APPENDIX A

Air Quality Impact Assessment

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

FINAL REPORT

AIR QUALITY IMPACT ASSESSMENT – COALPAC MODIFICATIONS

Coalpac Pty Limited

Job No: 3351K

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1 INTRODUCTION

This report has been prepared by Pacific Environment for Hansen Bailey Environmental Consultants on behalf of Coalpac Pty Limited (Coalpac). Coalpac owns and operates the existing operations of Invincible Colliery and Cullen Valley Mine. Each mine operates as a separate entity with separate planning approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Coalpac is seeking to modify both planning approvals under Section 75W of the former Part 3A of the EP&A Act. These modifications are sought to facilitate the extension to the respective approved mining areas at Invincible Colliery and Cullen Valley Mine and will be referred to jointly in this report as "the Modifications".

The air quality assessment is based on the use of a computer-based dispersion model to predict ground-level pollutant concentrations, including dust and diesel and blast fume, in the vicinity of the Modifications. To assess the effect that emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality criteria, (refer to **Section 5**).

The assessment follows the procedures outlined by the NSW Environmental Protection Authority (EPA) in their document titled *"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW"* (Approved Methods) (**EPA, 2005**). The Approved Methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data, emissions estimation and relevant air quality criteria.

In summary, the report provides information on the following:

- A description of operations at each site, with a focus on describing those aspects that will affect air quality,
- Air quality criteria that need to be met to protect the air quality environment,
- Meteorological and climatic conditions in the area,
- A description of the existing air quality environment including local climate and air quality monitoring data,
- The methods used to estimate emissions to air taking into account the current and proposed control measures to reduce these emissions,
- The expected dispersion patterns due to emissions from the Modifications and a comparison between the predicted pollutant levels and their relevant air quality criteria, and
- A description of all best practice management measures currently in place Invincible Colliery and Cullen Valley Mine and those proposed for the Modifications.

2 LOCAL SETTING

Invincible Colliery and Cullen Valley Mine are located adjacent to the Castlereagh Highway, approximately 25 kilometres (km) to the northwest of Lithgow near the township of Cullen Bullen, NSW.

Figure 2.1 shows the location of Invincible Colliery and Cullen Valley Mine, including the Modification Disturbance Boundary proposed for each site and the nearest sensitive receptors. Air quality impacts have been assessed at these locations and will be discussed in subsequent sections.

