary of Mining Operations

The DCM has been operating since 2003 and is owned and operated by DCPL, a wholly owned subsidiary of Gloucester Coal Ltd (GCL). The DCM is situated approximately 10 kilometres (km) north of the village of Stroud and approximately 20 km south of Stratford in the Gloucester Valley in NSW, as shown in **Figure D-1**.

Another GCL subsidiary, Stratford Coal Pty Ltd, owns and operates the Stratford Coal Mine (SCM), which is located some 20 km to the north of the DCM. The run-of-mine (ROM) coal produced at the DCM is transported by rail to the SCM, where it is unloaded and processed.

The DCM is a small drill and blast open pit coal mining operation using conventional hydraulic excavator and haul truck fleets. The DCM currently produces up to 1.8 million tonnes per annum (Mtpa) of ROM coal and operates 24 hours per day. The ROM coal is initially sized at the DCM prior to being transported by rail to the SCM coal handling and preparation plant.

ROM coal is loaded onto a dedicated train that runs between the two mines on the North Coast Railway. The existing DCM operations are undertaken within Mining Lease (ML) 1427 (**Figure D-2**).

D2.2 Particulate Sources and Emissions Associated with the Duralie Coal Mine

This sub-section provides a review of the likely sources of dust associated with the existing DCM.

Atmospheric pollutants generated by activities occurring at the DCM primarily comprise fugitive emissions of particulates (PM_{10}[1], TSP[2] and deposited dust), those generated through the combustion of fuel in vehicles (nitrogen oxides [NO_x], sulphur dioxide [SO_2], volatile organic compounds [VOCs], carbon monoxide [CO], PM_{10}) and fugitive emissions from the coal seam. It is considered that background concentrations of combustion-related particulates in the local area are low, due to the absence of significant combustion sources within the immediate region. Additionally, the emissions of these particulates from the DCM sources are small and resulting concentrations at the nearest receptors negligible, taking into account the plant and equipment used at the DCM and the low sulphur content of diesel used in Australia.

Therefore, the focus of this assessment will be fugitive emissions of dust and particulates.

Major sources of particulate pollution (PM_{10}, TSP and dust) from current mining activities at the DCM are expected to occur as a result of the activities presented in **Table D-1**.

[1] PM_{10} is used to describe particulate matter with an aerodynamic diameter of 10 microns (µm) or less.
[2] TSP (Total Suspended Particulate) describes particulate matter which is less than 50 microns in diameter.

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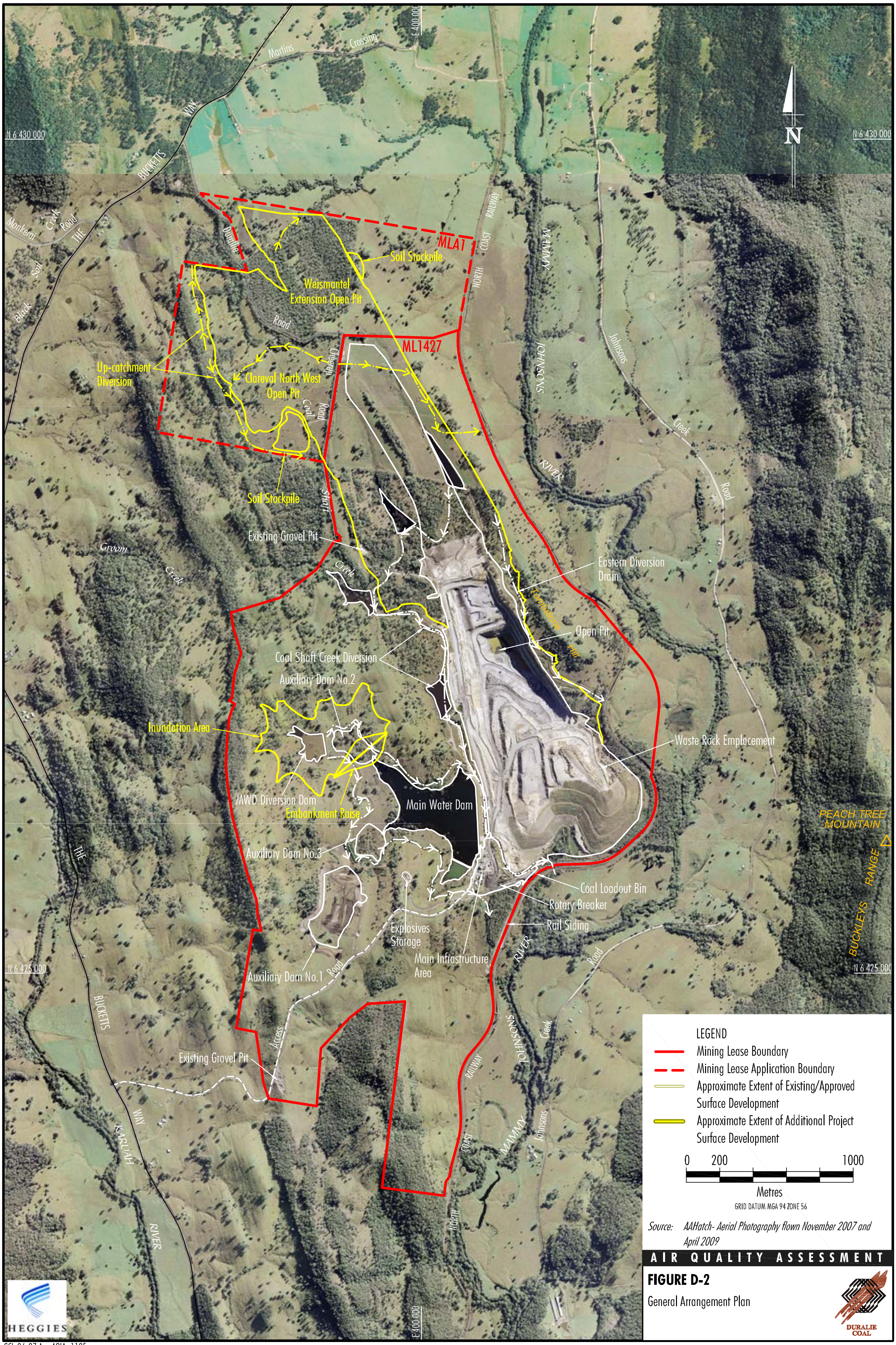

FIGURE D-2

General Arrangement Plan

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Table D-1 Probable Particulate Generating Activities Occurring at the Duralie Coal Mine

Activity	Particulate Emission Source
Soil Stripping	Soil removal
	Transport of soil to stockpiles by haul truck
	Dumping of soil to stockpiles
	Stockpile management by dozer
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	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 dozer
	Rotary breaker on ROM coal
Haul Route Management	Grader on haul routes
Gravel Extraction	Gravel extraction
Stockpiles/Open Areas	Wind erosion of stockpiles and open areas
Rail Operations	Loading of wagons
	Train movement to the SCM

Given the Project is essentially an extension of the existing mining activities at the DCM, the particulate emission sources presented in **Table D-1** are generally not predicted to significantly change as part of the Project. Quantification of the potential Project air quality emissions is provided in **Section D8.1**.

D2.3 Existing Air Quality Mitigation and Management Measures

Section D7 presents a summary of air quality monitoring undertaken in the vicinity of the DCM. Site specific monitoring data presented in **Section D7** indicates that PM_{10} concentrations and dust deposition levels in the vicinity of the DCM operations are low, suggesting generally best-practice current site dust management practice.

Current dust mitigation and management measures implemented at the DCM include:

- Watering of haul routes.
- Water spraying of coal in train wagons prior to departure from the DCM to the SCM.
- Rehabilitation of the waste rock emplacement as soon as practicable.
- Irrigation of the waste rock emplacement with a travelling and fixed sprinkler irrigation system in accordance with the "*Duralie Coal Mine Irrigation Management Plan"* (DCPL, 2008a).
- Where practicable, scheduling of blasting events to avoid poor dispersion conditions (i.e. early morning).
- Watering of ROM coal handling areas.
- Development of minor roads is limited with regularly used minor roads watered as required.
- All obsolete roads are ripped and revegetated.
- Long-term topsoil stockpiles are revegetated with a cover crop.

- Dust aprons on drill rigs are lowered during drilling. Water injection or dust suppression sprays are used on drilling equipment when dust generation potential is high.
- Water sprays are used on the ROM coal hopper and all coal transfer points between the hopper and the train loading bin, including the rotary breaker.

Current DCM air quality management measures, including air quality monitoring undertaken are presented in the "*Duralie Coal Mine Air Quality Monitoring Program (Incorporating Air Quality Management)*" (DCPL, 2007).

D2.4 Air Quality Complaints

Complaints pertaining to air quality are rarely received at the DCM. Six complaints pertaining to air quality issues have been received and were recorded in the complaints register between February 2003 and September 2009. Details of the six complaints are provided in **Table D-2**.

Table D-2 Air Quality Complaints Received at the Duralie Coal Mine (February 2003 to September 2009)

Date	Location of Complainant	Complaint	DCPL Response
7 February 2007	Bucketts Way, Wards River	"Smell sulphur from stationary laden Interail train"	Referred to Interail - possible locked brakes causing odour.
9 February 2007	Bucketts Way, Wards River	"Coal dust on outside of house"	A dust gauge was installed at Wards River. Analysis of dust gauge material indicated that coal dust comprises <10% of deposited dust.
19 April 2007	Bucketts Way, Wards River	"The Duralie train, dust and noise"	Dust is controlled by water spraying of trains prior to departure.
6 August 2009	Johnsons Creek Road	"Odour detected following blast event"	DCPL representative explained that the odour was possibly blast residue and the odour event was probably due to prevailing weather conditions.
18 September 2009	Johnsons Creek Road	"Dust and blast fumes drifting over property and explosives odour"	DCPL representative met with landowner to discuss and view photos taken of the dust cloud. Referred to mining contractor - possible anomalous due to prevailing weather conditions.
18 September 2009	Johnsons Creek Road	"Dust and blast fumes drifting over property and explosives odour"	Referred to mining contractor - possible anomalous due to prevailing weather conditions.

These complaints indicate that the main issue perceived in the community with regards to dust is the emission of coal dust from the ROM coal train, and in particular at dwellings in the village of Wards River, where the train line passes in close proximity to dwellings. No complaints with regards to air quality have been received in relation to mining activities such as mechanical movement of coal and waste rock and wind-blown dust at the DCM.

The odour complaints relate to an anomalous rail odour emission and three attributed to blasting residue following blast events. Given that no other odour complaints have been received, no further odour assessment is provided in this report.

It is also noted that no spontaneous combustion-related odour complaints have been recorded. Emissions of odours from coal mines can occur if the self-heating of coal is allowed to occur without management. At the DCM, the propensity of the coal to self-heat has not been an issue to date and therefore, spontaneous combustion events have not occurred. No further consideration of odours arising from spontaneous combustion events is provided.

D3 DURALIE EXTENSION PROJECT

The Project would involve mining extensions to the west and north-west within ML 1427 and a new Mining Lease Application (MLA) 1 area. The main activities associated with the development of the Project would include:

- continued development of open pit mining operations at the DCM to facilitate a ROM coal production rate of up to approximately 3 Mtpa, including:
  - extension of the existing approved open pit in the Weismantel Seam to the north-west (i.e. Weismantel Extension open pit) within ML 1427 and MLA 1; and
  - open pit mining operations in the Clareval Seam (i.e. Clareval North West open pit) within ML 1427 and MLA 1.
- ongoing exploration activities within existing exploration tenements;
- progressive backfilling of the open pits with waste rock as mining develops, and continued and expanded placement of waste rock in out-of-pit waste rock emplacements;
- increased ROM coal rail transport movements on the North Coast Railway between the DCM and SCM in line with increased ROM coal production;
- continued disposal of excess water through irrigation (including development of new irrigation areas within ML 1427 and MLA 1);
- raising of the existing approved Auxiliary Dam No. 2 from relative level (RL) 81 metres (m) to approximately RL 100 m to provide significant additional on-site storage capacity to manage excess water on-site;
- progressive development of dewatering bores, pumps, dams, irrigation infrastructure and other water management equipment and structures;
- development of new haul roads and internal roads;
- upgrade of existing facilities and supporting infrastructure as required in line with increased ROM coal production;
- continued development of soil stockpiles, laydown areas and gravel/borrow pits;
- establishment of a permanent Coal Shaft Creek alignment adjacent to the existing DCM mining area;
- ongoing monitoring and rehabilitation; and
- Other associated minor infrastructure, plant, equipment and activities.

Table D-3 provides a summary comparison of the approved DCM and the Project.

Table D-3 Summary Comparison of the Approved Duralie Coal Mine and the Project

Project Component	Summary of the Existing DCM	Summary of the Project
Open Pit Mining and ROM Coal Production	• Conventional open pit mining methods and equipment. • ROM coal production of approximately 12.3 million tonnes (Mt).	• Conventional open pit mining methods and equipment. • ROM coal production of approximately an additional 20.5 Mt[1].
Life of Mine	• Scheduled cessation of mining in 2010.	• Current mine planning indicates an additional operational life of approximately nine years.
Coal Seam/Pits	• Mining of the Weismantel Seam (Weismantel open pit).	• Mining of the Weismantel Seam by extending the existing open pit (Weismantel Extension open pit). • Mining of the Clareval Seam (Clareval North West open pit).
ROM Coal	• Production of approximately 1.8 Mtpa of ROM coal.	• Production of up to approximately 3 Mtpa.
Waste Rock Management	• Backfill within Weismantel open pit. • Out-of-pit waste rock emplacement. • Maximum elevation of backfilled waste emplacement approximately RL 110 m.	• Continued backfill within Weismantel and Weismantel Extension open pits and additional backfill within Clareval North West open pit. • Continued placement of waste rock in out-of-pit waste rock emplacement. • Maximum elevation backfilled waste rock emplacement approximately RL 110 m.
Total Waste Mined	• Approximately 40 million bank cubic metres (Mbcm).	• Approximately 114 Mbcm of additional waste rock.
ROM Coal Train Movement Hours	• 7.00 am to 10.00 pm.	• 7.00 am to 2.00 am.
Water Management	• Water management system comprises of water management storages, runoff diversions and control, sediment control, open pit dewatering and sewage treatment. • Disposal of excess water through on-site agricultural irrigation within ML 1427. • Water management system designed for no release of water to Mammy Johnsons River.	• Progressive upgrades and augmentation to existing water management system, including raising of embankment of Auxiliary Dam No. 2 from RL 81 m to approximately RL 100 m and utilisation of the Weismantel Extension open pit void as in-pit water storage. • Development of new irrigation areas within ML 1427 and MLA 1. • Water management system designed for no release of water to Mammy Johnsons River.
Coal Handling	• Coal handling area (including rotary breaker).	• Coal handling area (including rotary breaker).
Final Voids	• At the cessation of mining, the final void would remain in the Weismantel open pit.	• At the cessation of the Project, final voids would remain in the Clareval North West open pit and Weismantel Extension open pit.
Rehabilitation	• Rehabilitation of waste rock emplacement areas and other progressive surface disturbance areas.	• Continued rehabilitation of waste rock emplacement areas and other progressive surface disturbance areas.
Exploration	• Exploration activities undertaken ahead of the open pit mining operations to investigate geological structures and seam morphology as input to detailed mine planning.	• Exploration activities would continue to be undertaken in accordance with the requirements of existing exploration tenements.
Employment	• The existing number of operational employees is approximately 120 employees.	• It is anticipated that an average of approximately 135 employees would be required during operation of the Project.

[1] Approximately 1.5 Mt of ROM coal is associated with the continuation of the existing/approved extent of the Weismantel open pit (as modified by the Minister of Planning on 28 October 2009).

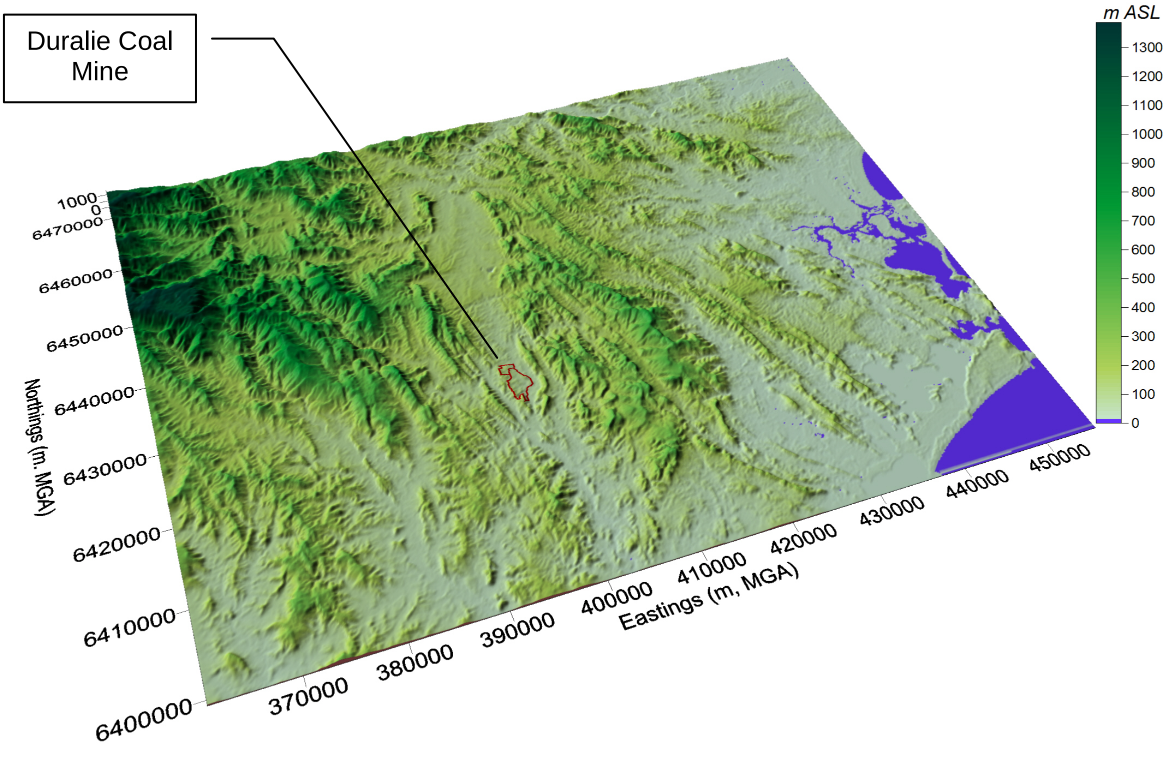
D4 STUDY AREA

D4.1 Local Topography

The DCM is located within a region of significant topographical variation, as shown on **Figure D-3**. The DCM is located within the Gloucester Valley between a number of ranges which more broadly form part of the Great Dividing Range.

The DCM is located at an altitude of between approximately 70 to 180 m Australian Height Datum (AHD). Buckleys Range (**Figure D-4**), to the immediate east of the DCM rises to approximately 370 m AHD. To the immediate west a north-south trending ridge is located with an elevation of approximately 300 m AHD. Further afield, to the west of the DCM are the Barrington Tops National Park and the Chichester State Forest (**Figure D-1**) with peaks of between 300 m and 1,500 m AHD. To the east of the DCM is located the Myall River State Forest (**Figure D-1**) with peaks of up to 600 m AHD.

Figure D-3 Three Dimensional Representation of Regional Scale Topography Surrounding the Duralie Coal Mine

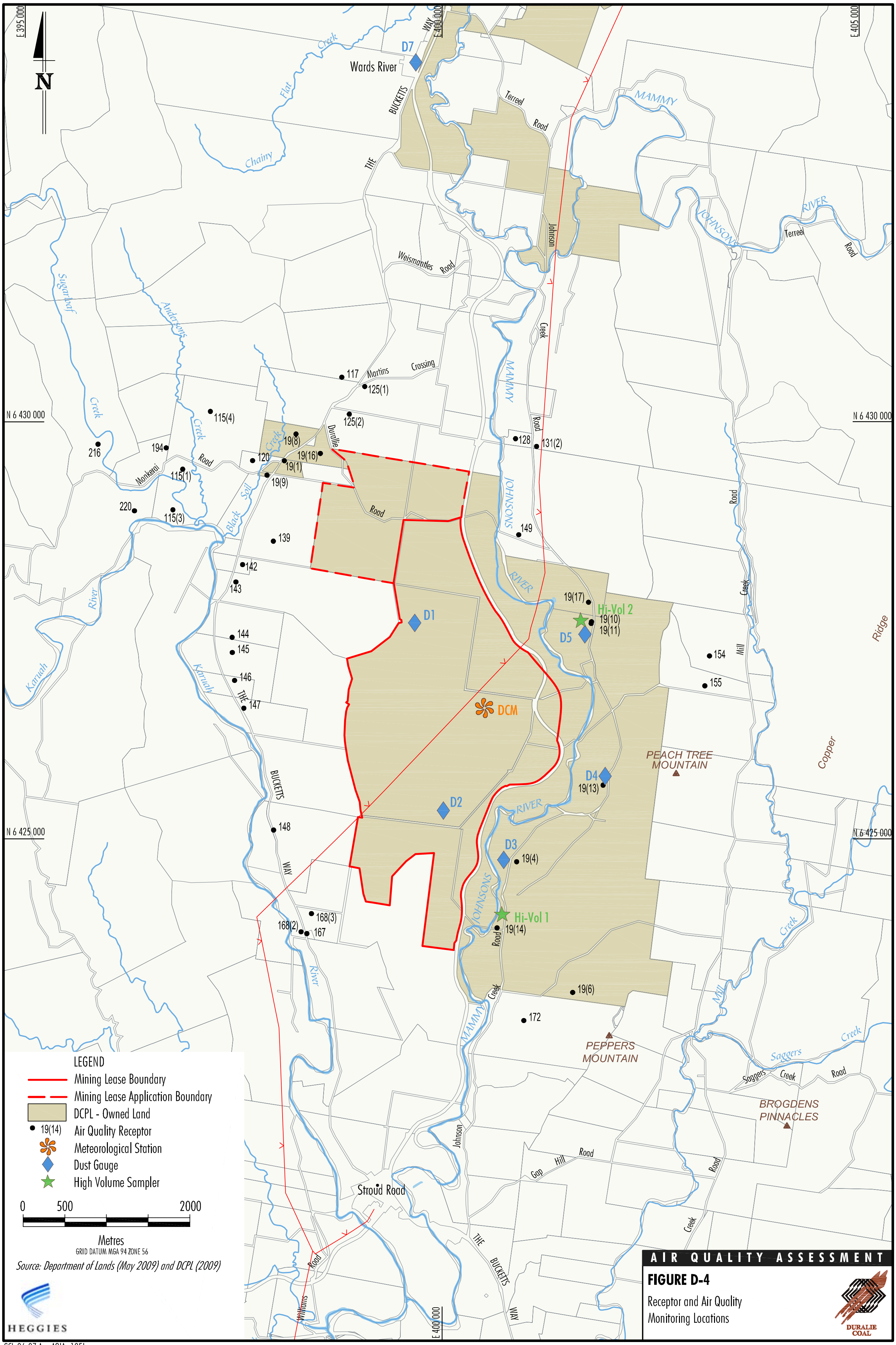


Note: Vertical exaggeration of two applied

D4.2 Receptors

A number of dwellings are situated in the area surrounding the DCM. Through the use of property ownership data provided by DCPL, Heggies has identified the nearest dwellings for use as receptor locations in the AQA for the Project.

Thirty-eight receptors have been selected for reporting purposes due to their proximity to the Project. The details of these receptors are provided in **Table D-4** and the locations shown on **Figure D-4**. A number of receptors located proximal to the North Coast Railway between the DCM and the SCM have also been considered.



AIR QUALITY ASSESSMENT

FIGURE D-4

Receptor and Air Quality Monitoring Locations

DURALIE COAL

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Table D-4 Sensitive Receptor Locations

Descriptor (refer to Figure D-4 for locations)	Owner	Location (m, MGA56)		Approximate Distance (km) / Direction from MLA 1/ML 1427
		Easting	Northing	
19(1)	Gloucester Coal Limited	398107	6429533	0.5/ W
19(4)		400893	6424725	0.4 /E
19(6)		401565	6423158	1.6 / SE
19(8)		398247	6429854	0.5/ W
19(9)		397899	6429361	0.6/ W
19(10)		401791	6427603	0.8 / E
19(11)		401787	6427582	0.8 / E
19(13)		401930	6425643	0.6 / E
19(14)		400658	6423932	0.5 / E
19(16)		398539	6429621	0.2/ W
19(17)		401755	6427837	1.0 / NE
115(1)	P.W.M. & B.D. & G.O. & M.J. Moylan & S.C.M. Newton	396888	6429432	1.6 / W
115(3)		396770	6428945	1.6 / W
115(4)		397220	6430125	1.6/ W
117	E.D. & L.M. Holmes	398796	6430535	0.9 / N
120	M.J. & C.A. Mahony	397726	6429535	0.9/ W
125(1)	T. & K. Zulumovski	399071	6430423	0.8 / N
125(2)		398886	6430092	0.4 / N
128	D.R. & B.M. Hare Scott	400880	6429798	0.7 / NE
131(2)	W.L. Relton	401132	6429705	0.9 / NE
139	M.S. Juttner	397975	6428569	0.5/ W
142	P.G. Madden	397606	6428288	0.8/ W
143	P.G. & K.A. Madden	397526	6428080	0.9/ W
144	D.J. Wielgosinski	397481	6427416	1.4/ W
145	D.H. & S.W. Owens	397483	6427234	1.4/ W
146	M.A. Bragg	397510	6426899	1.4/ W
147	J.I. Edwards	397621	6426566	1.2/ W
148	D.J. McAndrew	397978	6425105	1.0/ W
149	Hattam Pty Ltd	400918	6428646	0.6 / E
154	J.R. Morgan	403206	6427193	1.9 / E
155	M. & R. Guberina	403150	6426834	1.7 / E
167	M. & S.M. Ravagnani	398377	6423863	0.8/ SW
168(2)	V.R. & E.K. Schultz	398307	6423885	0.8/ SW
168(3)		398432	6424103	0.6/ W
172	S.J. & J.E. Lyall	400979	6422821	1.2 / SE
194	J. & C.L. Kellehear	396690	6429688	1.9 / W
216	D.M. Matcham	395872	6429732	2.7 / W
220	T.G. Lindfield and Associates Pty. Ltd	396309	6428933	2.1 / W

D4.3 Potential Cumulative Air Quality Emission Sources

D4.3.1 Local Sources

Sources of air quality emissions surrounding the DCM include the SCM, approximately 20 km to the north. It is considered that the nature of the particulate sources at the SCM indicates that minimal transportation of particulates to the area in the vicinity of the DCM would occur.

Emissions of coal dust from trains transporting ROM coal from the DCM to the SCM and from the SCM to Newcastle have the potential to impact upon dwellings neighbouring the rail line. Cumulative impacts from mining and coal transport for receptors located along the North Coast Railway are discussed in **Section D9.2**.

Gloucester Ruby Mine (Environmental Protection Licence No. 12197) operates in the Barrington Tops region. Due to the relatively small scale nature of the extraction activities (up to 100,000 tonnes per annum) and the distance to the DCM (over 20 km), it is considered that no potential exists for cumulative air quality impacts. In addition, other minor quarries and the Barrington Lime Mine are understood to be relatively small in scale and not significant potential cumulative dust sources for the Project.

No other large mines operate within a radius of approximately 75 km of the DCM, with the closest mine being Camberwell, approximately 76 km to the west in the Hunter Valley, NSW. It is considered that mines within the Hunter Valley do not have the potential to contribute to cumulative impacts in the vicinity of the DCM.

Within 75 km of the DCM, there are no industrial facilities that report under the National Pollutant Inventory, with the exception of the SCM.

The main sources of dust in the area are likely to be associated with agricultural activities. Given the seasonal nature of such activities, they are not considered significant enough to warrant consideration as cumulative air quality sources. Regional dust generation from agricultural activities is reflected in the background air quality monitoring.

Given the above, it is considered that there are no local potential cumulative air quality emission sources in the vicinity of the DCM that warrant inclusion in the modelling.

D4.3.2 Regional Sources

Concentrations of particulates can be regionally 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 regional network of air quality monitors.

D5 AIR QUALITY CRITERIA

D5.1 Goals Applicable to PM_{10}

PM_{10} 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_{10} assessment goals as expressed in the Approved Methods are:

- a 24-hour maximum of 50 micrograms per cubic metre ($\mu g/m^3$); and
- an annual average of 30 $\mu g/m^3$.

The 24-hour PM_{10} reporting standard of 50 $\mu g/m^3$ 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. This goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best practice dust control measures

D5.2 Goal Applicable to TSP

The annual goal for TSP is given as 90 $\mu g/m^3$, as recommended by the National Health and Medical Research Council (NHMRC) at their 92nd session in October 1981. This goal has also been adopted in the Approved Methods.

D5.3 Nuisance Impacts of Fugitive Emissions

The preceding sections are concerned in large part with the health impacts of particulate matter. Nuisance (amenity) impacts also need to be considered, mainly in relation to deposition of 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^2/month).

To avoid dust nuisance the DECCW has developed assessment criteria for dust fallout. **Table D-5** presents the allowable increase in dust deposition relative to the ambient levels.

Table D-5 DECCW Criteria for Dust Deposition

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

Source: DEC (2005).

D5.4 Project Air Quality Goals

The air quality goals adopted for the assessment of the Project are those specified in the Approved Methods or the NEPM.

In summary, the specific goals being applied to this study are as follows:

- PM_{10}: a 24-hour maximum of 50 µg/m^3 (Project-only[3]); and an Annual average of 30 µg/m^3 (Project and other sources).
- TSP: an annual average of 90 µg/m^3 (Project and other sources).
- Deposited Dust: an incremental (Project only) annual average dust deposition level of 2 g/m^2/month; and a total annual average dust deposition level of 4 g/m^2/month (Project and other sources).

[3] Based on recent approvals granted for mining projects, this goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best practice dust control measures. Refer to **Section 2.3** for a discussion of best practice dust control measures employed at the DCM.

D6 PREVAILING DISPERSION METEOROLOGY

To adequately characterise the dispersion meteorology of the DCM, data were reviewed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The climate and meteorology of and surrounding the DCM was characterised based on:

- climate statistics obtained from the nearest Commonwealth Bureau of Meteorology (BoM) weather stations at Chichester Dam (Station Number 061151), Paterson (Tocal) (Station Number 061250) and Stroud Post Office (Station Number 061071);
- hourly meteorological data from the DCM and SCM weather stations; and
- a site specific dataset generated through meteorological modelling conducted by Heggies for the purposes of air quality dispersion modelling.

The locations of the meteorological monitoring stations situated in relatively close proximity to the DCM for which data were obtained for analysis are detailed in **Table D-6** and shown on (**Figure D-1**). The data from these weather stations were used to characterise the local meteorology and provide the input datasets for the meteorological modelling undertaken.

Table D-6 Meteorological Monitoring Station Details

Station Name (refer to Figure D-1 for locations)	Location (m, MGA)		Distance (km) / Direction From the DCM	Elevation (m, AHD)
	Easting	Northing		
DCM	399893	6426520	0 km/-	121 m
SCM	400830	6444233	17 km/N	139 m
Chichester Dam (BoM)	375640	6432197	25 km/WNW	194 m
Paterson (Tocal) (BoM)	367731	6388852	50 km/SW	30 m
Stroud Post Office (BoM)	403133	6414759	10 km/S	44 m

D6.1 Meteorological Conditions

Meteorological data have been provided by DCPL for the DCM and the SCM. Supplementary data have also been obtained for the BoM weather station at Chichester Dam, located approximately 25 km to the west-northwest of the DCM at an altitude of approximately 194 m AHD. This site has been recording measurements of rainfall between 1942 and 2009 and provides a good indication of the climatological mean rainfall experienced in the area. Supplementary rainfall data from the BoM weather station at Stroud Post Office (altitude of 44 m AHD) have also been obtained. This site has been recording measurements of rainfall between 1889 and 2009.

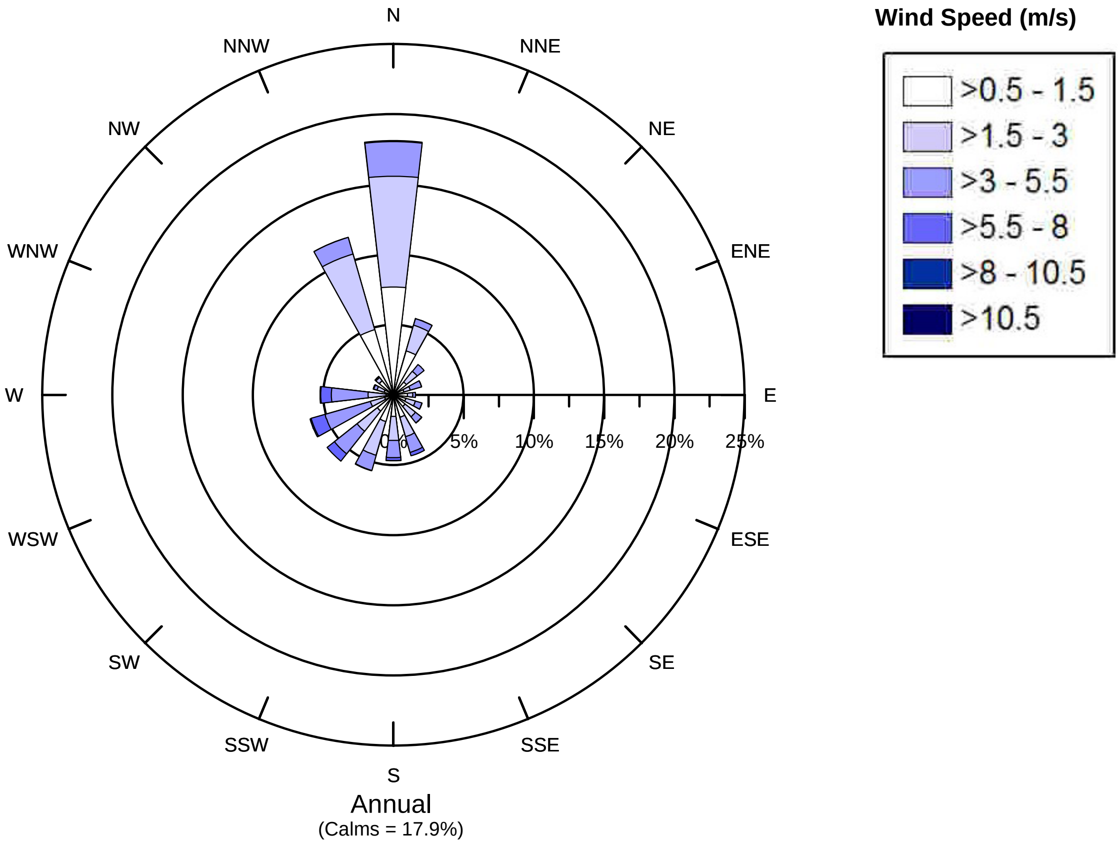
Data have also been obtained for the BoM weather station at Paterson (Tocal), approximately 50 km to the south-west of the DCM at an altitude of 30 m AHD. A wide range of meteorological variables have been measured at the Paterson (Tocal) between 1969 and 2009 and the climatological mean temperature data have been obtained for comparison with DCM data.

D6.1.1 Wind Regime

A summary of the 2007 annual wind behaviour measured at the DCM is presented as a windrose in **Figure D-5**. This wind rose displays occurrences of winds from all quadrants. Data availability for 2007 was generally good; however data were missing for parts of January and February 2007.

Figure D-5 indicates that winds experienced at the DCM are predominately light to fresh (between 1.5 metres per second [m/s] and 10.5 m/s) and primarily from the northern quadrant (approximately 40% of the time winds are from the northern quadrant). Calm wind conditions (wind speed less than 0.5 m/s) were observed to occur 17.9% of the time throughout 2007.

Figure D-5 Annual Observed Windrose for the Duralie Coal Mine - 2007



The seasonal variation in predicted wind behaviour at the DCM was also reviewed. Analysis of the seasonal wind variation indicated that:

- In spring, light to fresh winds are experienced predominantly from the north to north-northwest (approximately 40% of the time of seasonal wind direction).
- In summer, light to fresh winds (between 1.5 m/s and 5.5 m/s) are experienced predominantly from the north-northwest to north-northeast.
- In autumn, calm to fresh winds are experienced predominantly from the north to north-northwest.
- In winter, fresh winds are experienced predominantly from the west to south-west (approximately 35% combined of seasonal wind direction) with calm to light winds experienced from the north.

Heggies has also compared DCM data for 2007 with other years and also with data from the SCM meteorological station. Comparison of data from 2007 with data from 2008 and with that recorded at the SCM provides confidence that measured winds in 2007 are typical of those experienced at the DCM.

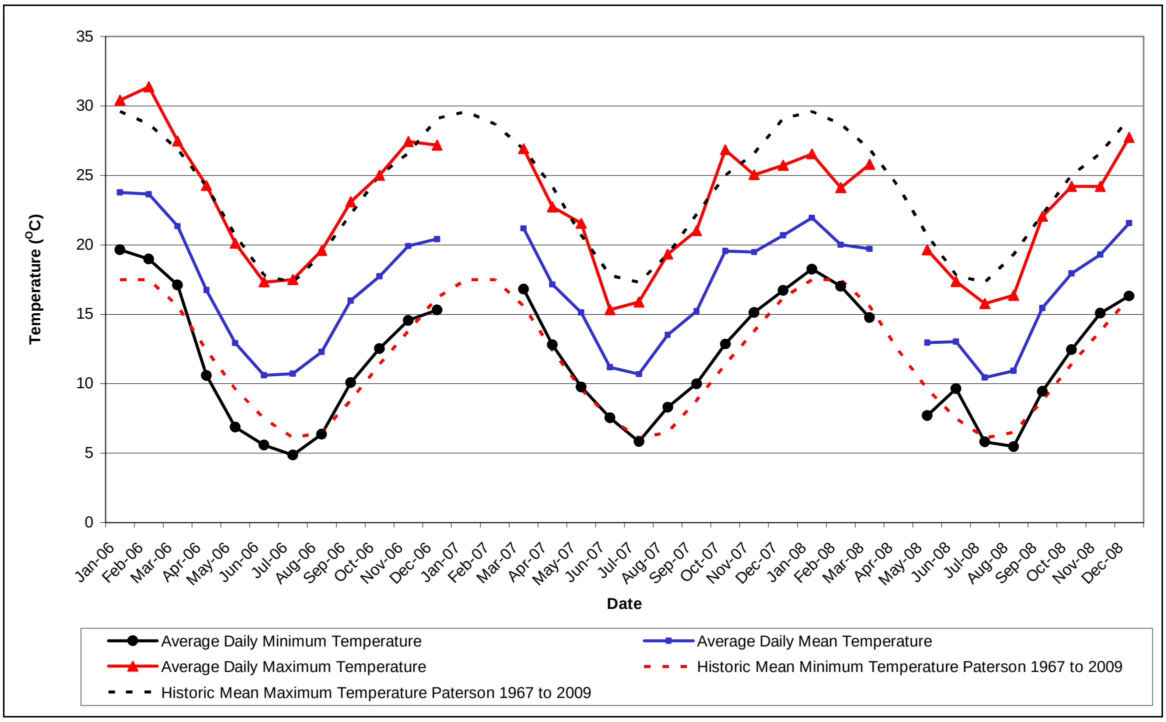
D6.1.2 Temperature

Observed temperature variance by month at the DCM for 2006 to 2008 is presented in **Figure D-6**. Additionally overlayed in **Figure D-6** are the historic mean maximum/minimum temperatures recorded at Paterson (Tocal) between 1967 and 2009.

It can be seen in **Figure D-6** that the observed temperature at the DCM between 2006 and 2008 matches well within the historical measurements at Paterson (Tocal). It is therefore considered that the DCM dataset is representative of the temperature experienced within the wider region surrounding the DCM.

From analysis of the recorded historical data, the temperature variance ranges between 11.9 degrees Celsius (°C) and 29.6°C in the summer months and between 6.1°C and 19.3°C in the winter months.

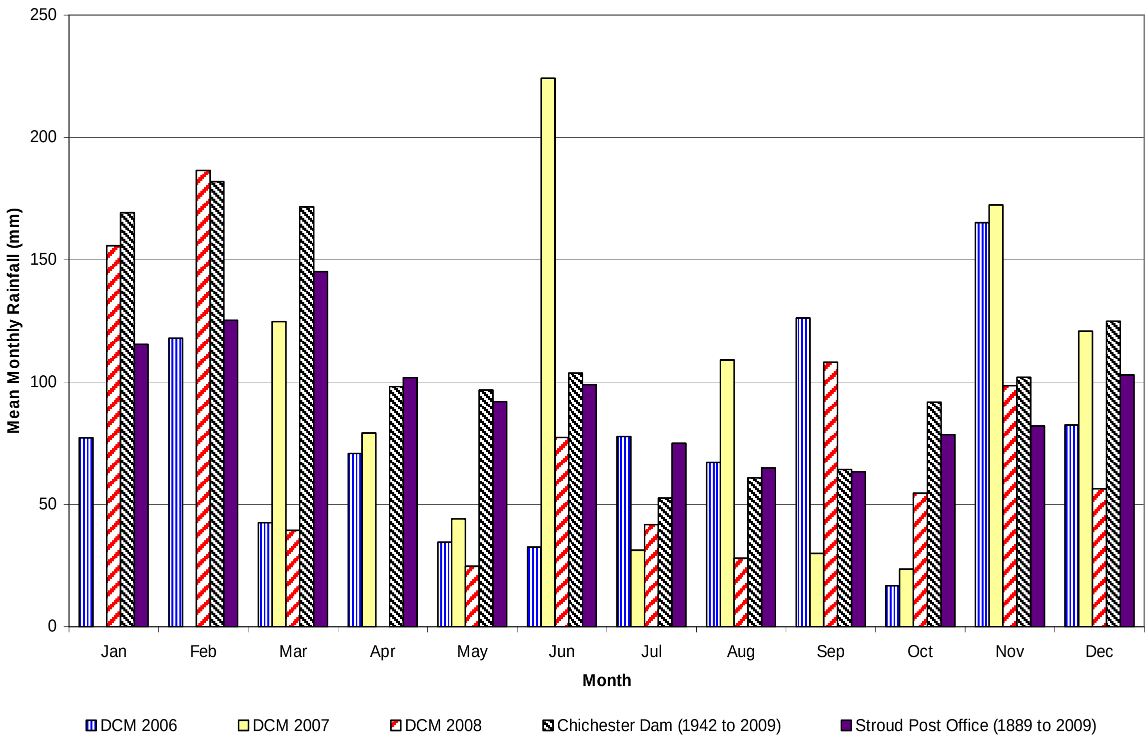
Figure D-6 Monthly Temperature Variance - Duralie Coal Mine - 2006 to 2008 and Regional Historic Data for Paterson (Tocal) 1967 to 2009



D6.1.3 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 particulates. A graph displaying the monthly rainfall measured at the DCM between 2006 and 2008 is shown on **Figure D-7**. Also shown on **Figure D-7** is the mean monthly rainfall measured at Chichester Dam between 1942 and 2009 and Stroud Road between 1889 and 2009.