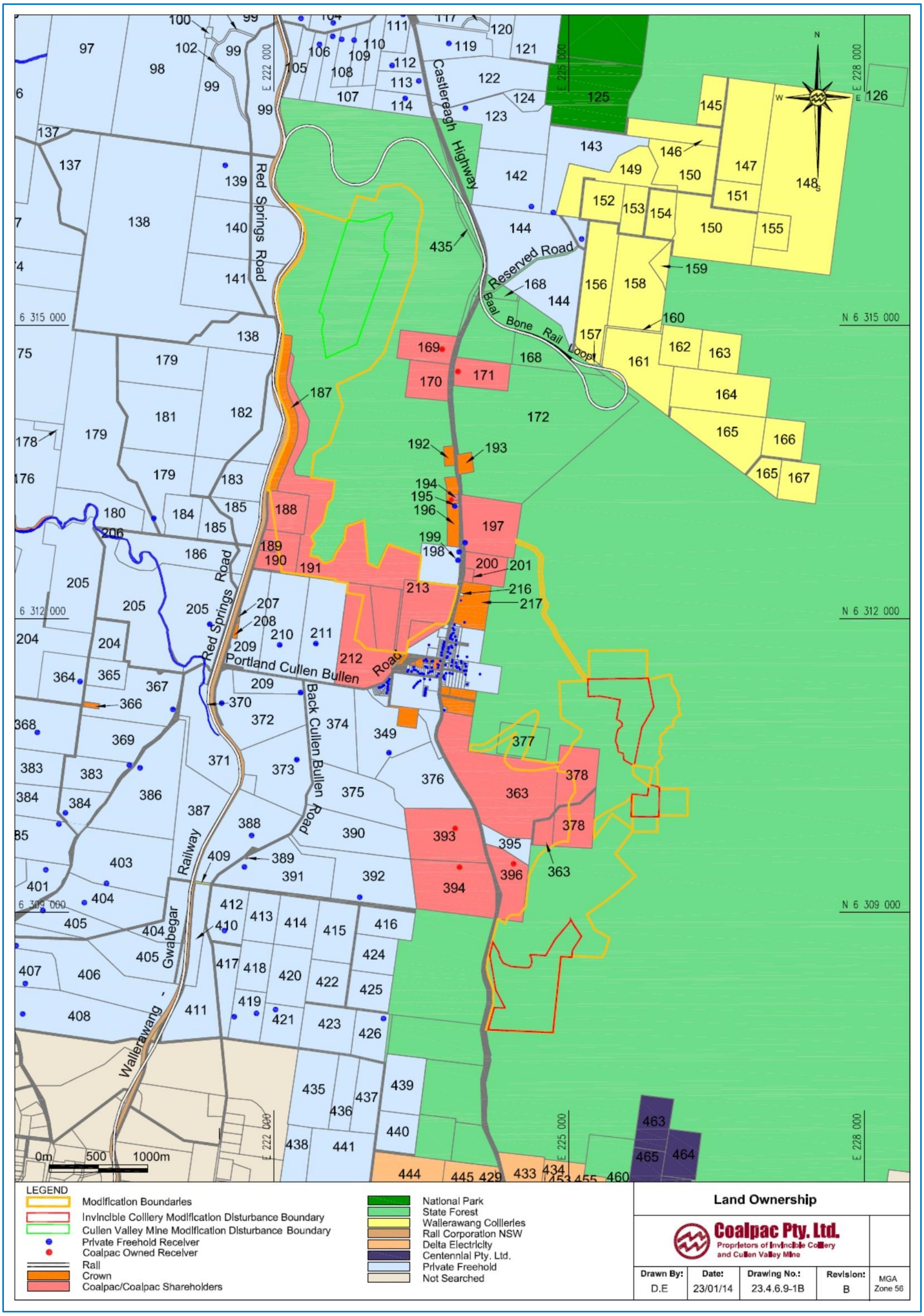


Figure 2.2 presents details of land ownership and a map with all sensitive receptors identified.