Figure D-7 Mean Monthly Rainfall Measured at the Duralie Coal Mine, Chichester Dam and Stroud Road



Extreme weather conditions and rainfall were experienced in the Hunter Valley on 8 and 9 June 2007, resulting in the largest Hunter River flood in 36 years (State Emergency Services [SES], 2007). Rainfall at the DCM on 8 June 2007 was measured at 111.8 millimetres (mm), half the June 2007 total rainfall experienced at the DCM.

Rainfall experienced at the DCM can be described as moderate to high, with the immediate area receiving between 870 and 960 mm per annum between 2006 and 2008. Data from Chichester Dam shows that between 1942 and 2009, the annual mean rainfall was 1,320 mm, whilst data from Stroud Road shows that between 1889 and 2009, the annual mean rainfall was 1,145 mm. Data from the SCM shows general agreement with the DCM data with annual rainfall between 2006 and 2008 of 670 to 950 mm.

Rainfall at the DCM is typically lower during the winter months with maxima generally experienced during the summer months.

D6.1.4 Relative Humidity

The relative humidity in the region surrounding the DCM can be described as moderate. The mean 9.00 am relative humidity at Paterson (Tocal) was 63 to 80%, while the 3.00 pm relative humidity varies between 46% and 59% throughout the year, recorded between 1972 and 2009. This is in general agreement with data collected at the DCM.

D6.2 Meteorological Modelling

D6.2.1 CALPUFF/CALMET Modelling

The particulate dispersion modelling carried out for the Project utilises the DECCW and United States Environmental Protection Agency (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. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. 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 17.9% in 2007) and the surrounding complicated terrain (see **Section D4.1**). The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as Ausplume) is its ability to simulate the spatially varying meteorological conditions that would be expected given the local topographical conditions.

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. variable meteorological conditions caused by undulating topography).

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain (Scire *et al*., 2000). Associated two dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different landuses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final wind field thus reflects the influences of local topography and landuses.

Meteorological conditions have been predicted using the CALMET model for a regular Cartesian grid with 400 m spacing, covering an area of approximately 37 km by 32 km centred on the DCM. Surface observations for 2007 from the SCM and DCM weather stations have been used in addition to an upper air dataset, predicted using the The Air Pollution Model (TAPM) model (**Section D6.2.2**).

D6.2.2 TAPM Modelling

Modelling of meteorological parameters across the CALMET domain requires information on meteorology within several layers above the ground surface (up to approximately 8 km). Upper air soundings are not available for the area surrounding the DCM and therefore, TAPM meteorological model (Version 3) has been used to generate this dataset.

TAPM was developed by the Commonwealth Scientific and Industrial Research Organisation and 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, 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 calibrate 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 DCM and SCM meteorological station locations were input into TAPM simulations to calibrate to local and regional conditions.

Table D-7 details the parameters used in TAPM meteorological modelling for this assessment.

Table D-7 Meteorological Parameters used for this Study

TAPM (v 3.0)	
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	399700 m E, 6425781 m S
Data assimilation	Meteorological data assimilation using wind data from the DCM and SCM weather stations
Upper air dataset extraction point	388765 m E, 6414098 m S

D6.2.3 Predicted Wind Speed and Direction

A predicted annual windrose for 2007 generated by CALMET is shown in **Figure D-8**. Comparison between the DCM measured data (**Figure D-5**) with the CALMET windrose (**Figure D-8**) shows good agreement. Slight differences between the windroses generated for observed data and CALMET predictions were evident in the summer months in 2007, although this can be explained by the missing data for January and February 2007 (some 1,320 hours). This missing data has not significantly affected the CALMET modelling since data from the SCM weather station for January and February 2007 were used to verify the CALMET model predictions.

It is also prudent to compare data from other available summer months from the DCM to gain confidence in the model output.

Monitoring data for summer 2005 (December 2004, January and February 2005) has been compared with that CALMET predicted summer wind regime for 2007 (**Figure D-9**).

Figure D-8 Annual CALMET Predicted Windrose for the Duralie Coal Mine - 2007

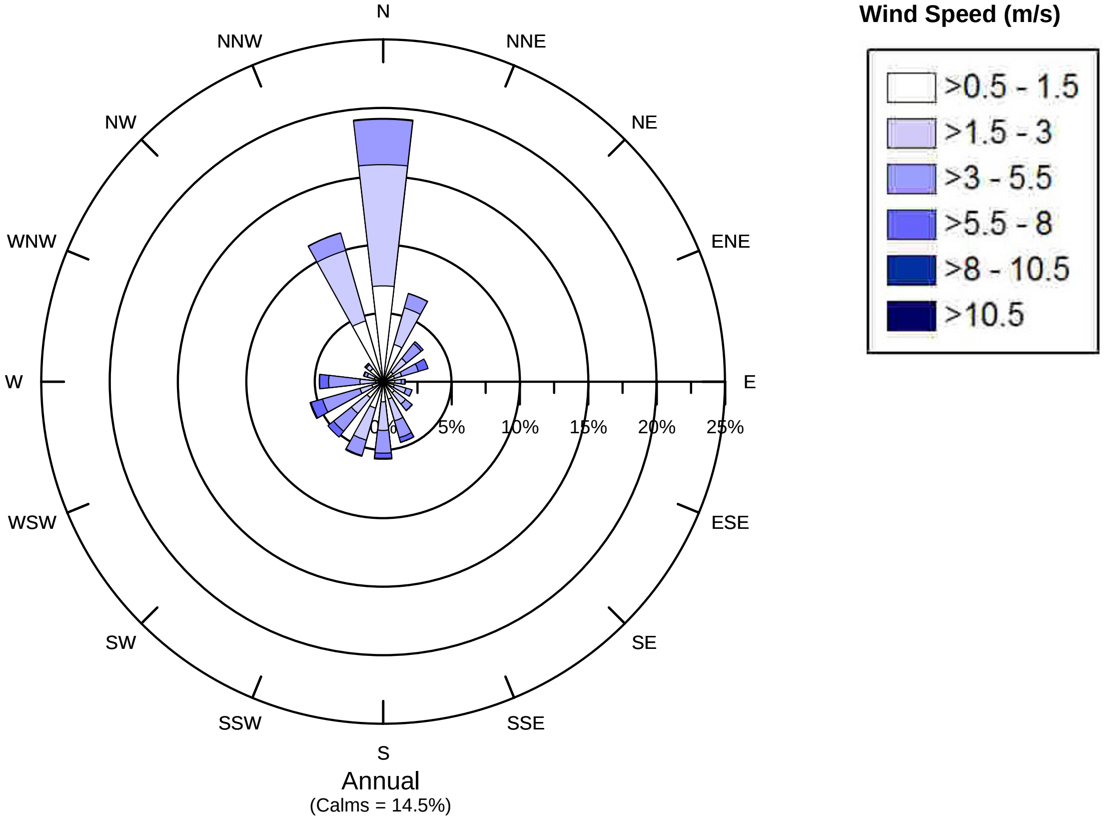
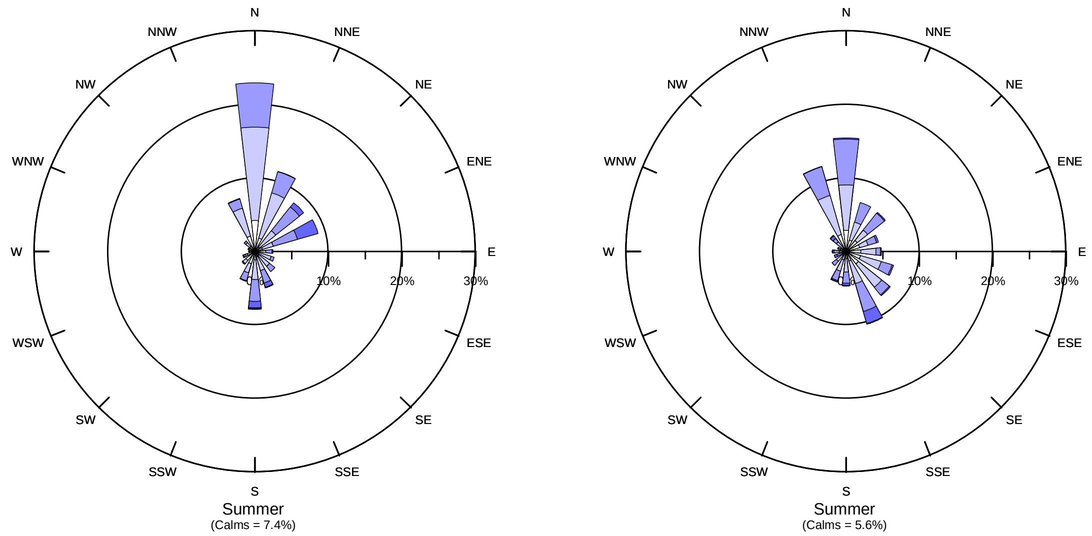


Figure D-9 Comparison between Summer Windroses - CALMET and Observed

CALMET Predicted Wind Rose - Summer 2007	**Observed Wind Rose - Summer 2005 (Dec 2004, Jan and Feb 2005)**



It is shown that the summer CALMET predictions generally represent the observed wind flow conditions experienced at the DCM in the summer of 2004/2005. The dominant northerly component predicted by CALMET and observed at the DCM in 2007 (**Section D6.1.1**) is not shown to be as dominant a feature in the observations from 2005 although the general pattern of wind distribution is shown to be consistent.

D6.2.4 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 D-8**).

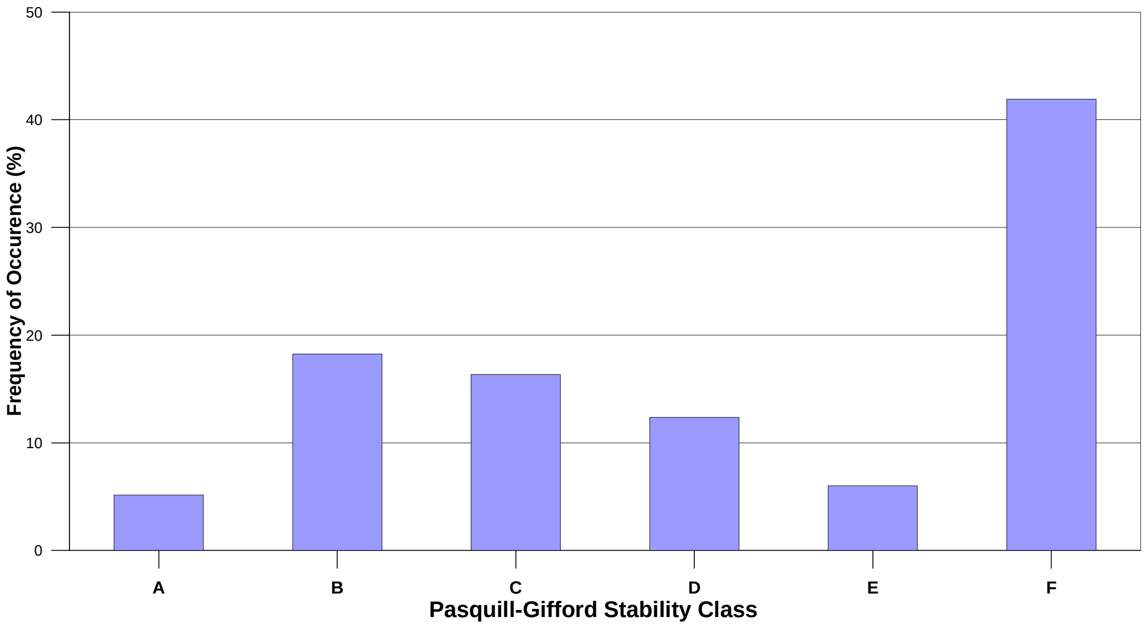
Table D-8 Description of Atmospheric Stability Classes

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

The frequency of each stability class at the DCM, as predicted by CALMET, is presented in **Figure D-10**.

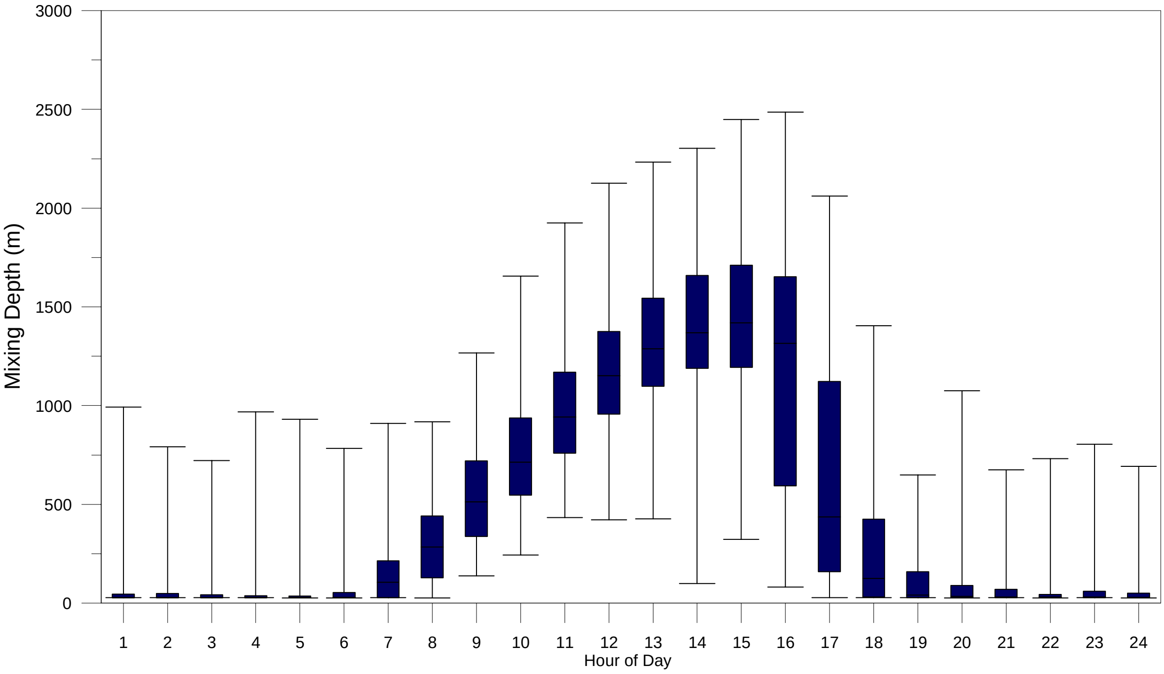
The results indicate a high frequency of conditions typical to Stability Class “F”. Stability Class “F” is indicative of very stable conditions, conducive to a low level of particulate dispersion due to reduced mechanical mixing. These conditions are typical of low wind speeds during night-time conditions.

Figure D-10 CALMET - Predicted Annual Stability Class Distributions for the Duralie Coal Mine, 2007



Diurnal variations in maximum and average mixing depths predicted by CALMET at the DCM during 2007 are illustrated in **Figure D-11**. It can be seen that an increase in the mixing depth during the morning, arising due to the onset of vertical mixing following sunrise, is apparent with maximum mixing heights occurring in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

Figure D-11 CALMET - Predicted Diurnal Variation in Mixing Depth for the Duralie Coal Mine, 2007



Note: The ‘box’ indicates the range of the lower and upper quartiles, while the ‘whisker’ indicates the minimum and maximum.

D7 BASELINE AIR QUALITY

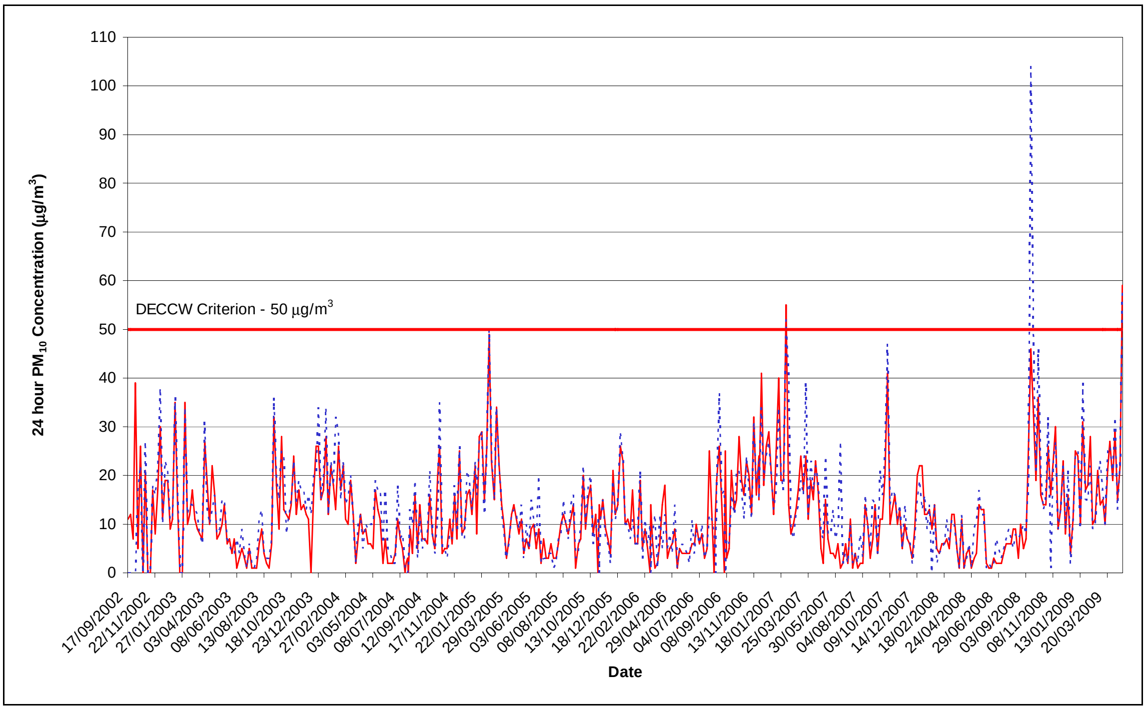
The existing DECCW licence conditions for the DCM (Environmental Protection Licence No. 11701) specify that PM_{10} monitoring be undertaken at two locations and dust deposition monitoring be undertaken at five locations. The subsections below present a summary of the particulate matter and dust deposition data obtained in the vicinity of the DCM.

D7.1 Particulate Matter

PM_{10} concentrations (24-hour average, 1-in-6 day cycle) are measured at two sites on properties owned by DCPL. These sites are 'High Noon' and 'Twin Houses', identified as Hi-Vol 1 and Hi-Vol 2, respectively. 'High Noon' is located to the south south-east of the DCM with 'Twin Houses' located to the east of the DCM. The locations of these sites are presented on **Figure D-4**.

PM_{10} data have been collected at the DCM since September 2002, prior to commencement of mining operations (which commenced during March 2003). Data for the period September 2002 to April 2009 are presented in **Figure D-12**.

Figure D-12 24-hour Average PM_{10} Concentrations Measured at the Duralie Coal Mine - September 2003 to April 2009



Note: 'Twin Houses' – Blue dotted and 'High Noon' – Red

A summary of the dataset for complete years 2003 to 2008 is provided in **Table D-9**.

Table D-9 PM_{10} Monitoring Summary

Criterion	High Noon (Hi-Vol 1)						Twin Houses (Hi-Vol 2)					
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Maximum 24 hour average (µg/m^3)	35	28	49	41	***55***	46	36	35	50	37	***52***	***104***
Number of exceedances of 24-hour criterion	0	0	0	0	1	0	0	0	0	0	1	1
Annual Average (µg/m^3)	11.4	10.4	12.2	12.0	12.5	10.7	12.8	12.1	12.7	11.6	14.5	12.5

Note: Following completion of this report, limited 24-hour PM_{10} data were received from additional DCPL Hi-Vol samplers. These data were not materially different from the data presented in **Table D-9**.

Exceedances shown in italicised bold.

DECCW maximum 24 hour average criterion = 50 µg/m^3.

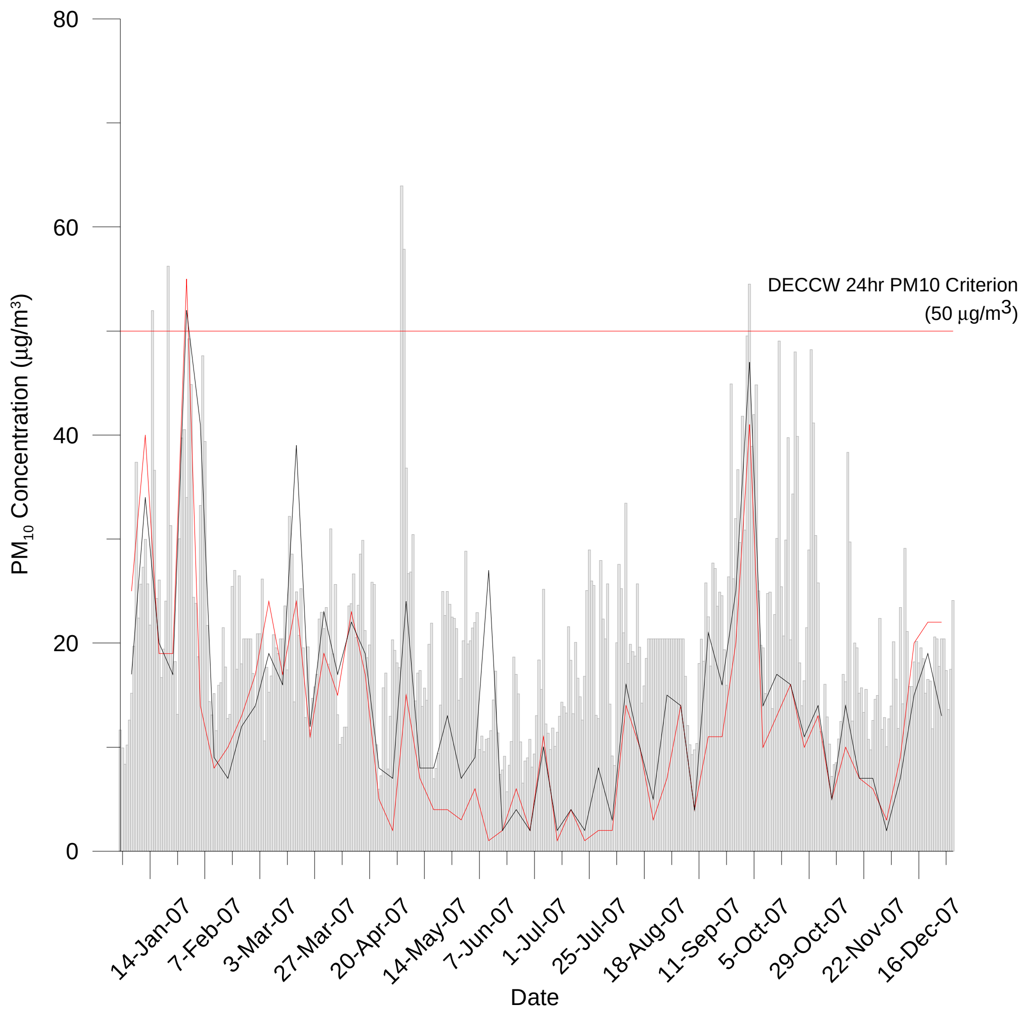
It is shown that the annual average PM_{10} concentrations are well below the DECCW criterion of 30 µg/m^3 with concentrations monitored at both 'High Noon' and 'Twin Houses' accounting for around 40% of the criterion.

Measurements of 24-hour average PM_{10} concentration are shown to be generally low (refer **Figure D-12**), with measurements at both 'High Noon' and 'Twin Houses' following a similar trend. With these sampling units being approximately 4 km apart to the east and south south-east of the DCM, the trend matching indicates that sources of particulate from the DCM are not the dominant source of particulates within the area. If the DCM was a significant regional source of dust, it would be expected to be reflected by elevated dust concentrations at Hi-Vol 1, given the northerly prevailing winds in the area (**Section D6.1.1**). Comparison of site specific data and PM_{10} data from the DECCW air quality monitoring site at Beresfield (approximately 60 km south-southeast of the DCM) confirms this (refer **Figure D-13**).

Exceedances of the 24-hour PM_{10} criterion have been observed at both 'High Noon' (2007) and 'Twin Houses' (2007, 2008) as shown in **Table D-9**. However, these exceedances are not shown to be frequent, with up to one incidence of 24 hour PM_{10} criterion exceedance in each of the years monitored.

Comparison of PM_{10} data monitored at the DCM with that measured at the DECCW air quality monitoring site at Beresfield (approximately 60 km south-southeast of the DCM) indicates that elevated levels and exceedances of 24 hour PM_{10} criteria observed at both 'High Noon' and 'Twin Houses' in 2007 were also reflected in the data for Beresfield (see **Figure D-13**). This confirms the dominance of regional particulates in the concentrations measured at the DCM rather than local sources. Thus, exceedances observed in 2007 at the DCM can be attributed to regional (i.e. non-DCM) sources.

Figure D-13 Comparison of PM_{10} Data for Beresfield, High Noon and Twin Houses, 2007



Source: DECCW (2009).

Note: Beresfield – gray bars, High Noon – red line, Twin Houses – black line.

D7.2 Dust Deposition

Monthly average dust deposition levels are measured at five locations surrounding the DCM and at one location in Wards River, approximately 6 km to the north of the DCM. The locations of the dust deposition gauges are shown on **Figure D-4**.

Results from May 2006 to May 2009 for all six locations are presented in **Table D-10** and **Figure D-14**.

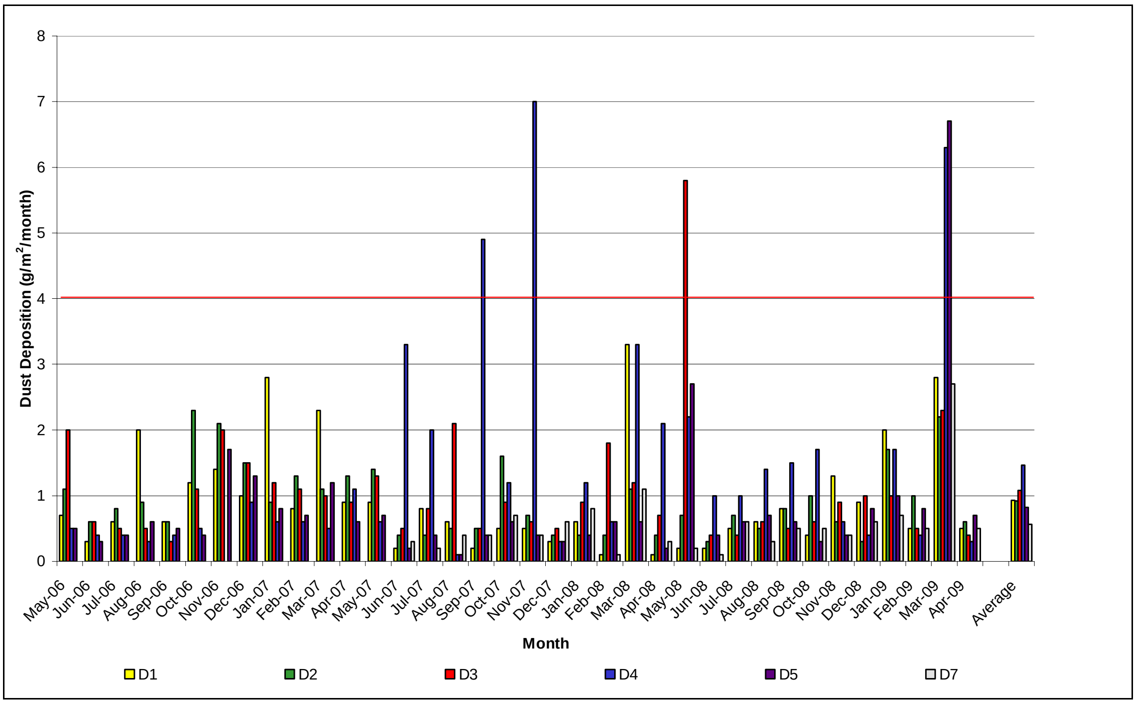
Table D-10 Table of Monthly Average Dust Deposition Levels surrounding the Duralie Coal Mine - May 2006 to May 2009

Date	Dust Gauge ID – Monthly Average Dust Deposition (g/m^2/month) (locations shown on Figure D-4)					
	D1	**D2**	**D3**	**D4**	**D5**	**D7**
May-06	0.7	1.1	2.0	0.5	0.5	-
Jun-06	0.3	0.6	0.6	0.4	0.3	-
Jul-06	0.6	0.8	0.5	0.4	0.4	-
Aug-06	2.0	0.9	0.5	0.3	0.6	-
Sep-06	0.6	0.6	0.3	0.4	0.5	-
Oct-06	1.2	2.3	1.1	0.5	0.4	-
Nov-06	1.4	2.1	2.0	-	1.7	-
Dec-06	1.0	1.5	1.5	0.9	1.3	-
Jan-07	2.8	0.9	1.2	0.6	0.8	-
Feb-07	0.8	1.3	1.1	0.6	0.7	-
Mar-07	2.3	1.1	1.0	0.5	1.2	-
Apr-07	0.9	1.3	0.9	1.1	0.6	-
Annual	**1.2**	**1.2**	**1.1**	**0.6**	**0.8**	-
May-07	0.9	1.4	1.3	0.6	0.7	-
Jun-07	0.2	0.4	0.5	3.3	0.2	0.3
Jul-07	0.8	0.4	0.8	2.0	0.4	0.2
Aug-07	0.6	0.5	2.1	0.1	0.1	0.4
Sep-07	0.2	0.5	0.5	4.9*	0.4	0.4
Oct-07	0.5	1.6	0.9	1.2	0.6	0.7
Nov-07	0.5	0.7	0.6	7.0*	0.4	0.4
Dec-07	0.3	0.4	0.5	0.3	0.3	0.6
Jan-08	0.6	0.4	0.9	1.2	0.4	0.8
Feb-08	0.1	0.4	1.8	0.6	0.6	0.1
Mar-08	3.3	1.1	1.2	3.3	0.6	1.1
Apr-08	0.1	0.4	0.7	2.1	0.2	0.3
Annual	**0.7**	**0.7**	**1.0**	**1.5**	**0.4**	**0.5**
May-08	0.2	0.7	5.8*	2.2	2.7	0.2
Jun-08	0.2	0.3	0.4	1.0	0.4	0.1
Jul-08	0.5	0.7	0.4	1.0	0.6	0.6
Aug-08	0.6	0.5	0.6	1.4	0.7	0.3
Sep-08	0.8	0.8	0.5	1.5	0.6	0.5
Oct-08	0.4	1.0	0.6	1.7	0.3	0.5
Nov-08	1.3	0.6	0.9	0.6	0.4	0.4
Dec-08	0.9	0.3	1.0	0.4	0.8	0.6
Jan-09	2.0	1.7	1.0	1.7	1.0	0.7
Feb-09	0.5	1.0	0.5	0.4	0.8	0.5
Mar-09	2.8	2.2	2.3	6.3*	6.7*	2.7
Apr-09	0.5	0.6	0.4	0.3	0.7	0.5
Annual	**0.9**	**0.9**	**0.8**	**1.1**	**0.8**	**0.6**
Average Annual Mean 2006 to 2009	**0.9**	**0.9**	**0.9**	**1.0**	**0.7**	**0.6**

Note: Following completion of this report, limited dust deposition data were received from additional DCPL dust deposition gauges. These data were not materially different from the data presented in **Table D-10**.

* Sample contaminated and excluded from annual average calculations.

Figure D-14 Monthly Average Dust Deposition Levels Surrounding the Duralie Coal Mine - May 2006 to May 2009



As shown in **Table D-10** and **Figure D-14**, the annual average dust deposition across all monitoring sites is generally low, with levels of between 0.6 and 1.5 g/m^2/month reported as an annual average. Elevations in deposition levels are observed in certain months mainly at sites D3, D4 and D5 although these do not affect the overall trend of low deposition levels.

Dust deposition exceeded the DECCW criterion of 4 g/m^2/month in September 2007 (D4), November 2007 (D4), May 2008 (D3), and March 2009 (D4 and D5). These exceedances were primarily attributable to sample contamination from bird dung, insects or plant material.

D7.3 Background Air Quality for Assessment Purposes

For the purposes of this assessment background air quality concentrations/levels as presented **Table D-11** have been adopted. The maximum monitored values from site data have been adopted. No background 24-hour PM_{10} concentration has been used for assessment purposes due to the assessment goal being incremental (i.e. the Project) only.

No monitoring data are available for TSP. PM_{10} 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 areas in the Hunter Valley where co-located TSP and PM_{10} monitors have been operated indicate that long-term average PM_{10} concentrations represent approximately 40% of the corresponding long-term TSP concentration (NSW Minerals Council, 2000). This relationship has been adopted for this study.

Table D-11 Background Air Quality Levels used for Assessment Purposes

Air Quality Parameter	Concentration / Level
PM_{10}	14.5 µg/m^3 (annual average)
TSP	36.3 µg/m^3 (annual average)
Dust Deposition	1.5 g/m^2/month (annual average)

The background levels in **Table D-11** are likely to include some contribution from the DCM. Therefore the assessment approach of adding background concentrations to modelled Project results for comparison with criteria adds an element of double-counting, which is conservative.

D8 AIR QUALITY MODELLING METHODOLOGY

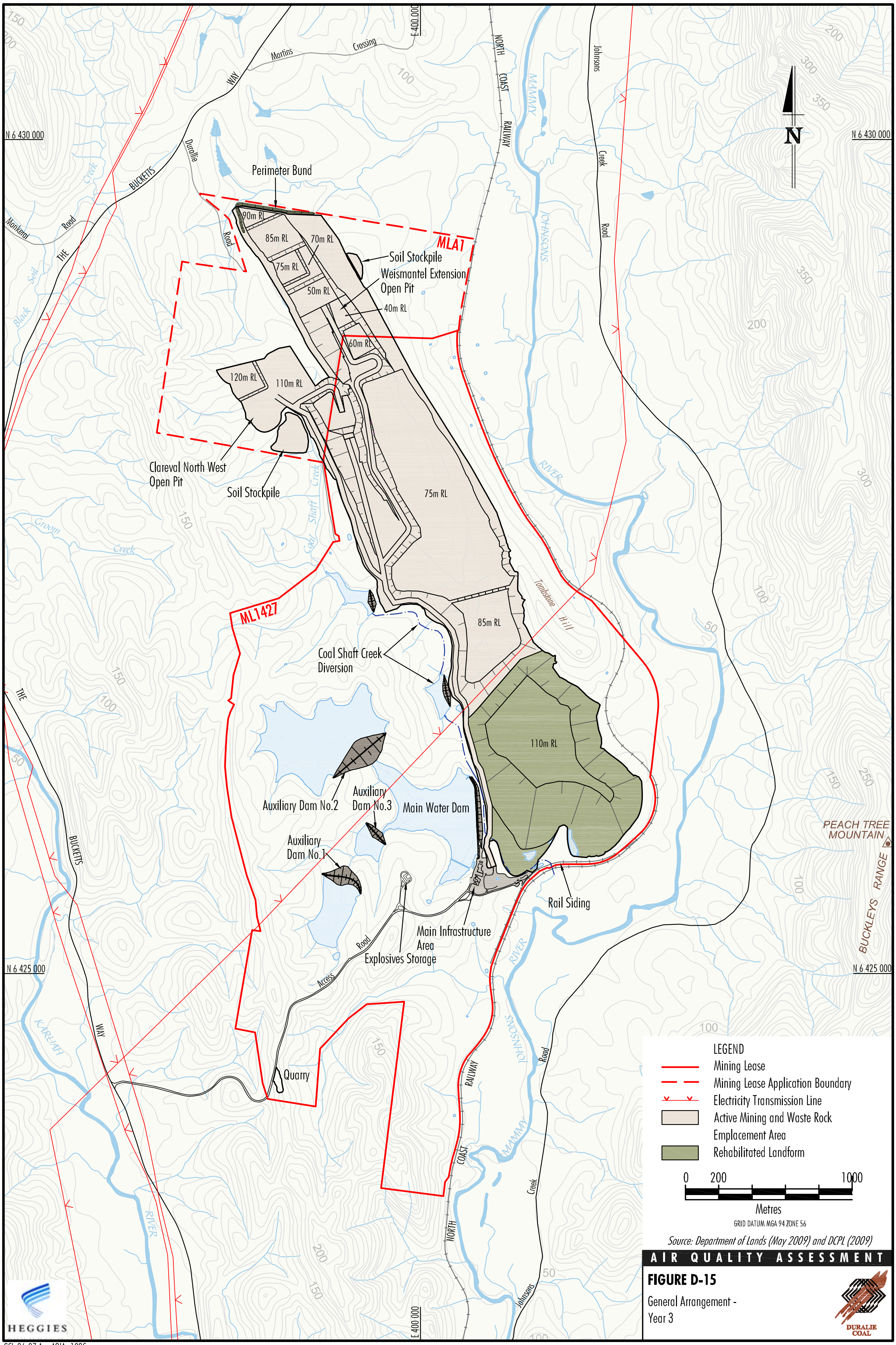
Activities associated with the existing DCM with the potential to generate particulates have been identified in **Section D2.2** of this report. As the Project is proposed to be a continuation of existing DCM operations, potential sources of dust are considered to be generally the same, however the locations of mining activities and the intensity of mining would be altered as a result of the Project.

The dust generating activities identified in **Section D2.2** have been quantified for the three different scenarios of the Project which represent different stages of the mining operations. The selected scenarios are described as follows:

- Project Year 3 operations, representative of the northern extremity of mining within the Weismantel Extension open pit plus the early stages of mining in the Clareval North West open pit, refer **Figure D-15**.
- Project Year 5 operations, representative of the Project year with the greatest materials movement (3 Mt ROM coal and 14.4 Mbcm waste rock), refer **Figure D-16**.
- Project Year 8 operations, representative of the northern extremity of mining within the Clareval North West open pit, refer **Figure D-17**.

D8.1 Emissions Inventory

The quantities of dust emissions from the Project have been estimated using various factors developed by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA) EETM. Where appropriate EETM factors are not available, factors developed by the US EPA have been used. **Table D-12** below presents the emissions inventory for the three scenarios. The Project activity data, emissions estimate assumptions and details of the emissions inventory calculations are presented as **Attachment DA**.



Source: Department of Lands (May 2009) and DCPL (2009)

AIR QUALITY ASSESSMENT

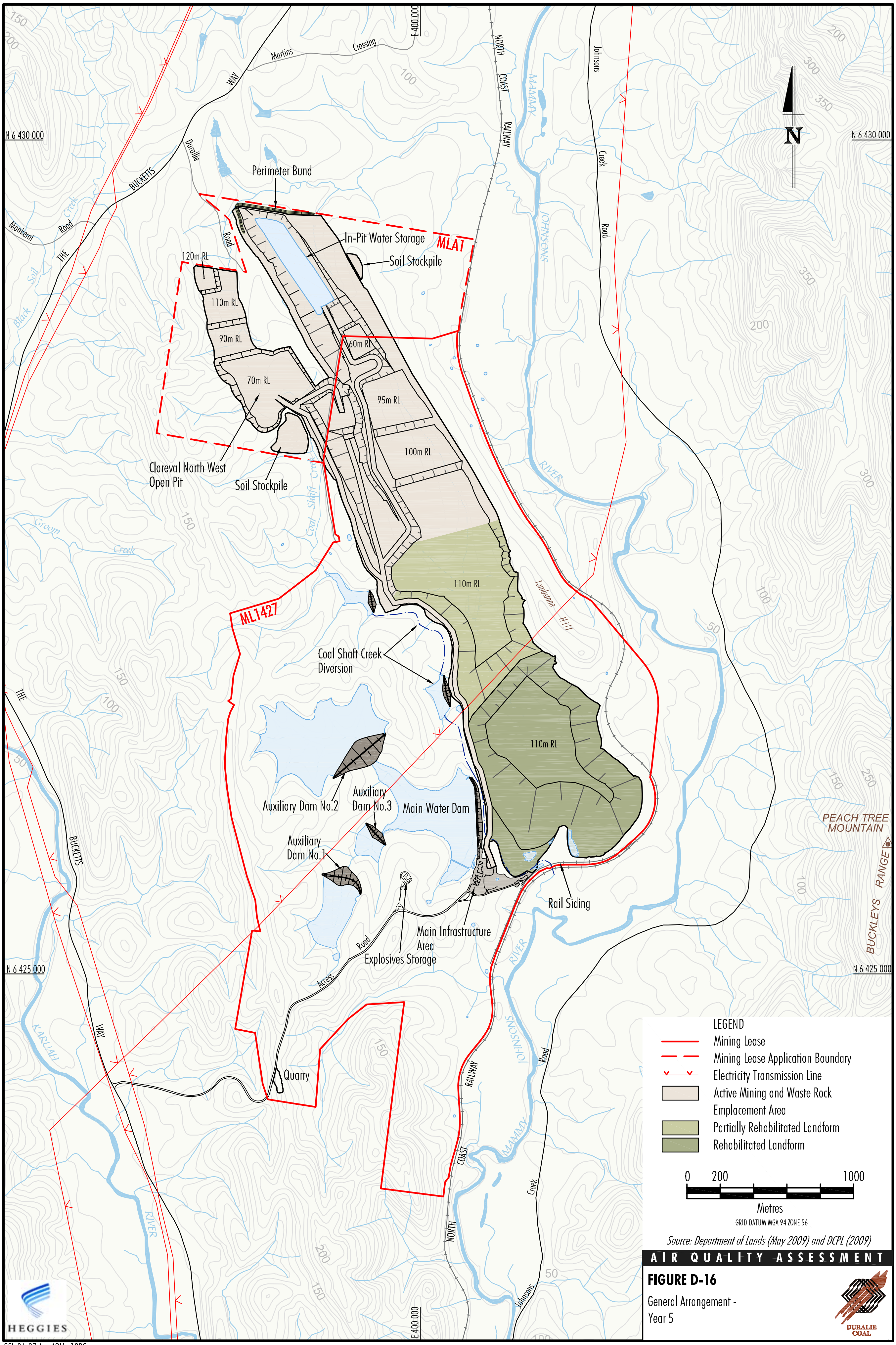
FIGURE D-15

General Arrangement -
Year 3

HEGGIES

DURALIE COAL

GCL-06-07 App AQIA_102C



Source: Department of Lands (May 2009) and DCPL (2009)