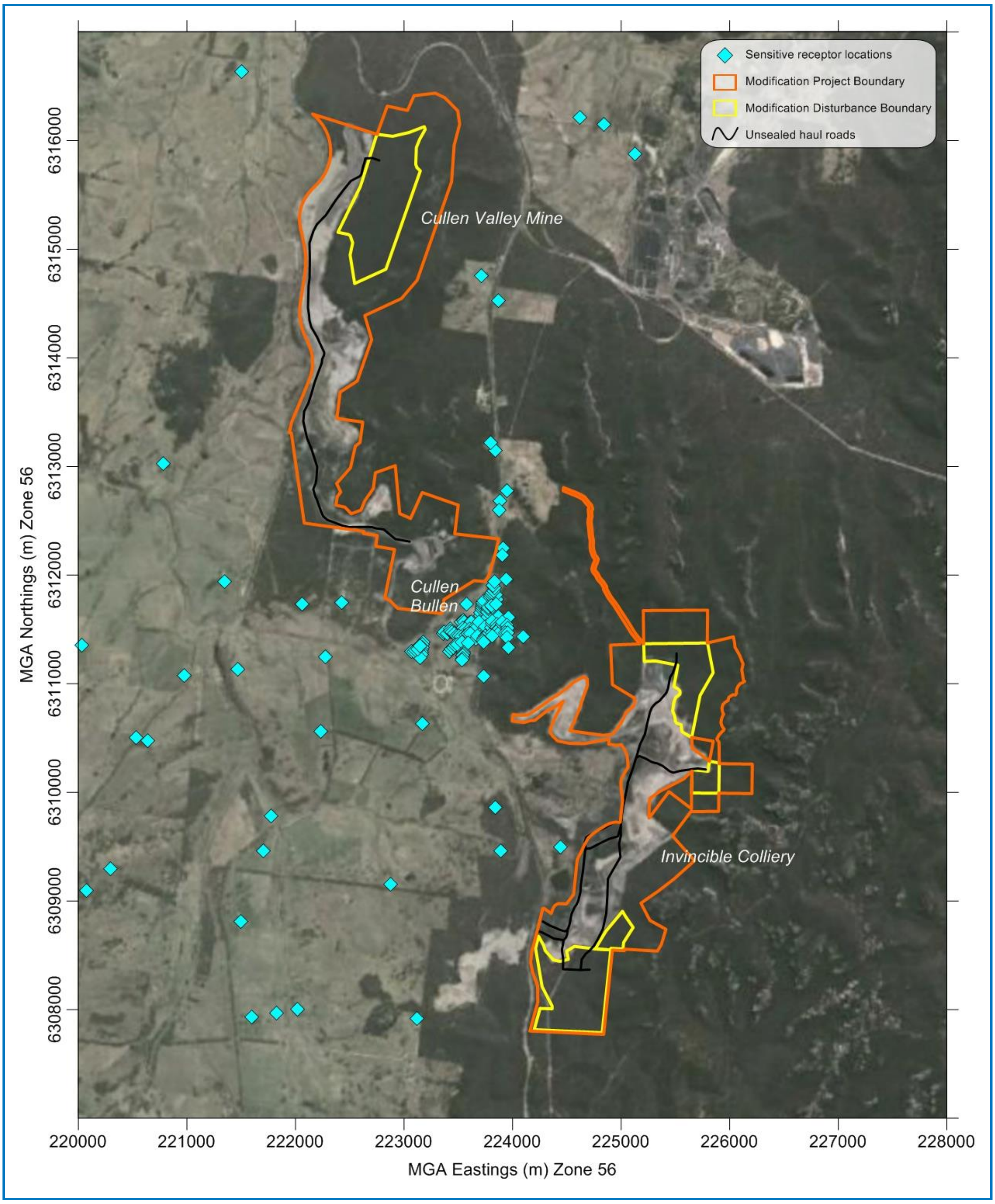


Figure 2.1: Location of Modifications

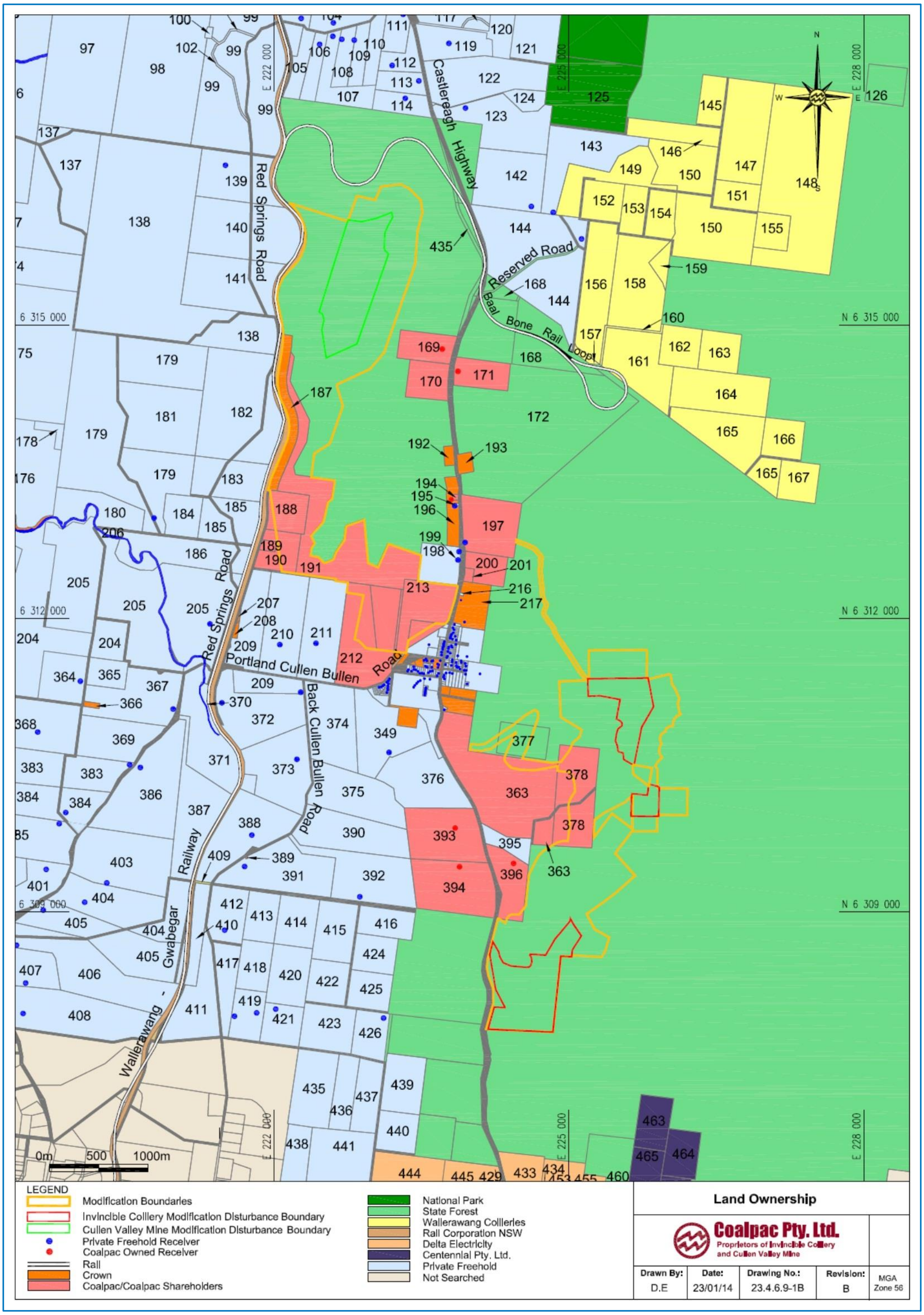


Figure 2.2: Land Ownership and Receptor Locations

Figure 2.3 shows the topography of the area. Invincible Colliery and Cullen Valley Mine are located on the western slopes of the Great Diving Range. The topography surrounding both sites typically consists of moderately undulating terrain.

Activities within both Modification Boundaries are predominantly associated with existing mining operations and recreational activities within the Ben Bullen State Forest. Land use in the wider region includes other mining operations (e.g. Baal Bone Colliery, Ivanhoe North Mine and the Pinedale Mine) as well as agricultural and forestry activities. The closest residential area to the Modifications is the township of Cullen Bullen, located on the Castlereagh Highway to the southeast of the Cullen Valley Mine and the northwest of the Invincible Colliery.