AIR QUALITY ASSESSMENT

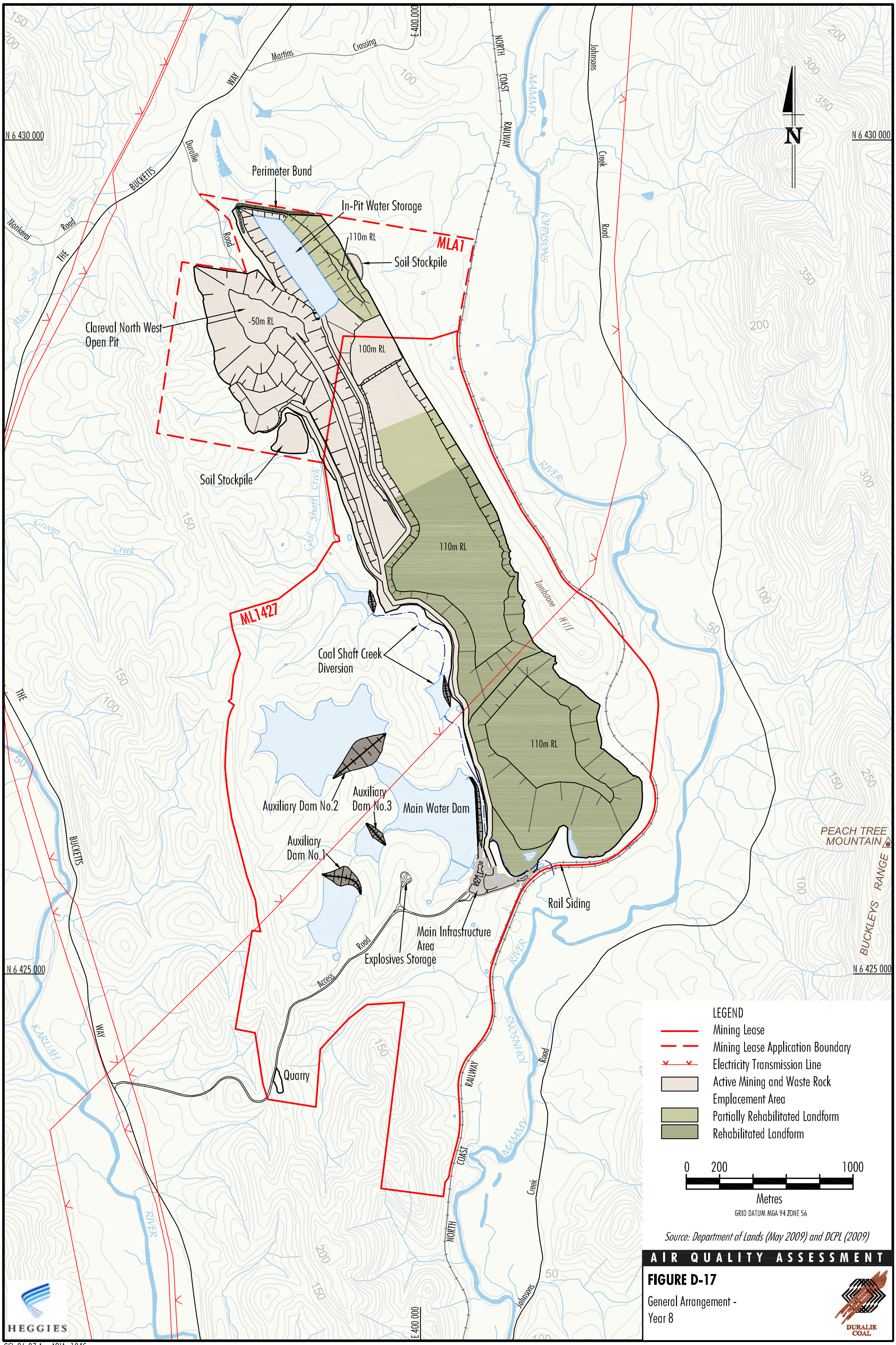
FIGURE D-16

General Arrangement -
Year 5

HEGGIES

DURALIE COAL

GCL-06-07 App AQIA_103C



Source: Department of Lands (May 2009) and DCPL (2009)

AIR QUALITY ASSESSMENT

FIGURE D-17

General Arrangement -
Year 8

HEGGIES

DURALIE COAL

GCL-06-07 App AQIA_104C

Table D-12 Emissions Inventory Summary

Project Component	Year 3		Year 5		Year 8	
	TSP (t/year)	PM_{10} (t/year)	TSP (t/year)	PM_{10} (t/year)	TSP (t/year)	PM_{10} (t/year)
Mining Operations						
Drilling	8.0	4.2	8.3	4.4	6.8	3.6
Blasting	8.9	4.6	12.4	6.4	9.4	4.9
Topsoil removal (excavator)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Transport of topsoil to stockpiles	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dumping of topsoil	0.2	0.1	0.2	0.1	0.2	0.1
Dozer on topsoil	0.8	0.1	1.0	0.2	0.8	0.1
Dozer on overburden	15.6	4.9	19.5	6.1	16.2	5.1
Dozer on coal	5.8	3.1	7.3	3.8	6.0	3.2
Overburden to haul truck (excavator)	3.0	2.7	3.0	2.7	2.5	2.2
Coal to haul truck (excavator)	28.8	26.3	36.0	32.9	30.0	27.4
Transport of coal to ROM/loader (haul road wheel dust)	5.6	1.3	7.2	1.7	6.6	1.6
Transport of overburden to waste rock dump (haul road wheel dust)	694.2	166.1	352.0	84.2	621.3	148.6
Grader on haul roads	32.7	11.6	22.7	8.0	36.2	12.8
Dumping of coal to ROM (direct dump)	4.8	2.0	6.0	2.5	5.0	2.1
Dumping of coal to loader (direct dump)	9.6	4.0	12.0	5.0	10.0	4.2
Rotary breaker	24.0	9.6	30.0	12.0	25.0	10.0
Loading trains	0.3	<0.1	0.4	<0.1	0.3	<0.1
Dumping of waste rock to waste rock emplacement	272.6	97.7	276.5	99.1	224.6	80.5
Dozer on waste rock at waste rock emplacement	15.6	2.6	19.5	3.2	16.2	2.7
Gravel extraction	0.1	0.1	0.1	0.1	0.1	0.1
Dam Construction						
Excavator	<0.1	<0.1	0.1	<0.1	-	-
Dozer	0.2	<0.1	0.6	0.1	-	-
Wind Erosion						
Wind erosion	279.3	139.7	177.1	88.5	137.8	68.9

t/year = tonnes per year.

D8.1.1 Wind Erosion Estimation

Details of the estimation of wind erosion are provided in **Attachment DA**.

D8.2 Atmospheric Dispersion Modelling

D8.2.1 CALPUFF – Emissions from Mine Sources

As discussed in **Section D6.2.1**, the CALPUFF modelling system has been utilised within this assessment to assess the dispersion of particulates generated by the Project. The model has been set-up to assess the concentrations and deposition of dust and particulate at the receptors identified in **Section D4.2** and across a grid centred on the Project area.

CALPUFF requires particle distribution data (geometric mass mean diameter, standard deviation) to compute the dispersion of particulates. Alternatively, hourly varying deposition velocity data can be used. Deposition velocity data for TSP and PM_{10} has been taken from the Visibility Improvement State and Tribal Association of the Southeast (2005) report and has been used as a constant value of 1 m per minute (0.0167 m/s) across each modelled day.

Results of the CALPUFF dispersion modelling are presented in **Section D9.1**.

D8.2.2 CAL3QHCR – Emissions from Coal Wagons

Given that ROM coal from the Project would be transported solely by rail, it is pertinent to assess potential emissions associated with coal dust from train wagons. This assessment is also a requirement of the EARs (**Section D1**)

Currently, a maximum of four trains loaded with coal leave the DCM for the SCM between the hours of 7.00 am and 10.00 pm each day. The Project would increase the hours and number of train movements to a maximum of six between the hours of 7.00 am and 2.00 am each day[4].

Queensland Rail Limited (QR) (the contractor currently used by DCPL for the transportation of ROM coal) recently commissioned a comprehensive study into fugitive dust emissions from a number of their coal rail transportation systems in the Queensland coal fields (Katestone Scientific, 2008). This study comprised a literature review, a network of air quality monitoring equipment and atmospheric dispersion and numerical modelling.

During this assessment, reference was made to a paper by Ferreira *et al*. (2003) which focused on the release of coal dust from train wagons. The study by Ferreira *et al*. (2003) conducted measurement of TSP emissions from coal wagons over a 350 km journey, and found that for such a distance, a 60 tonne (t) semi-covered wagon would lose approximately 0.001% of its load. The total emission for uncovered rail wagons was found to be 9.6 grams of TSP per kilometre per wagon.

The findings of Ferreria *et al.* (2003) were used to derive emission factors for the dispersion modelling assessment conducted by Katestone Scientific (2008) for QR. The resulting predicted concentrations compared well with track-side air quality monitoring conducted during the QR study, suggesting that the conclusions of the Ferreria *et al*. (2003) study were acceptable for estimating the fugitive coal dust emissions from rail wagons. Consequently, in the absence of site specific emissions estimation methods, the findings of Ferreria *et al*. (2003) have been adopted to estimate coal dust emissions from trains leaving the Project.

For the Project, based on a train load of 2,500 t, with each train comprising of 65 to 75 t capacity wagons and travel distance of approximately 20 km, an emission rate of 370 grams of TSP per kilometre travelled has been derived for trains leaving the Project.

To determine the potential impact along the rail route from the Project, the transportation dispersion model CAL3QHCR, developed by the USEPA, was used. CAL3QHCR is based on the dispersion algorithms contained within CALINE-3. While this model is designed to represent road transport emissions, it includes in-built algorithms to account for thermal turbulence and, given the similar linear nature of rail emissions compared with road transport emissions, it is deemed appropriate for the purpose of this assessment.

The 20 km route from the DCM rail siding to the SCM rail loop has been used to produce an indication of the potential fugitive coal dust emissions from rail wagons. Calculation points positioned at 10 m, 30 m, 50 m, 100 m and 200 m from the centre of the railway path were selected at 10 m intervals.

[4] Trains to leave the DCM by 2.00 am.

The closest five receptor points to the rail line have been identified to be within approximately 40 m of the rail line at offset distances of 21 m, 25 m, 39 m, and two receptors at 41 m. One dwelling is located in Wards River, with the remaining four nearby dwellings located between Wards River and the SCM.

Results of the CAL3QHCR modelling are presented in **Section D9.2**.

D9 AIR QUALITY MODELLING RESULTS

Results of the dispersion model predictions for mine and rail transport-related emissions sources are presented in the following sections.

D9.1 CALPUFF Modelling Results

Dispersion modelling predictions of dust deposition, TSP and PM_{10} concentrations for the receptors nominated in **Section D4.2** attributable to the Project operations for Years 3, 5 and 8 are presented in **Section D9.1.1** to **Section D9.1.3**.

D9.1.1 Dust Deposition

Table D-13 shows the results of the dispersion modelling for dust deposition from the Project at each of the identified receptors for Years 3, 5 and 8, using the emission rates calculated in **Attachment DA**. For the purposes of this assessment receptors are defined as dwellings.

The results for all three scenarios indicate that annual average dust deposition levels at all receptors surrounding the Project are predicted to be below the Project criterion of 4 g/m^2/month (cumulative dust deposition) when using a conservative background deposition level of 1.5 g/m^2/month.

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

Table D-13 Incremental and Cumulative Dust Deposition at Nearest Receptors - All Scenarios

Descriptor	Owner	Dust Deposition- Annual Average (g/m²/month)						Assessment Criteria (g/m²/month)	
		Year 3 (Increment)	Year 3 (Cumulative)	Year 5 (Increment)	Year 5 (Cumulative)	Year 8 (Increment)	Year 8 (Cumulative)	Increment	Cumulative
19(1)	Gloucester Coal Limited	0.2	1.7	0.2	1.7	0.2	1.7	2	4
19(4)		1.1	2.6	0.3	1.8	0.3	1.8	2	4
19(6)		0.1	1.6	0.0	1.5	0.0	1.5	2	4
19(8)		0.4	1.9	0.3	1.8	0.2	1.7	2	4
19(9)		0.1	1.6	0.1	1.6	0.1	1.6	2	4
19(10)		0.4	1.9	0.2	1.7	0.2	1.7	2	4
19(11)		0.4	1.9	0.2	1.7	0.2	1.7	2	4
19(13)		0.2	1.7	0.1	1.6	0.1	1.6	2	4
19(14)		0.8	2.3	0.3	1.8	0.4	1.9	2	4
19(16)		0.8	2.3	0.6	2.1	0.3	1.8	2	4
19(17)		0.4	1.9	0.2	1.7	0.2	1.7	2	4
115(1)	P.W.M. & B.D. & G.O. & M.J. Moylan & S.C.M. Newton	0.0	1.5	0.0	1.5	0.0	1.5	2	4
115(3)		0.0	1.5	0.0	1.5	0.0	1.5	2	4
115(4)		0.1	1.6	0.1	1.6	0.1	1.6	2	4
117	E.D. & L.M. Holmes	0.6	2.1	0.4	1.9	0.3	1.8	2	4
120	M.J. & C.A. Mahony	0.1	1.6	0.1	1.6	0.1	1.6	2	4
125(1)	T. & K. Zulumovski	0.5	2.0	0.4	1.9	0.4	1.9	2	4
125(2)		0.9	2.4	0.7	2.2	0.4	1.9	2	4
128	D.R. & B.M. Hare Scott	0.5	2.0	0.3	1.8	0.3	1.8	2	4
131(2)	W.L. Relton	0.3	1.8	0.2	1.7	0.2	1.7	2	4
139	M.S. Juttner	0.2	1.7	0.2	1.7	0.2	1.7	2	4
142	P.G. Madden	0.1	1.6	0.1	1.6	0.1	1.6	2	4
143	P.G. & K.A. Madden	0.1	1.6	0.1	1.6	0.1	1.6	2	4
144	D.J. Wielgosinski	0.1	1.6	0.1	1.6	0.1	1.6	2	4
145	D.H. & S.W. Owens	0.1	1.6	0.1	1.6	0.1	1.6	2	4
146	M.A. Bragg	0.1	1.6	0.1	1.6	0.1	1.6	2	4
147	J.I. Edwards	0.1	1.6	0.1	1.6	0.1	1.6	2	4

Table D-13 Incremental and Cumulative Dust Deposition at Nearest Receptors – All Scenarios (Continued)

Descriptor	Owner	Dust Deposition- Annual Average ($g/m^2/month$)						Assessment Criteria ($g/m^2/month$)	
		Year 3 (Increment)	Year 3 (Cumulative)	Year 5 (Increment)	Year 5 (Cumulative)	Year 8 (Increment)	Year 8 (Cumulative)	Increment	Cumulative
148	D.J. McAndrew	0.1	1.6	0.1	1.6	0.1	1.6	2	4
149	Hattam Pty Ltd	0.9	2.4	0.6	2.1	0.6	2.1	2	4
154	J.R. Morgan	0.1	1.6	0.1	1.6	0.1	1.6	2	4
155	M. & R. Guberina	0.1	1.6	0.1	1.6	0.1	1.6	2	4
167	M. & S.M. Ravagnani	0.1	1.6	0.1	1.6	0.1	1.6	2	4
168(2)	V.R. & E.K. Schultz	0.1	1.6	0.1	1.6	0.1	1.6	2	4
168(3)		0.1	1.6	0.1	1.6	0.1	1.6	2	4
172	S.J. & J.E. Lyall	0.2	1.7	0.1	1.6	0.1	1.6	2	4
194	J. & C.L. Kellehear	0.0	1.5	0.0	1.5	0.0	1.5	2	4
216	D.M. Matcham	0.0	1.5	0.0	1.5	0.0	1.5	2	4
220	TG Lindfield and Associates	0.0	1.5	0.0	1.5	0.0	1.5	2	4

D9.1.2 TSP

Table D-14 shows the results of the dispersion modelling for TSP from the Project at each of the identified receptors for Years 3, 5 and 8 using the emission rates calculated in **Attachment DA**. As discussed in **Section D7.3**, a conservative background concentration of 36.3 µg/m^3 has been assumed for the Project area.

Annual average TSP concentrations are well within the criterion of 90 µg/m^3 at all modelled receptors for Years 3, 5 and 8.

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

D9.1.3 PM_{10}

Table D-15 and **Table D-16** show the results of the dispersion modelling for annual average and 24-hour maximum PM_{10} from the Project at each of the identified receptors for Years 3, 5 and 8 using the emission rates calculated in **Attachment DA.**

An annual average background concentration of 14.5 µg/m^3 has been applied to obtain an indication of the potential cumulative impacts associated with the Project and to allow comparison with the annual average PM_{10} criterion of 30 µg/m^3.

Annual average PM_{10} concentrations are predicted to satisfy the criterion of 30 µg/m^3 at all the modelled receptors for Years 3, 5 and 8.

Exceedances of the incremental 24-hour maximum PM_{10} criterion are predicted at the following near-by receptors (**Table D-16 and Figure D-4**):

- Receptor 19(16) (GCL) – exceedance during Year 3.
- Receptor 149 (Hattam PL) - exceedances during Year 5 and 8.

The predicted 24 hour PM_{10} exceedances at these receptors would occur due to the close proximity to the mining operations (i.e. receptors 19[16] and 149 are located approximately 200 m and 600 m from the mining tenements, respectively).

Contour plots of the incremental increase in PM_{10} concentrations attributable to each scenario are presented in **Attachment DB**. The contour plots are indicative of the concentrations of PM_{10} that could potentially be reached under the conditions modelled.

Contour plots of the maximum 24-hour PM_{10} concentration for all modelled years indicate that largely, the highest concentrations of PM_{10} are restricted to the area immediately surrounding the DCM with the zone of greatest impact largely reflecting the annual wind roses (north-south alignment). However, dispersion model predictions indicate that areas approximately 1.5 km to the east of the DCM are shown to experience maximum 24-hour particulate concentrations of over 50 µg/m^3 $PM_{10.}$ Whilst no receptors exist within these areas, further examination of the meteorological conditions causing these concentrations was undertaken.

It is noted that the dominant wind direction experienced at the DCM is in a north-south alignment, and it would generally not be expected that concentrations of up to 50 µg/m^3 as a maximum 24-hour average would be experienced in this easterly location. However, the contour plots represent the highest concentration during any 24-hour period (from 365 days) at each gridded receptor point. Therefore, only one day of high emissions is required to be transported to the east for this impact to be observed in the contour plots.

Table D-14 Incremental and Cumulative TSP Concentrations at Nearest Receptors - All Scenarios

Descriptor	Owner	TSP Concentrations- Annual Average (µg/m³)						Assessment Criterion (µg/m³)
		Year 3 (Increment)	Year 3 (Cumulative)	Year 5 (Increment)	Year 5 (Cumulative)	Year 8 (Increment)	Year 8 (Cumulative)	Cumulative
19(1)	Gloucester Coal Limited	4.5	27.7	4.8	28.0	4.3	27.5	90
19(4)		24.1	47.3	7.2	30.4	6.8	30.0	90
19(6)		1.3	24.5	0.6	23.8	0.7	23.9	90
19(8)		9.1	32.3	6.9	30.1	5.1	28.3	90
19(9)		2.6	25.8	3.0	26.2	3.1	26.3	90
19(10)		9.7	32.9	3.9	27.1	4.4	27.6	90
19(11)		9.7	32.9	3.8	27.0	4.3	27.5	90
19(13)		3.9	27.1	2.0	25.2	2.0	25.2	90
19(14)		18.2	41.4	7.9	31.1	8.5	31.7	90
19(16)		18.3	41.5	14.4	37.6	7.9	31.1	90
19(17)		8.5	31.7	4.4	27.6	4.6	27.8	90
115(1)	P.W.M. & B.D. & G.O. & M.J. Moylan & S.C.M. Newton	0.9	24.1	1.0	24.2	1.1	24.3	90
115(3)		0.8	24.0	0.7	23.9	0.9	24.1	90
115(4)		2.3	25.5	1.8	25.0	1.6	24.8	90
117	E.D. & L.M. Holmes	12.6	35.8	10.1	33.3	6.4	29.6	90
120	M.J. & C.A. Mahony	2.7	25.9	2.7	25.9	2.7	25.9	90
125(1)	T. & K. Zulumovski	12.5	35.7	9.6	32.8	8.7	31.9	90
125(2)		20.4	43.6	15.5	38.7	10.0	33.2	90
128	D.R. & B.M. Hare Scott	11.6	34.8	6.5	29.7	7.2	30.4	90
131(2)	W.L. Relton	7.0	30.2	4.6	27.8	4.4	27.6	90
139	M.S. Juttner	3.7	26.9	4.0	27.2	3.8	27.0	90
142	P.G. Madden	1.9	25.1	1.9	25.1	2.0	25.2	90
143	P.G. & K.A. Madden	1.9	25.1	2.0	25.2	2.1	25.3	90
144	D.J. Wielgosinski	2.1	25.3	2.4	25.6	2.8	26.0	90
145	D.H. & S.W. Owens	2.3	25.5	2.5	25.7	3.0	26.2	90
146	M.A. Bragg	2.0	25.2	2.3	25.5	2.9	26.1	90

Table D-14 Incremental and Cumulative TSP Concentrations at Nearest Receptors – All Scenarios (Continued)

Descriptor	Owner	TSP Concentrations- Annual Average (µg/m^3)						Assessment Criterion (µg/m^3)
		Year 3 (Increment)	Year 3 (Cumulative)	Year 5 (Increment)	Year 5 (Cumulative)	Year 8 (Increment)	Year 8 (Cumulative)	Cumulative
147	J.I. Edwards	2.0	25.2	2.3	25.5	2.7	25.9	90
148	D.J. McAndrew	2.2	25.4	1.7	24.9	2.1	25.3	90
149	Hattam Pty Ltd	20.6	43.8	13.1	36.3	14.2	37.4	90
154	J.R. Morgan	3.2	26.4	2.1	25.3	1.9	25.1	90
155	M. & R. Guberina	3.4	26.6	1.8	25.0	1.8	25.0	90
167	M. & S.M. Ravagnani	1.9	25.1	1.7	24.9	2.1	25.3	90
168(2)	V.R. & E.K. Schultz	1.8	25.0	1.6	24.8	2.0	25.2	90
168(3)		2.1	25.3	1.9	25.1	2.4	25.6	90
172	S.J. & J.E. Lyall	4.1	27.3	1.8	25.0	1.9	25.1	90
194	J. & C.L. Kellehear	1.1	24.3	1.0	24.2	1.1	24.3	90
216	D.M. Matcham	0.9	24.1	0.7	23.9	0.7	23.9	90
220	TG Lindfield and Associates Pty. Ltd	0.8	24.0	0.7	23.9	0.7	23.9	90

Table D-15 Incremental and Cumulative Annual Average PM_{10} Concentrations at Nearest Receptors – All Scenarios

Descriptor	Owner	PM_{10} Concentrations- Annual Average (µg/m^3)						Assessment Criterion (µg/m^3)
		Year 3 (Increment)	Year 3 (Cumulative)	Year 5 (Increment)	Year5 (Cumulative)	Year 8 (Increment)	Year 8 (Cumulative)	Cumulative
19(1)	Gloucester Coal Limited	1.2	15.7	1.6	16.1	1.5	16.0	30
19(4)		7.5	22.0	2.4	16.9	2.2	16.7	30
19(6)		0.4	14.9	0.2	14.7	0.2	14.7	30
19(8)		2.3	16.8	1.6	16.1	1.8	16.3	30
19(9)		0.8	15.3	1.1	15.6	1.1	15.6	30
19(10)		2.9	17.4	1.3	15.8	1.3	15.8	30
19(11)		3.0	17.5	1.3	15.8	1.3	15.8	30
19(13)		1.2	15.7	0.7	15.2	0.7	15.2	30
19(14)		5.8	20.3	2.7	17.2	2.7	17.2	30
19(16)		5.3	19.8	3.8	18.3	2.9	17.4	30
19(17)		2.6	17.1	1.5	16.0	1.3	15.8	30
115(1)	P.W.M. & B.D. & G.O. & M.J. Moylan & S.C.M. Newton	0.3	14.8	0.3	14.8	0.3	14.8	30
115(3)		0.3	14.8	0.3	14.8	0.3	14.8	30
115(4)		0.5	15.0	0.4	14.9	0.5	15.0	30
117	E.D. & L.M. Holmes	3.0	17.5	2.2	16.7	2.3	16.8	30
120	M.J. & C.A. Mahony	0.7	15.2	0.9	15.4	0.9	15.4	30
125(1)	T. & K. Zulumovski	3.9	18.4	2.8	17.3	3.1	17.6	30
125(2)		5.3	19.8	3.6	18.1	3.7	18.2	30
128	D.R. & B.M. Hare Scott	3.5	18.0	1.9	16.4	2.3	16.8	30
131(2)	W.L. Relton	2.1	16.6	1.5	16.0	1.4	15.9	30
139	M.S. Juttner	1.1	15.6	1.4	15.9	1.3	15.8	30
142	P.G. Madden	0.6	15.1	0.7	15.2	0.7	15.2	30
143	P.G. & K.A. Madden	0.6	15.1	0.8	15.3	0.8	15.3	30
144	D.J. Wielgosinski	0.7	15.2	1.0	15.5	0.9	15.4	30
145	D.H. & S.W. Owens	0.8	15.3	1.0	15.5	1.0	15.5	30
146	M.A. Bragg	0.7	15.2	0.9	15.4	0.9	15.4	30

Table D-15 Incremental and Cumulative Annual Average PM_{10} Concentrations at Nearest Receptors – All Scenarios (Continued)

Descriptor	Owner	PM_{10} Concentrations- Annual Average (µg/m^3)						Assessment Criterion (µg/m^3)
		Year 3 (Increment)	Year 3 (Cumulative)	Year 5 (Increment)	Year5 (Cumulative)	Year 8 (Increment)	Year 8 (Cumulative)	Cumulative
147	J.I. Edwards	0.6	15.1	0.8	15.3	0.8	15.3	30
148	D.J. McAndrew	0.7	15.2	0.6	15.1	0.6	15.1	30
149	Hattam Pty Ltd	6.3	20.8	4.4	18.9	4.2	18.7	30
154	J.R. Morgan	1.0	15.5	0.7	15.2	0.6	15.1	30
155	M. & R. Guberina	1.0	15.5	0.6	15.1	0.5	15.0	30
167	M. & S.M. Ravagnani	0.6	15.1	0.6	15.1	0.6	15.1	30
168(2)	V.R. & E.K. Schultz	0.6	15.1	0.6	15.1	0.6	15.1	30
168(3)		0.7	15.2	0.7	15.2	0.7	15.2	30
172	S.J. & J.E. Lyall	1.2	15.7	0.6	15.1	0.6	15.1	30
194	J. & C.L. Kellehear	0.3	14.8	0.3	14.8	0.3	14.8	30
216	D.M. Hatcham	0.2	14.7	0.2	14.7	0.2	14.7	30
220	TG Lindfield and Associates Pty. Ltd	0.2	14.7	0.2	14.7	0.2	14.7	30

Table D-16 Incremental 24-hour Maximum PM_{10} Concentrations at Nearest Receptors – All Scenarios

Descriptor	Owner	PM_{10} Concentrations- 24-hour maximum (µg/m^3)			Assessment Criterion (µg/m^3)
		Year 3 (Increment)	Year 5 (Increment)	Year 8 (Increment)	Increment
19(1)	Gloucester Coal Limited	14.5	23.1	21.3	50
19(4)		31.2	14.3	13.4	50
19(6)		2.7	2.4	1.6	50
19(8)		23.0	15.8	19.9	50
19(9)		10.4	25.2	30.2	50
19(10)		42.9	21.3	17.1	50
19(11)		42.8	21.0	16.6	50
19(13)		18.8	7.6	6.4	50
19(14)		22.7	11.9	12.7	50
19(16)		***60.3***	33.1	26.1	50
19(17)		23.4	38.3	22.6	50
115(1)	P.W.M. & B.D. & G.O. & M.J. Moylan & S.C.M. Newton	6.9	12.8	13.5	50
115(3)		4.7	3.9	4.7	50
115(4)		12.9	8.6	7.1	50
117	E.D. & L.M. Holmes	26.0	27.6	22.8	50
120	M.J. & C.A. Mahony	8.3	17.3	22.5	50
125(1)	T. & K. Zulumovski	30.2	22.3	25.5	50
125(2)		33.4	34.4	34.3	50
128	D.R. & B.M. Hare Scott	22.5	17.7	32.0	50
131(2)	W.L. Relton	13.0	27.3	14.5	50
139	M.S. Juttner	7.3	9.8	12.0	50
142	P.G. Madden	5.8	5.7	6.1	50
143	P.G. & K.A. Madden	6.7	8.4	7.3	50
144	D.J. Wielgosinski	6.7	11.8	9.3	50
145	D.H. & S.W. Owens	9.2	15.9	10.3	50
146	M.A. Bragg	8.9	10.0	8.9	50
147	J.I. Edwards	4.9	7.4	5.8	50

Table D-16 Incremental 24-hour Maximum PM_{10} Concentrations at Nearest Receptors – All Scenarios (Continued)

Descriptor	Owner	PM_{10} Concentrations- 24-hour maximum (µg/m³)			Assessment Criterion (µg/m³)
		Year 3 (Increment)	Year 5 (Increment)	Year 8 (Increment)	Increment
148	D.J. McAndrew	4.8	3.7	4.3	50
149	Hattam Pty Ltd	48.4	***68.5***	***54.1***	50
154	J.R. Morgan	21.7	20.6	14.5	50
155	M. & R. Guberina	19.4	22.4	14.0	50
167	M. & S.M. Ravagnani	3.7	3.8	4.6	50
168(2)	V.R. & E.K. Schultz	3.2	3.3	4.6	50
168(3)		4.1	4.4	5.1	50
172	S.J. & J.E. Lyall	9.6	4.9	5.3	50
194	J. & C.L. Kellehear	5.9	12.9	16.8	50
216	D.M. Matcham	4.6	7.9	8.0	50
220	TG Lindfield and Associates Pty. Ltd	3.8	3.8	3.9	50

Note: Exceedances shown in italicised bold.

Examination of the model output files and CALMET input files for the 24-hour period in question (30 March 2007) show that during this period, strong (greater than 5 m/s) westerly winds dominate across the day. This is important as, as discussed in **Attachment DA**, emissions resulting from wind erosion of the waste rock dumps and exposed areas is initiated during winds of greater than 5 m/s. Sustained emissions and easterly transport of dust during these hours results in the abovementioned areas of 24-hour PM_{10} exceedances to the east of the DCM.

D9.2 Potential Rail Transportation Air Quality Emissions

A representative distribution plot of 24-hour average TSP and PM_{10} predicted concentrations of coal dust from uncovered rail wagons leaving the Project, as predicted by CAL3QHCR, is presented in **Figure D-18**. Peak 24-hour average PM_{10} concentrations along the modelled route are predicted to be in the order of 7 µg/m^3, occurring close to the release point for the modelled future rail transport scenario.

Peak 24-hour average TSP concentrations are predicted to be approximately 14 µg/m^3 close to the point of release.

For both PM_{10} and TSP, concentrations quickly decrease to negligible levels as distance from the track increases (approximately 0.8 µg/m^3 and 1.6 µg/m^3 at 100 m from the track, respectively).

It should be noted that these conservative predictions do not take into account the watering of rail wagons prior to departure of the DCM.

As discussed in **Section D8.2.2**, the closest receptor to the rail line is approximately 20 m from the centre line. Maximum 24 hour concentrations of PM_{10} at 20 m from the rail centre line are predicted to be approximately 4 µg/m^3, with similar concentrations predicted for both the current and proposed rail transport scenarios.

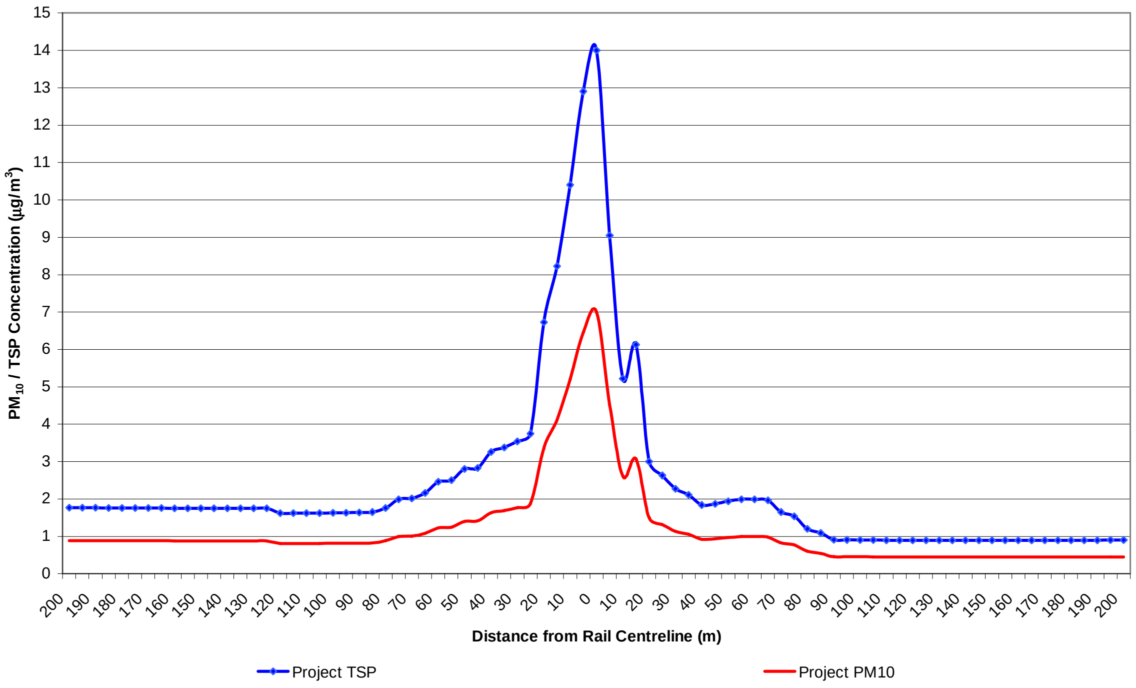
Even when conservatively adding the maximum concentration of dust emissions from rail emissions to the assumed PM_{10} background concentrations of 14.5 µg/m^3, no exceedance of the annual average or 24 hour PM_{10} criterion would be predicted at receptors located adjacent to the North Coast Railway due to DCM rail movements.

It is considered that based on the predicted concentrations of TSP and PM_{10} associated with rail transportation of ROM coal, there is unlikely to be a significant impact associated with particulates generated by the movement of coal in uncovered wagons and no exceedances of relevant particulate criteria would be expected. It is also considered that the results of this modelling are likely to be conservative given that the coal train wagons are sprayed with water prior to departing the DCM, which was not specifically included in the modelling.

In relation to potential cumulative impacts, it is noted that some receptors along the North Coast Railway may be influenced by air quality emissions associated with the SCM. From review of receptor locations, it is noted that receptors in the Craven area are generally more remote from the rail line than other receptors (e.g. in Wards River) between the DCM and SCM. Given that the predicted relatively low dust concentration levels from Project rail operations (i.e. maximum 24 hour concentrations of PM_{10} at 20 m from the rail centre line of approximately 4 µg/m^3 and negligible concentrations at 100 m from the rail line), cumulative air quality impacts with SCM or DCM emissions are not anticipated.

It is also noted that other users of the North Coast Railway include trains containing product coal from the SCM. From review of the frequency of these trains (i.e. a maximum of approximately 10 coal trains transporting coal per day, including the Project), it is not considered that exceedances of the cumulative air quality criteria would generally occur.

Figure D-18 Predicted 24-hour Average TSP and PM_{10} Concentrations Fugitive Coal Dust from Rail Wagons with Distance from the Rail Centre Line



D9.3 Air Quality Mitigation, Management and Monitoring Measures

As discussed in **Section D2.3**, DCPL currently employs air quality mitigation and management measures at the DCM which are considered to be generally best practice. These measures are described in the "*Duralie Coal Mine Air Quality Monitoring Program (Incorporating Air Quality Management)*" (DCPL, 2007).

Specific air quality mitigation measures that were included in the dispersion modelling include:

- Watering of all active haul roads using a water cart.
- Increased frequencies of watering of the main 'trunk' haul roads.
- Watering of drilling activities.
- Enclosure of the rail load-out facility.
- Progressive rehabilitation of mine waste rock dumps as mining progresses to reduce wind-blown dust emission.
- Water sprays on ROM coal trains prior to departure.

It is recommended that the existing "*Duralie Coal Mine Air Quality Monitoring Program (Incorporating Air Quality Management)*" (DCPL, 2007) be reviewed and revised for the Project, if required.

It is also recommended that the existing Air Quality Monitoring Program continues to be implemented by DCPL, incorporating the following elements:

- Two Hi-Vol air samplers recording PM_{10}, including relocation of one Hi-Vol air sampler to the north-west of MLA 1.
- Six dust gauges recording dust deposition.
- The DCM meteorological station recording (as a minimum) rainfall, temperature, wind speed and wind direction.

D10 GREENHOUSE GAS ASSESSMENT

A quantitative greenhouse gas assessment has been undertaken to estimate potential greenhouse gas emissions associated with the Project in accordance with the EARs (**Section D1**).

D10.1 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 (CO2-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 CO2-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.*

D10.2 Greenhouse Gas Calculation Methodology

Quantification of potential Project emissions has been undertaken in relation to both carbon dioxide (CO_2) and other non-CO_2 greenhouse gas emissions.

For comparative purposes, non-CO_2 greenhouse gas are awarded a "CO_2-equivalence" (CO_2-e) based on their contribution to the enhancement of the greenhouse effect. The CO_2-e of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO_2 greenhouse gases are contained within 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_4): GWP of 21 (21 times more effective as a greenhouse gas than CO_2); and
- nitrous oxide (N_2O): GWP of 310 (310 times more effective as a greenhouse gas than CO_2).

The short-lived gases such as carbon monoxide (CO), nitrogen dioxide (NO_2), 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 Project have been assessed, in accordance with the Director-General Requirements, in terms of direct (Scope 1) emission potential, indirect (Scope 2) emission potential and significant upstream/downstream (Scope 3) emission potential (**Section D1**).

A summary of the potential Project greenhouse gas emission sources is provided in **Table D-17**.

Table D-17 Summary of Potential Project 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 carbon dioxide as a result of the Project.	NA	NA
Diesel	Emissions from the combustion of diesel at the Project.	NA	Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project.
Electricity	NA	Emissions from the generation of purchased electricity at the Project.	Estimated emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed at the Project and the electricity lost in delivery in the transmission and distribution network.
Explosives	Emissions from explosives used at the Project.	NA	NA
ROM Coal Transport	NA	NA	Emissions from the combustion of diesel consumed by rail contractors transporting ROM coal to the SCM.
Combustion of Coal	NA	NA	Emissions from the combustion of coal from the Project.
Vegetation Clearance	Emissions from vegetation clearance associated with the Project.	NA	NA

D10.2.1 Scope 1: Direct Emissions

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_2-e (as methane) resulting from fugitive emissions at open pit 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 provides a default figure for NSW open pit coal mines of 0.045 t CO_2-e per t of raw coal (t CO_2-e/t raw coal).

Site-specific testing of coal product at the DCM has indicated that CO_2-e emissions (0.006 t CO_2-e/t raw coal) are significantly lower than the default provided in the NGA Factors (GeoGAS, 2009). It should be noted however that this site-specific emission factor has been derived from a small number of tests (GeoGAS, 2009).

Given the limited number of site-specific measurements available, the default emission factor provided in the NGA Factors has been used in this assessment. It is considered that the use of the default emission factor is conservative given the results of the available site-specific testing and is therefore likely to significantly overestimate Project Scope 1 emissions from coal.

Diesel Usage

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

The primary fuel source for the vehicles operating at the Project would be Diesel. Diesel consumption for all mobile and fixed equipment is estimated as 11,640 kilolitres (kL) in year one of the Project (2010/11) increasing to 14,760 kL in Year 5 of the Project (year of maximum coal extraction).

The annual emissions of carbon dioxide and other greenhouse gases from this source have been estimated using emission factors contained in Table 4 of the NGA Factors. 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 with Fuel Oil [ANFO] and Emulsion). For the purposes of this assessment, it is assumed that ANFO explosives would be used as part of the Project.

The current edition of the NGA Factors (DCC, 2009) does not include emission factors for CO_2-e resulting from the use of ANFO explosives. However, an emission factor of 0.17 t CO_{2-}e per t of explosive (t CO_2-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 Project would result in the release of greenhouse gas emissions. **Table D-18** summarises the types and amount of vegetation cleared over the life of the Project. For this assessment it has been assumed that vegetation clearance would occur in Years 1 to 5 of the Project.

Table D-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 CO2-e/t carbon)
Spotted Gum – Red Ironbark – Thick-leaved Mahogany Forest	61	272	136	8,296	3.67
Spotted Gum – Grey Ironbark – Thick-leaved Mahogany Forest	2	272	136	272	3.67
Red Gum Grassy Woodland	20	200	100	2,000	3.67
Grey Gum – Red Gum – Apple Riparian Forest	3	272	136	408	3.67
Stringybark - Paperbark Forest	1	272	136	136	3.67
Secondary Grasslands	109	2	1	109	3.67

Derived from AGO (2000).