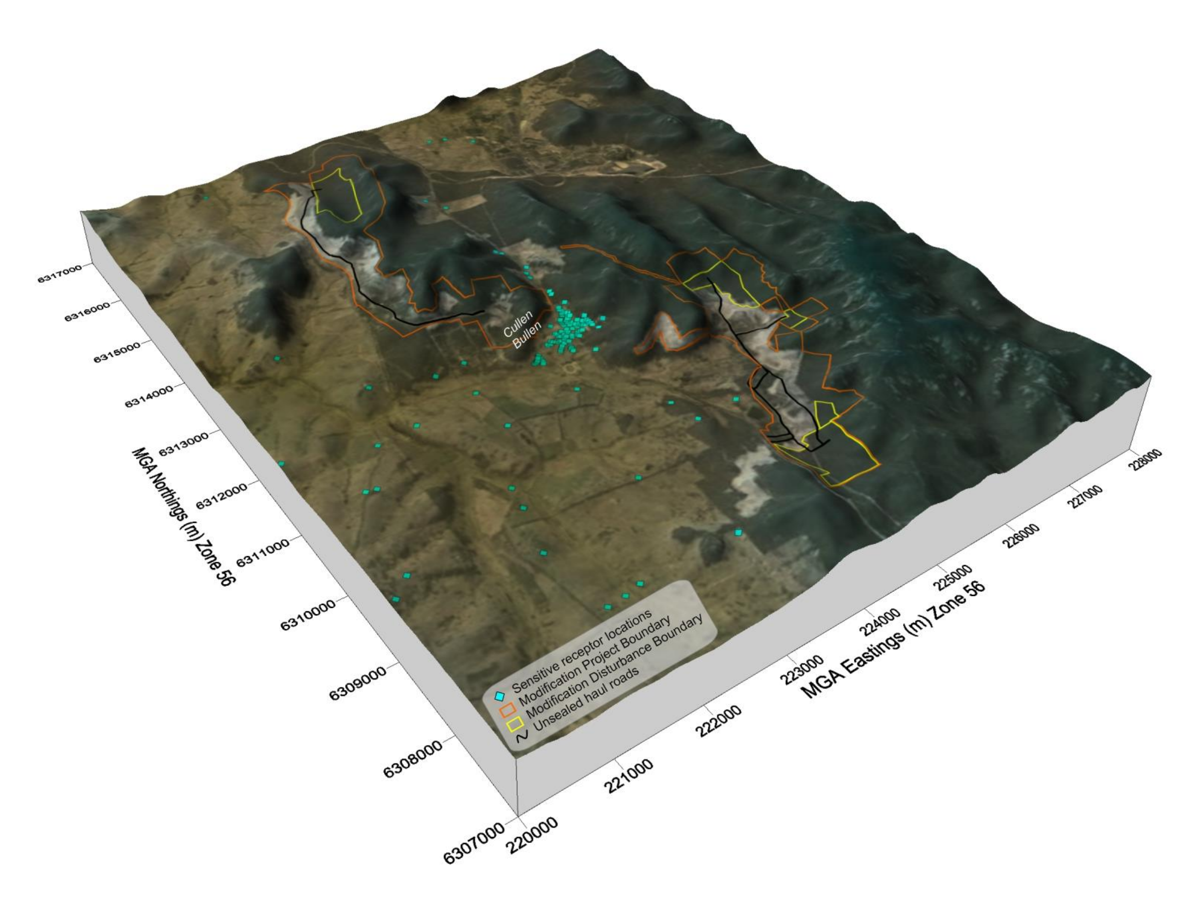


Figure 2.3: Pseudo 3-Dimensional Topographic Representation

3 MODIFICATION DESCRIPTION

The Invincible Colliery Modification (INV MOD4) will seek approval for the following activities that are not approved under its current Project Approval (PA 07_0127):

- Extension to PA 07_0127 for four years from December 2016 to December 2020;
- Extension of 88 ha to areas approved for open cut mining;
- Extension of 86 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Installation of a water pipeline which will result in the ability to transfer water between Invincible Colliery and Cullen Valley Mine. The pipeline alignment will largely remain on or adjacent to existing access tracks within the Ben Bullen State Forest; and
- Backfilling of the residual final voids resulting from existing mining operations and the rehabilitation of areas affected by subsidence from historic underground mining operations in the area to create a free-draining final landform.

All other aspects of operations on site, including coal production and processing, coal transport, operational hours and employment would generally remain consistent with that approved under PA 07_0127.

The Cullen Valley Mine Modification (CV MOD2) is seeking approval for the following activities that are not approved under its current Development Approval (DA 200-5-2003):

- Extension of 62 ha to areas approved for open cut mining;
- Extension of 80 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Ability to benefit from the transfer of water to and from Invincible Colliery;
- Backfilling and rehabilitation of the residual final void resulting from existing mining operations to create a free-draining final landform.

All other aspects of operations, including coal production and processing, coal transport, operational hours and employment would generally remain consistent with that approved under DA 200-5-2003.

4 AIR QUALITY ISSUES

4.1 Particulate Matter

The key pollutant for the Modifications will be dust emissions associated with open-cut mining operations.

Particulate matter has the capacity to affect health and to cause nuisance effects, and is categorised by size and/or by chemical composition. The potential for harmful effects depends on both. The particulate size ranges are commonly described as:

- TSP – refers to all suspended particles in the air. In practice, the upper size range is typically 30 µm to 50 µm.
- PM_{10} – refers to all particles with equivalent aerodynamic diameters of less than 10 µm, that is, all particles that behave aerodynamically in the same way as spherical particles with diameters less than 10 µm and with a unit density. PM_{10} are a sub-component of TSP.

- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of less than 2.5 μm diameter (a subset of PM_{10}). These are often referred to as the fine particles and are a sub-component of PM_{10}.
- $PM_{2.5-10}$ – defined as the difference between PM_{10} and $PM_{2.5}$ mass concentrations. These are often referred to as coarse particles.

Evidence suggests that health effects from exposure to airborne particulate matter are predominantly related to the respiratory and cardiovascular systems (**WHO, 2011**). The human respiratory system has in-built defensive systems that prevent larger particles from reaching the more sensitive parts of the respiratory system. Particles larger than 10 μm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air, referred to as TSP. In practice particles larger than 30 to 50 μm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 μm.

Both natural and anthropogenic processes contribute to the atmospheric load of particulate matter. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal materials from roads, farming, mining and dust storms. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts. Mining dust is likely to be composed of predominantly coarse particulate matter (and larger).

Fine particles or $PM_{2.5}$ are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation and natural processes such as bush fires. Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions. $PM_{2.5}$ may penetrate beyond the larynx and into the thoracic respiratory tract and evidence suggests that particles in this size range are more harmful than the coarser component of PM_{10}.

The size of particles determine their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them. This is demonstrated in **Figure 4.1**, which shows the relative deposition by particle size within various regions of the respiratory tract. Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air and is a key consideration in assessing exposure.

The health-based assessment criteria used by the EPA have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion (**EPA, 1998**; **National Environment Protection Council [NEPC], 1998a**; **NEPC, 1998b**). This means that, in contrast to dust of crustal origin, the particulate matter from urban areas would be composed of smaller particles and would generally contain substances that are associated with combustion.

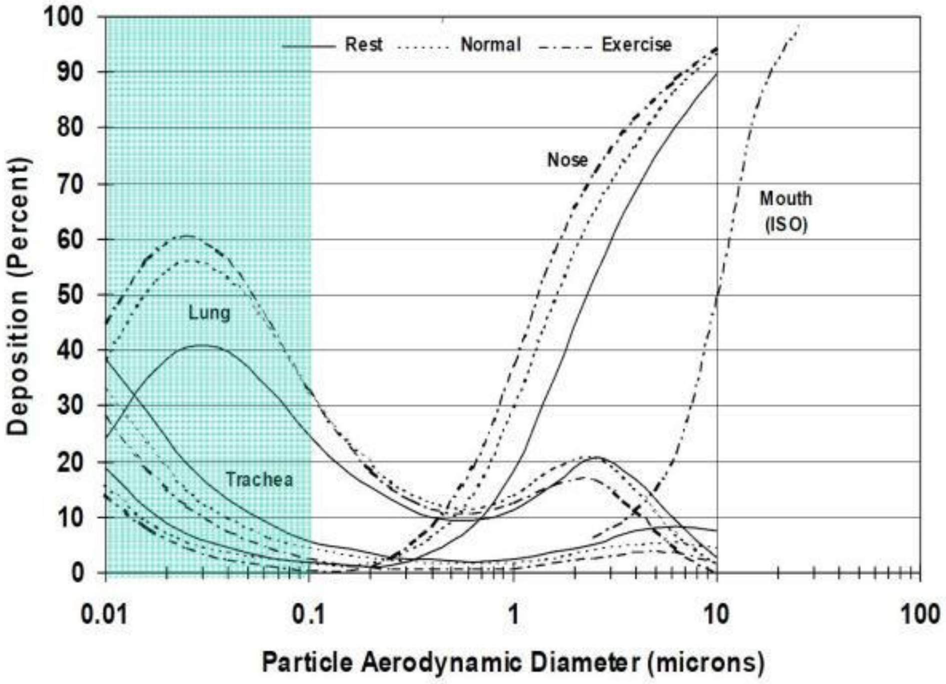


Figure 4.1: Particle Deposition within the Respiratory Tract (*Phalen et al, 1991*)

5 NSW EPA IMPACT ASSESSMENT CRITERIA

The Approved Methods specify impact assessment criteria relevant for assessing impacts from air pollution (**EPA, 2005**). The impact assessment criteria for pollutants relevant to this assessment refer to the total pollutant load in the environment and impacts from new sources of these pollutants must be added to existing background levels for compliance assessment. In other words, consideration of background dust levels needs to be made when using the goals outlined in the Approved Methods to assess potential impacts. These criteria are health-based, that is they are set at levels to protect against health effects, including for the most vulnerable in society.