* Assuming 50% of biomass is carbon.

t CO_{2-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 and 2009b). The PAE Holmes methodology is based on various technical reports (AGO, 1999, 2000, 2002 and 2003).

D10.2.2 Scope 2: Indirect Emissions through the Consumption of Purchased Electricity

Scope 2 greenhouse gas emissions relate to the consumption of purchased electricity. The NGA Factors provides Scope 2 emission factors for the consumption of purchased electricity by each state of Australia.

State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

The emission factor for Scope 2 (0.89 t CO_2-e per kilowatt hour [t CO_2-e/kWh]) covers emissions from fuel combustion at power stations associated with the consumption of purchased electricity in NSW.

D10.2.3 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 Project. Up to 3 Mtpa of ROM coal is expected to be produced by the Project, with the majority destined for international markets.

This calculation assumes that 61% of ROM coal produced by the Project is beneficiated at the SCM to product coal and is combusted by third parties. Product coal consists of 34% coking coal and 66% thermal coal.

The greenhouse gas emissions from combustion of product coal by other (non-DCPL) entities have been based on a coal energy content of 30 gigajoules per tonne (GJ/t) for coking coal and 27 GJ/t for thermal (black coal) (Table 1 of the NGA Factors). Standard emission factors for Scope 1[5] emissions from coal combustion have been taken from Table 1 of the NGA Factors.

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 kilometre (Whitehaven Coal Pty Ltd, pers. comm.). The SCM is located approximately 20 km to the north.

The annual emissions of CO_2 and other greenhouse gases from this source have been estimated using Table 4 of the NGA Factors. It has been assumed that the energy content of diesel is 38.6 MJ/L (DCC, 2009).

Extraction, Production and Transport of Fuel Burned for the Generation of Electricity and Electricity Consumed in the Transmission and Distribution System

The NGA Factors provides Scope 3 emission factors for the consumption of purchased electricity by each state. State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

[5] 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.

The NSW Scope 3 emission factor (0.18 kilograms [kg] CO_2-e/kWh) covers both the emissions from the extraction, production and transport of fuels used in the production of the purchased electricity (ie fugitive emissions and stationary and mobile fuel combustion emissions) and also the emissions associated with the electricity lost in transmission and distribution on route to the customer. In this report, Scope 2 and 3 emissions for the consumption of purchased electricity have been reported separately so that the share of the transport and distribution loss can be correctly attributed under Scope 3 emissions - Generation of Electricity Consumed in a transmission and distribution system.

Extraction, Production and Transport of Diesel Consumed at the Project

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

The annual emissions of CO_2 and other greenhouse gases from this source have been estimated using Table 38 of the NGA Factors.

D10.3 Greenhouse Gas Calculation Results

Calculated Scope 1, Scope 2 and Scope 3 emissions of greenhouse gas resulting from the emissions sources outlined above for the Project (**Table D-17**) are presented in **Table D-19**, **Table D-20** and **Table D-21** , respectively. Total Project emissions in each year of operation, and a total Project lifetime emission has been calculated and is presented in **Table D-22**.

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 lifetime direct (Scope 1) emissions from the Project are estimated to be approximately 1.29 Mt CO_2-e, or an average of 0.14 Mt CO_2-e in any one year.

Indirect (Scope 2 and 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total lifetime indirect emissions (Scope 2 and 3) from mining transport and end use of the coal are estimated to be 31.28 Mt CO_2-e, or an average of 3.48 Mt CO_2-e per annum.

A comparison of the predicted direct (Scope 1) emissions against Australia’s 2007 net emissions of 597 Mt CO_2-e demonstrates the Project 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_2-e) demonstrates that the Project would represent approximately 0.08% of NSW emissions (DCC, 2007).

Table D-19 Scope 1 Emissions from the Project

Year	Emission Sources				Calculated Emissions (kt CO_2-e)				
	ROM Coal Production (Mt)	Diesel Consumption (kL)	Explosive Usage (t)	Vegetation Clearance (t of carbon)	Diesel	Explosives	Vegetation Clearance (t)	Fugitive Methane	Total
1	2.0	11,640	7,308	2,244	31.4	1.2	8.2	90.0	130.8
2	2.2	14,190	9,009	2,244	38.2	1.5	8.2	99.0	146.9
3	2.4	14,220	8,946	2,244	38.3	1.5	8.2	108.0	156.0
4	2.4	14,310	9,009	2,244	38.6	1.5	8.2	108.0	156.3
5	3.0	14,760	9,072	2,244	39.8	1.5	8.2	135.0	184.5
6	2.2	14,190	9,009	-	38.2	1.5	-	99.0	138.7
7	2.3	13,980	8,820	-	37.7	1.5	-	103.5	142.7
8	2.5	12,030	7,371	-	32.4	1.2	-	112.5	146.1
9	1.5	5,940	3,528	-	16.0	0.6	-	67.5	84.1

Table D-20 Scope 2 Emissions from Project

Year	Emission Sources	Calculated Emissions (kt CO_2-e)	
	Electricity (MWh)	Electricity	Total
1	2,175	1.9	1.9
2	2,355	2.1	2.1
3	2,535	2.3	2.3
4	2,535	2.3	2.3
5	3,075	2.7	2.7
6	2,355	2.1	2.1
7	2,445	2.2	2.2
8	2,625	2.3	2.3
9	1,725	1.5	1.5

Table D-21 Scope 3 Emissions from Project

Year	Emission Sources							Calculated Emissions (kt CO_2-e)					
	ROM Coal Production (Mt)	Total Product Coal (Mt)	Thermal Coal (Mt)	Coking Coal (Mt)	Rail Diesel Consumption (kL)	Site Diesel Consumption (kL)	Electricity (MWh)	Thermal Coal	Coking Coal	Rail Diesel	Site Diesel	Electricity	Total
1	2	1.22	0.81	0.41	600	11,640	2,175	1,922.5	1,122.7	1.6	2.4	0.4	3,049.6
2	2.2	1.342	0.89	0.46	660	14,190	2,355	2,114.8	1,235.0	1.8	2.9	0.4	3,354.9
3	2.4	1.464	0.97	0.50	720	14,220	2,535	2,307.0	1,347.2	1.9	2.9	0.5	3,659.5
4	2.4	1.464	0.97	0.50	720	14,310	2,535	2,307.0	1,347.2	1.9	2.9	0.5	3,659.5
5	3	1.83	1.21	0.62	900	14,760	3,075	2,883.8	1,684.0	2.4	3.0	0.6	4,573.8
6	2.2	1.342	0.89	0.46	660	14,190	2,355	2,114.8	1,235.0	1.8	2.9	0.4	3,354.9
7	2.3	1.403	0.93	0.48	690	13,980	2,445	2,210.9	1,291.1	1.9	2.9	0.4	3,507.2
8	2.5	1.525	1.01	0.52	750	12,030	2,625	2,403.1	1,403.4	2.0	2.5	0.5	3,811.5
9	1.5	0.915	0.60	0.31	450	5,940	1,725	1,441.9	842.0	1.2	1.2	0.3	2,286.6

Table D-22 Scope 1, 2 and 3 Greenhouse Gas Emissions Attributable to the Project

Year	Calculated Emissions (kt CO_2-e)			TOTAL (kt CO_2-e)
	Scope 1	Scope 2	Scope 3	
1	130.8	1.9	3,049.6	3,182.3
2	146.9	2.1	3,354.9	3,503.9
3	156	2.3	3,659.5	3,817.8
4	156.3	2.3	3,659.5	3,818.1
5	184.5	2.7	4,573.8	4,761.0
6	138.7	2.1	3,354.9	3,495.7
7	142.7	2.2	3,507.2	3,652.1
8	146.1	2.3	3,811.5	3,959.9
9	84.1	1.5	2,286.6	2,372.2
Project Lifetime	**1,286.1**	**19.4**	**31,257.4**	**32,563.0**

D10.4 Greenhouse Gas Mitigation Measures

DCPL is currently implementing a number of measures to minimise to the greatest extent practicable greenhouse gas emissions from the DCM. Relevant measures are described below:

- Maximising energy efficiency as a key consideration in the development of the mine plan. For example, significant savings of greenhouse gas emissions (through increased energy efficiency) are achieved by mine planning decisions which minimise haul distances for ROM coal and waste rock transport and therefore fuel use.
- GCL has prepared and implemented an Energy Savings Action Plan (ESAP) in accordance with the NSW *Energy Administration Amendment (Water and Energy Savings) Act, 2005*. GCL has conducted a comprehensive analysis of energy usage and management strategies at the DCM, and has identified cost-effective energy saving opportunities, including (DCPL, 2008b):
  - installation of power factor correction equipment to reduce the maximum electricity demand at the DCM by an estimated 10%;
  - replacement of conventional electric hot water systems with energy efficient heat pumps in bathhouse facilities;
  - potential adjustment of conveyor belt weight and roller types; and
  - potential adjustment of the number and location of lights in mining and infrastructure areas.

The outcomes of the implementation of the ESAP and annual greenhouse gas emissions at the DCM are and would continue to be reported in the AEMR. The ESAP would be reviewed and updated as necessary for the Project.

Additional measures that would be implemented for the Project include:

- Regular maintenance of plant and equipment to minimise fuel consumption.
- Consideration of energy efficiency in plant and equipment selection/phase.
- Implementation of a vegetation offset programme.

D11 CONCLUSIONS

Modelling of potential mining fugitive dust, PM_{10} and TSP emissions was undertaken using the CALPUFF Dispersion Model software approved by the DECCW.

Three scenarios were modelled to represent potential Project emissions:

- Project Year 3 operations, representative of the northern extremity of mining within the Weismantel Extension open pit and the early stages of mining in the Clareval North West open pit mining, refer **Figure D-15**.
- Project Year 5 operations, representative of the Project year with the greatest materials movement (3 Mt ROM coal and 14.4 Mbcm waste rock), refer **Figure D-16.**
- Project Year 8 operations, representative of the northern extremity of mining within the Clareval North West open pit, refer **Figure D-17**.

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

- Dust deposition levels are predicted to be below the Project air quality criteria at all surrounding dwellings for all modelled scenarios.
- Cumulative annual average TSP concentrations are predicted to satisfy the Project criterion at all surrounding dwellings during all scenarios modelled.
- Cumulative annual average PM_{10} concentrations are predicted to be below the Project air quality goal at all surrounding dwellings.
- Incremental maximum 24-hour PM_{10} concentrations attributable to the Project are predicted to be well below the Project air quality goals at the majority of surrounding dwellings. However, exceedances are predicted at the following near-by receptors, during the identified modelled Scenarios:
  - Receptor 19(16) (GCL) – exceedance during Year 3; and
  - Receptor 149 (Hattam PL) - exceedances during Year 5 and 8.

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.

An assessment of the particulate matter emissions from uncovered rail wagons was also undertaken, to identify any impact on dwellings located in close proximity to the North Coast Railway between the DCM and SCM. Modelling results indicate that rail operations would generate only minor additions to maximum 24 hour PM_{10} concentrations at the closest receptors to the rail line.

The assessment also considers emissions of methane and carbon dioxide from the proposed Project and includes estimates of direct and indirect greenhouse gas emissions.

Indirect (Scope 2 and 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total lifetime indirect emissions (Scope 2 and 3) from mining coal and end use of the coal are estimated to be 31.28 t CO_2-e, or an average of 3.48 t CO_2-e per annum.

A comparison of the predicted direct (Scope 1) emissions against Australia’s 2007 net emissions of 597 Mt CO_2-e demonstrates the Project would represent approximately 0.02 % of the total Australian emissions. A comparison of the predicted Scope 1 emissions against NSW emissions in 2007 (162.7 Mt CO_2-e) demonstrates that the Project would represent approximately 0.08% of NSW emissions.

D12 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.
- 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".
- 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 (2009) "Hourly PM_{10} monitoring data from Beresfield, 2007".
- Duralie Coal Pty Ltd (2007) "Duralie Coal Mine Air Quality Monitoring Program (Incorporating Air Quality Management)".
- Duralie Coal Pty Ltd (2008a) "Duralie Coal Mine Irrigation Management Plan".
- Duralie Coal Pty Ltd (2008b) "Annual Environmental Management Report".
- Ferreira, A.D., Viegas, D.X. and Sousa, A.C.M. (2003) "Full-scale Measurements for Evaluation of Coal Dust Release from Train Wagons with two Different Shelter Covers". *Journal of Wind Engineering and Industrial Dynamics* 91: pp 565-577.
- GeoGas (2009) "Gas Content Testing Boreholes DU180C, DU181C".
- Intergovernmental Panel on Climate Change (1996) "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories".
- Katestone Scientific (2008) "Environmental Evaluation of Fugitive Coal Dust Emissions from Coal Trains - Goonyella, Blackwater and Moura Coal Rail Systems - Queensland Rail Limited".
- 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".

- Scire, J., Strimaitis, D. and Yamartino, R. (2000) "A User's Guide for the CALPUFF Dispersion Model".
- State Emergency Service (2007) "The Maitland Flood of 2007".
- Visibility Improvement State and Tribal Association of the Southeast (2005) "Protocol for the Application of the CALPUFF Model for Analyses of Best Available Retrofit Technology (BART)".

EMISSIONS INVENTORY FOR SITE OPERATIONS

Tables DA-1 to **DA-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 Commonwealth Department of the Environment, Water, Heritage and the Arts 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 DA-9** with relevant control factors presented in **Table DA-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 DA-1 Mining Related Emissions - Operational Hours

Scenario	Activity	Hours of Operation
Existing	Mining Operations	24 hours/7 days
	ROM Coal Train Movement	7.00 am to 10.00 pm/7 days
Project	Mining Operations	24 hours/7 days
	ROM Coal Train Movement	7.00 am to 2.00 am/7 days

ROM = run-of-mine

Table DA-2 Coal and Overburden Parameters used in Emissions Estimation

Parameter	Value	Units	Source	Notes
Silt Content	3.5	%	Assumed[1]	Applied to haul roads and waste rock
	4.5	%	Duralie Coal Mine (DCM) NPI return, 2007/2008	Applied to coal
Moisture Content	5.6	%	Assumed	Applied to waste rock emplacement
	4.5	%	DCM NPI return, 2007/2008	Applied to blasted material
	4.5	%		Applied to coal
Gravel Extraction	30,000	Tonnes (t)	Assumed	
Area Blasted	396,139	square metres (m^2)	DCM NPI return, 2007/2008	Area blasted per annum
Depth of blast holes	15	metres (m)	DCM NPI return, 2007/2008	
Holes drilled per year	12,730	number of holes	DCM NPI return, 2007/2008	
Blasts per year	96	number of blasts	DCM NPI return, 2007/2008	
Grader mean speed	8	kilometres per hour (km/h)	DCM NPI return, 2007/2008	

[1] Heggies measurements indicated 1.6%. 3.5% used as conservative.

For Years 3, 5 and 8, the figures presented in **Table DA-3** have been adjusted where appropriate based on the increases in coal extraction or overburden removal. Data on hours of activity for certain equipment has also been adjusted based on coal extraction rates.

Table DA-3 Activity Data for Mining Operations - Years 3, 5 and 8

Activity	**Year 3**	**Year 5**	**Year 8**	**Notes**
Number of holes drilled per year	13,485	14,135	11,536	Based on coal extraction rate and orebody production
Number of blasts per year	96	96	96	Assumed to remain constant
Area blasted per year (m^2)	538,397	672,996	560,830	Based on coal extraction rate
Dozer on orebody (hours) per year	16,165	20,206	16,838	Based on orebody production
Dozers on coal in-pit (hours) per year	440	550	459	Based on coal extraction rate
Direct dumping (t) per year	1,920,000	2,400,000	2,000,000	Based on coal extraction rate
Dumping of coal at ROM (t) per year	480,000	600,000	500,000	Based on coal extraction rate
Loading from stockpile with front-end loader (FEL) (t) per year	125,038	156,298	130,248	Based on coal extraction rate
Loading ROM bin with FEL (t) per year	125,038	156,298	130,248	Based on coal extraction rate
Loading trains (t) per year	2,400,000	3,000,000	2,500,000	Based on coal extraction rate
Excavator on topsoil (t) per year	15,358	19,197	15,998	Based on coal extraction rate
Dozers on topsoil (hrs) per year	405	506	422	Based on coal extraction rate
Trucks dumping topsoil (t) per year	15,385	19,231	16,026	Based on coal extraction rate
Gravel extraction (t) per year	30,000	30,000	30,000	Based on data provided by Duralie Coal Pty Ltd (DCPL)

Table DA-4 Area of Wind Erosion Sources used in Dispersion Modelling (hectares [ha])

Project Year	**Partially Rehabilitated Areas**	**ROM**	**Topsoil Stockpile**	**Active Mining Areas**
Year 3	0	0.5	10.2	215
Year 5	50	0.5	10.2	165
Year 8	28.5	0.5	10.2	135

Table DA-5 Haulage Parameters used in Emissions Estimation

Project Year	Coal		Waste Rock		Topsoil	
	Haul Road Distance (km)	Daily truck movements[1]	Haul Road Distance (km)	Daily truck movements[1]	Haul Road Distance (km)	Daily truck movements[1]
Year 3	3.4	48	5.8	458	1.5	1
Year 5	3.5	60	2.9	464	1.5	1
Year 8	3.9	50	6.3	377	1.5	1

[1] Truck movements averaged over a year. A movement is a return trip.

km = kilometre.

Table DA-6 Meteorological data required for Emissions Estimation

Parameter	Value	Units	Source
Mean wind speed	2.1	m/s	Based on site recorded meteorological data
Percentage of time when wind speed > 5.4 m/s	4.0	%	Based on site recorded meteorological data
Average hourly evaporation rate	0.18	mm/hr	Based on long-term average data from BoM Paterson (Tocal) AWS
Number of days with rainfall > 0.25 mm	133	days	Based on site recorded meteorological data

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

Table DA-7 Project Extraction Rates - Current and Proposed

Project Year	Coal (Mtpa)	Waste Rock (Mbcm)	Topsoil (Mtpa)
Year 3	2.4	14.2	0.035
Year 5	3.0	14.4	0.043
Year 8	2.5	11.7	0.036

Note: Density of Waste Rock and Overburden assumed to be 1.6 tonnes per cubic metre (t/m^3) for moist packed earth (from Table 2-120 of Perry's Chemical Engineers Handbook [1973]).

Mtpa = million tonnes per annum.
Mbcm = million bank cubic metres.

Table DA-8 Control Factor Variables

Parameter	Value	Units	Source
Water application intensity on haul routes	2	L/m^2	DCM NPI return, 2007/2008
Time between water application on haul routes	1	hours	DCM NPI return, 2007/2008

L/m^2 = litres per square metre.

Table DA-9 Emission Factor Equations

Activity	Emission Factor Equation	Units	Source	Variables
Drilling	Default of 0.59 for total suspended particulates (TSP)	kg/hole	NPI EETM v2.3 (p11)	
	Default of 0.31 for particulate matter less than 10 microns in size (PM_{10})			
Blasting	$= 0.00022 \times A^{1.5}$ for TSP	kg/blast	AP42 Western Surface Coal Mining	A = Area Blasted (m^2) M = Moisture content (%) D = Depth of blast holes (m)
	As above multiplied by 0.52 for PM_{10}			
Excavator on overburden	$= k \times 0.0016 \times (U/2.2)^{1.3} \times (M/2)^{-1.4}$	kg/t	NPI EETM v2.3 (p11)	k = 0.74 (TSP) k = 0.35 (PM_{10}) 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_{10}) 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_{10}) 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	kg/t	NPI EETM v2.3 (p11)	
	Default of 0.0042 for PM_{10}			
Trucks dumping overburden	Default of 0.012 for TSP	kg/t	NPI EETM v2.3 (p11)	
	Default of 0.0043 for PM_{10}			
Dozer on coal	TSP $= 35.6 \times s^{1.2} \times M^{-1.4}$	kg/hr	NPI EETM v2.3 (p11)	s=silt content (%) M=Moisture content (%)
	$PM_{10} = 6.33 \times s^{1.5} \times M^{-1.4}$			
Dozer on material other than coal	TSP $= 2.6 \times s^{1.2} \times M^{-1.3}$	kg/hr	NPI EETM v2.3 (p11)	s=silt content (%) M=Moisture content (%)
	$PM_{10} = 0.34 \times s^{1.5} \times M^{-1.4}$			
Grader	TSP $= 0.0034 \times S^{2.5}$	kg/VKT	NPI EETM v2.3 (p12)	S=mean vehicle speed (km/h)
	$PM_{10} = 0.0034 \times S^{2.0}$			

Activity	Emission Factor Equation	Units	Source	Variables
Rotary Breaker	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_{10} (Emission Factor for Primary Crushing, High Moisture Ore)			
Coal loading to trains	Default of 0.0004 for TSP	kg/t	NPI EETM v2.3 (p12)	
	Default of 0.00017 for PM_{10}			
Coal Transport	Default of 9.6 for TSP	g/km/wagon	Ferreira *et al*. (2003)	
Wind Erosion	$TSP = 1.9 \times \left(\frac{s}{1.5}\right) \times 365 \times \left(\frac{365-p}{235}\right) \times \left(\frac{f}{15}\right)$ PM_{10}=As above multiplied by 0.5	kg/ha/year	NPI EETM v2.3 (p41)	s = silt content (%) p = number of days in year with rainfall greater than 0.25 mm f = percentage of time that wind speed is greater than 5.4 m/s at the mean height of the stockpile
	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. CALPUFF (see **Section D8.2.1**) provides the following default wind speed bands by which the emission rate for a source can be varied: 0-1.54, 1.54-3.09, 3.09-5.14, 5.14-8.23, 8.23-10.8 and 10.8+ m/s. To derive a wind erosion proportion for each wind speed band, the US EPA's erosion potential equation within Chapter 13, Section 13.2.5 Industrial Wind Erosion (US EPA, 2006), was used to estimate the erosion potential for each band. Within this equation, a Particle Threshold Friction Velocity of 0.5 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).			

Table DA-10 Emission Control Factors

Mitigation Measure	Applicable to	Value	Units	Source	Variables
Water Spraying	Haul routes [1]	$CF = 100 - \frac{(0.8 \times P \times d \times t)}{I}$	%	Cowherd et al (1988) *Control of Open Fugitive Dust Sources*	P=Potential Average Daytime Evaporation Rate (mm/hr) d = Daily average truck movements I = Water Application Intensity (L/m)[2] t = Time between application (hours).
	Drilling	50	%	NPI EETM v2.3 (p16) – conservatively used	
Pit Retention	Activities in-pit: Blasting Drilling Excavator Dozer Haul route and Grader (certain sections)	TSP=50	%	NPI EETM v2.3 (p16)	
		PM_{10}=5			
Enclosure	Loading to trains	70	%	NPI EETM v2.3 (p16)	

1 Control Factor varies by haul route (ROM, WRD and Topsoil).
2 Rainfall has been taken into account during the calculation of wind erosion emissions (refer **Table DA-9**).

REFERENCES

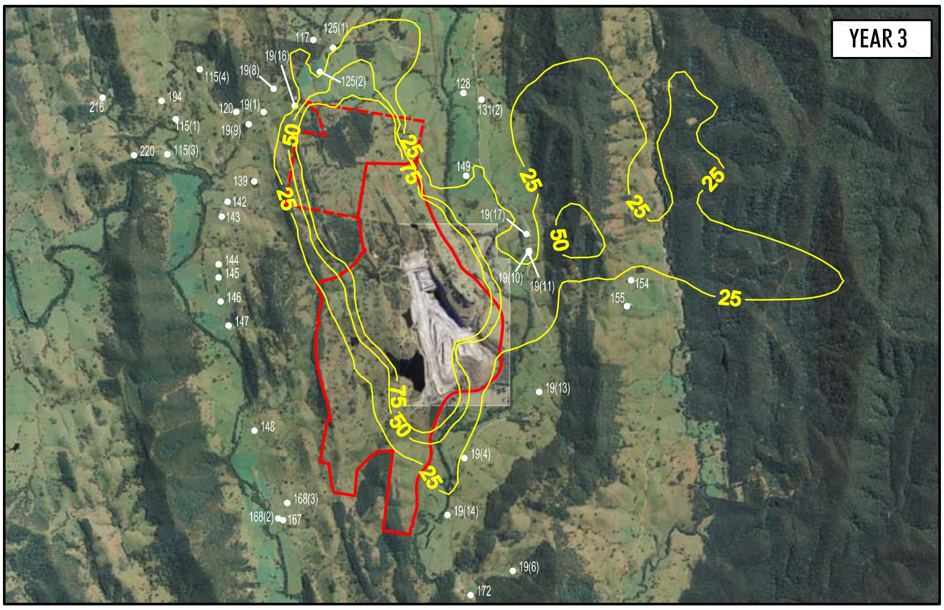
- Commonwealth of Australia (2001) “National Pollutant Inventory, Emission Estimation Technique Manual for Mining, Version 2.3, December 2001”.
- Cowherd (1988) “Control of Open Fugitive Dust Sources”.
- Ferreira , A.D., Viegas, D.X. and Sousa, A.C.M. (2003), “Full-scale Measurements for Evaluation of Coal Dust Release from Train Wagons with two Different Shelter Covers”,. *Journal of Wind Engineering and Industrial Dynamics* 91: pp 565-577.
- Perry (1973) “Chemical Engineers Handbook”.
- Sinclair Knight Merz (2005) “Improvement of NPI Fugitive Particulate Matter Emission Estimation Techniques”.
- US EPA (2006) “Compilation of Air Pollutant Emission Factors AP-42” (Chapter 13, Section 13.2.5 Industrial Wind Erosion).

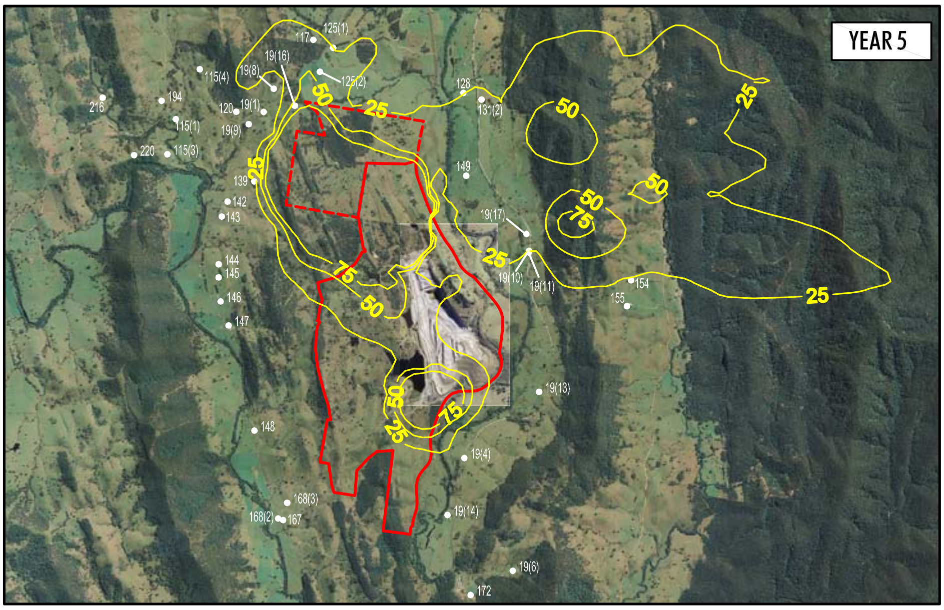
ATTACHMENT DB

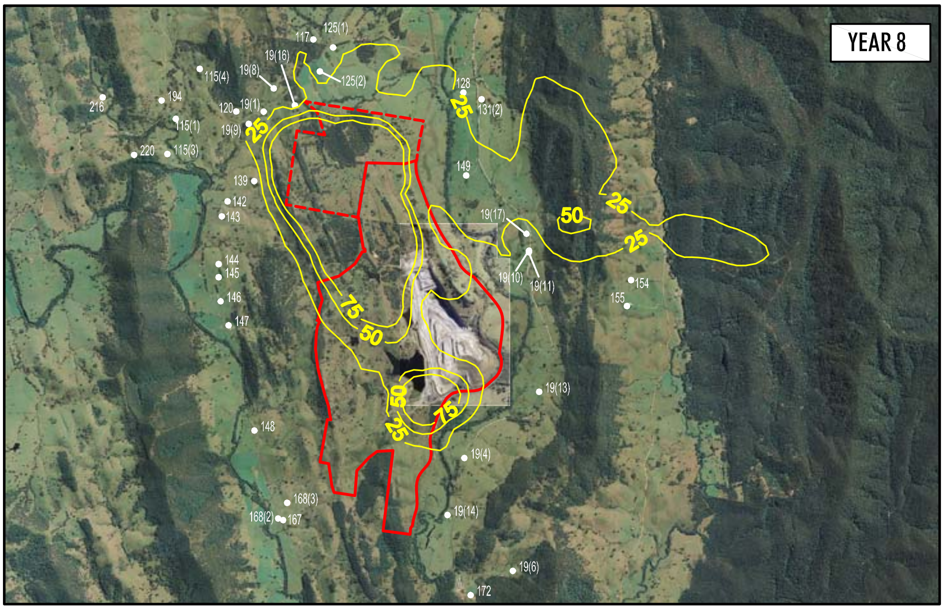
Report 8034-R3

CONTOUR PLOTS OF DISPERSION MODEL PREDICTIONS

N







LEGEND

Mining Lease Boundary

Mining Lease Application Boundary

19(14) Air Quality Receptor

Project Only - Air Quality Contour

Source: Department of Lands (May 2009) and DCPL (2009)

0 500 2500

Metres

GRID DATUM MGA 94 ZONE 56

AIR QUALITY ASSESSMENT

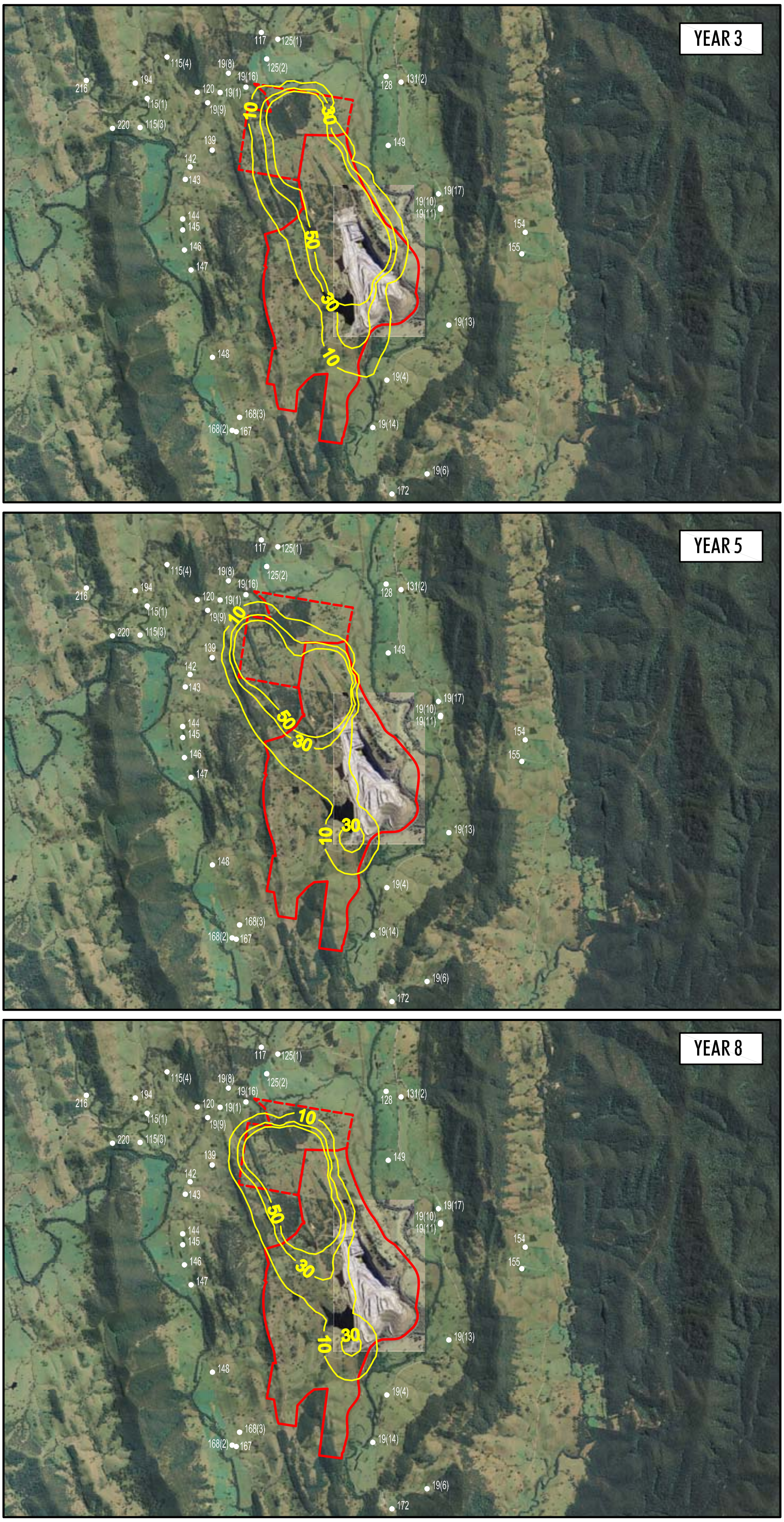
FIGURE DB-1

24 Hour PM_{10} Contours

HEGGIES

DURALIE COAL

GCL-06-07 App AQIA_109F



Source: Department of Lands (May 2009) and DCPL (2009)

LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- 19(14) Air Quality Receptor
- Project Only - Air Quality Contour

0 500 2500

Metres

GRID DATUM MGA 94 ZONE 56

HEGGIES

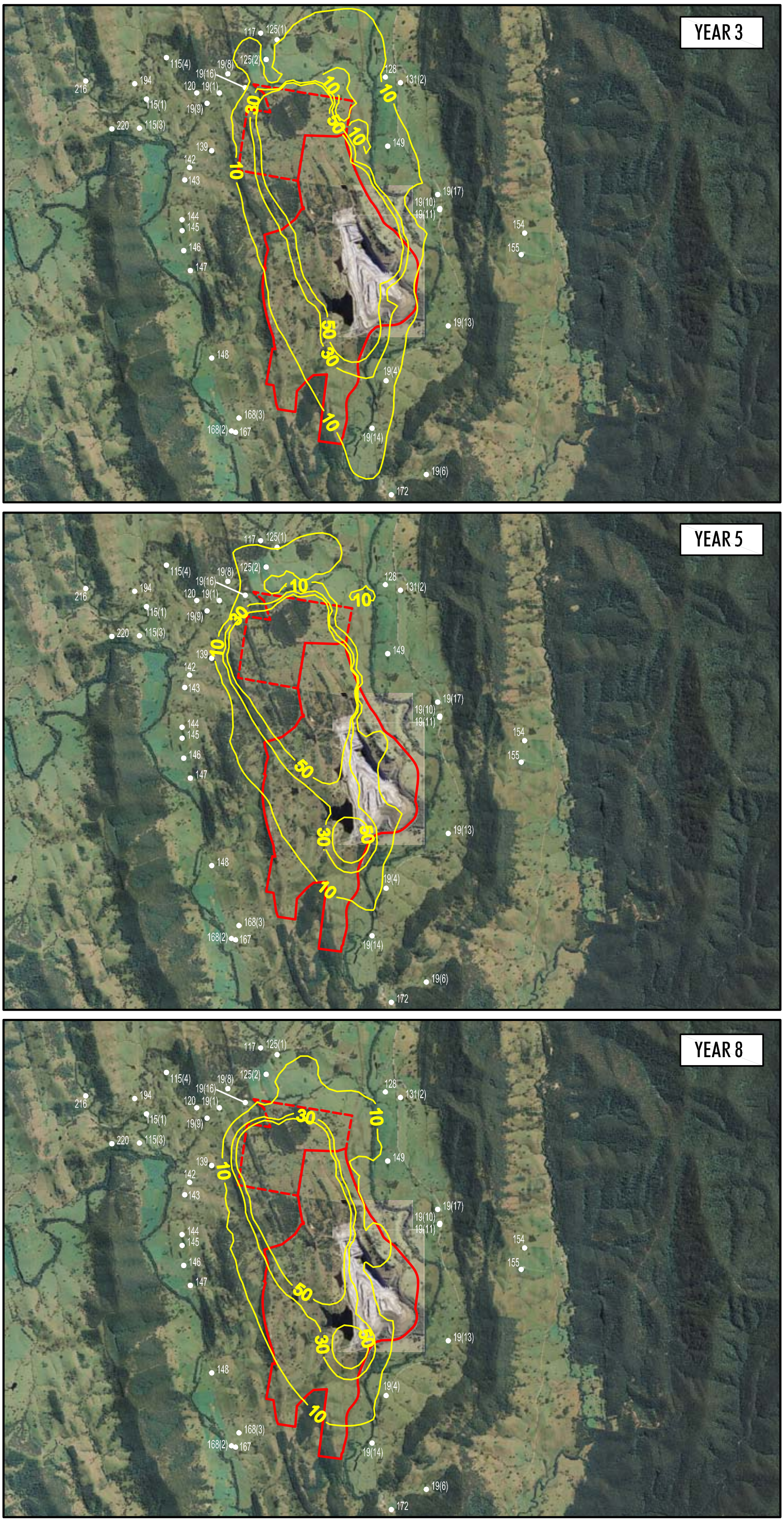
AIR QUALITY ASSESSMENT

FIGURE DB-2

Annual Average PM_{10} Contours

DURALIE COAL

GCL-06-07 App AQIA_106F



N

LEGEND
Mining Lease Boundary
Mining Lease Application Boundary
19(14) Air Quality Receptor
Project Only - Air Quality Contour

0 500 2500
Metres
GRID DATUM MGA 94 ZONE 56

Source: Department of Lands (May 2009) and DCPL (2009)

AIR QUALITY ASSESSMENT

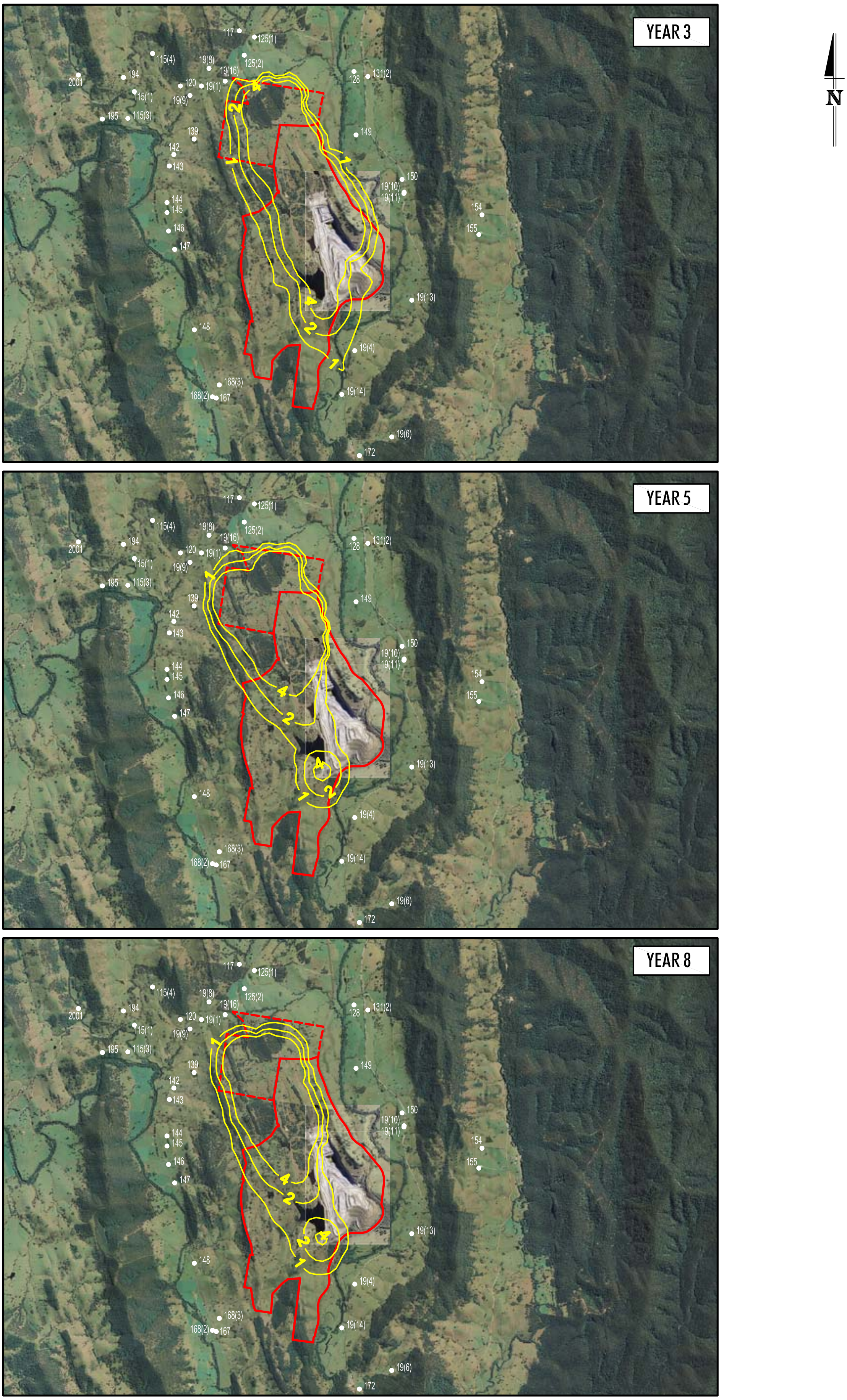
FIGURE DB-3

Annual Average $\mu g/m^3$ TSP Contours

HEGGIES

DURALIE COAL

GCL-06-07 App AQIA_107F



Source: Department of Lands (May 2009) and DCPL (2009)

LEGEND

- Mining Lease Boundary
- Mining Lease Application Boundary
- 19(14) Air Quality Receptor
- Project Only - Air Quality Contour

0 500 2500
Metres
GRID DATUM MGA 94 ZONE 56

HEGGIES

AIR QUALITY ASSESSMENT

FIGURE DB-4

Dust Deposition g/m^2/month Contours

DURALIE COAL

GCL-06-07 App AQIA_108F