These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). However, the EPA's criteria includes averaging periods, which are not included in the Ambient Air-NEPM, and also references other measures of air quality, namely dust deposition and TSP.

In May 2003, the NEPC released a variation to the Ambient Air-NEPM (**NEPC, 2003**) to include advisory reporting standards (ARS) for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$). The purpose of the variation was to gather sufficient data nationally to facilitate the review of the Ambient Air NEPM, which is currently underway. The variation includes a protocol setting out monitoring and reporting requirements for $PM_{2.5}$ particles. It is noted that the Ambient Air NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria.

Notwithstanding the above, in the absence of any other relevant standard/goal, the advisory reporting standards have been used in this report for comparison against dispersion modelling results (**Section 10**).

Table 5.1 summarises the air quality goals for concentrations of particulate matter that are relevant to this study. It is important to note that these criteria are applied to the cumulative impacts due to the Modifications and other sources.

In addition, contemporary project approval and development consent conditions issued by DP&I have also referenced short-term criteria for property acquisition on the basis of predicted air quality, as listed in **Table 5.2**. The Applicant has been required to acquire land on request when the maximum 24-hour average PM_{10} level exceeds 50 µg/m³ (Modifications alone) and 150 µg/m³ cumulatively, at any residence on privately-owned land. Long term criteria for property acquisition (annual average PM_{10}, TSP, Dust Deposition) are the same as those listed in **Table 5.1** and **Table 5.3**.

Table 5.1: EPA air quality impact assessment criteria and NEPM advisory reporting standards for particulate matter concentrations

Pollutant	Averaging period	Criteria/ARS	Agency
PM_{10}	24-hour maximum	50 µg/m³	EPA impact assessment criteria (cumulative) Ambient Air-NEPM reporting goal, allows five exceedances per year for bushfires and dust storms
	Annual mean	30 µg/m³	EPA impact assessment criteria (cumulative)
$PM_{2.5}$	24-hour maximum	25 µg/m³	Ambient Air-NEPM Advisory Reporting Standard (cumulative)
	Annual mean	8 µg/m³	
TSP	Annual mean	90 µg/m³	National Health and Medical Research Council (cumulative)

Note: µg/m³ – micrograms per cubic metre

Table 5.2: Recent DP&I short-term acquisition criteria for PM_{10}

Pollutant	Averaging period	Criteria	Project only or cumulative
PM_{10}	24-hour maximum	50 µg/m³	Project only
		150 µg/m³	Cumulative

Airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fallout relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment, and are assessed for nuisance or amenity impacts.

Table 5.3 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts.

Table 5.3: EPA criteria for dust deposition (insoluble solids)

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

Note: g/m²/month – grams per square metre per month

6 EXISTING ENVIRONMENT

The Coalpac air quality monitoring network currently consists of an array of dust deposition gauges and particulate monitoring sites. The locations of these are shown in **Figure 6.1**, and data collected from each site are described in the following sections.

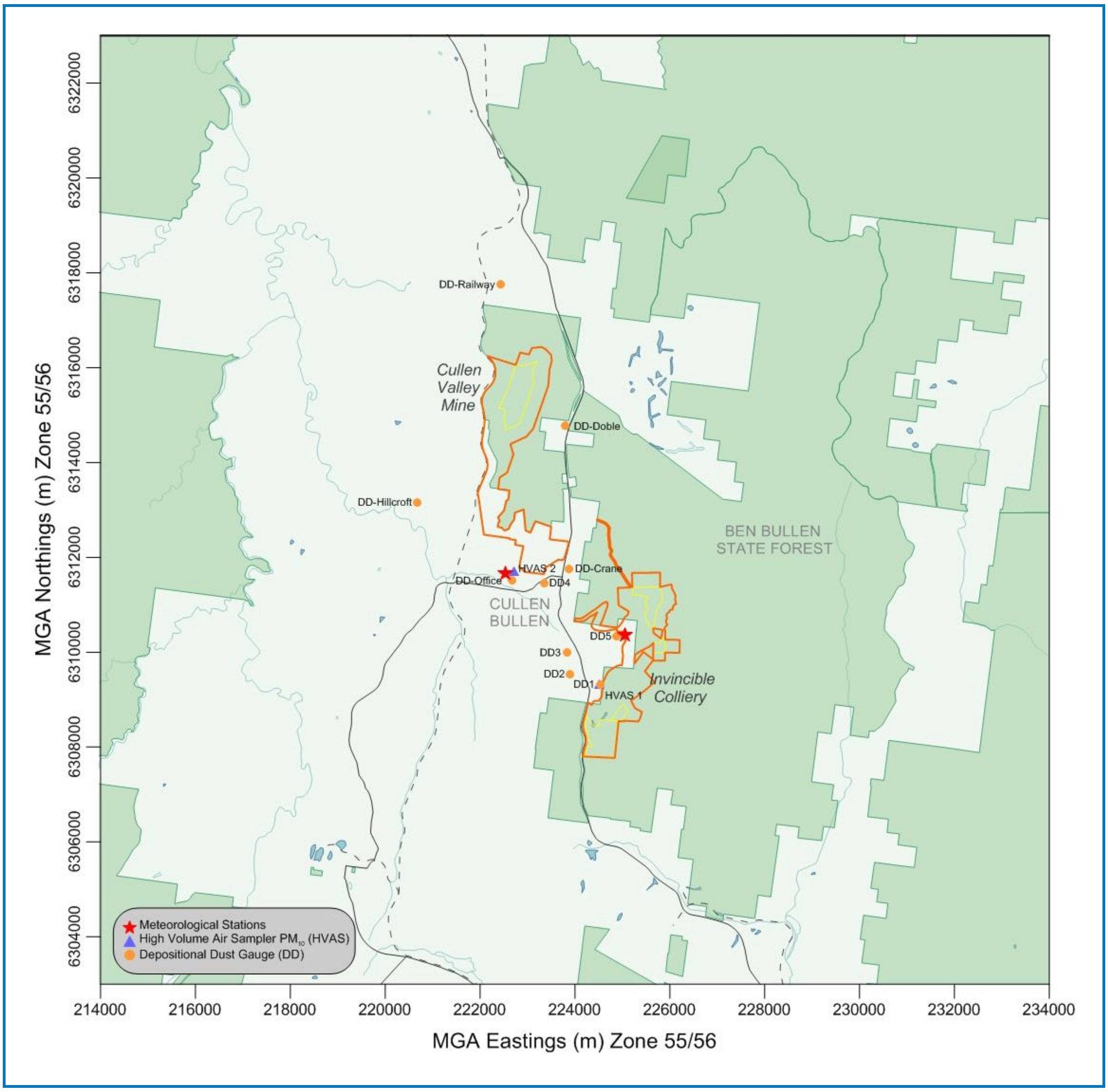


Figure 6.1: Local meteorological and dust monitoring sites

6.1 Meteorology

Figure 6.2 presents annual and seasonal windroses for the meteorological stations at Cullen Valley Mine and Invincible Colliery. The locations of these sites are shown on **Figure 6.1**.

On an annual basis, **Figure 6.2** shows a prominent westerly and easterly pattern of winds at the Cullen Valley site. Winds from the eastern quadrant are more prominent in summer and autumn and winds from the north are also more prominent in summer and spring. Winds from the western quadrant are predominant in winter and spring. On an annual basis, the percentage of calms is 41.2%. This is an unusually high level of calms especially when compared to the annual level of calms (12.9%) at the Invincible Colliery meteorological station (also shown **Figure 6.2**). An explanation for this could be the potentially sheltered location of the Cullen Valley meteorological station with elevated terrain to the east.

At the Invincible Colliery site, **Figure 6.2** shows prominent winds from the southwest and northeast directions on an annual basis. The summer and autumn windroses show a higher percentage of winds from the northwest sector, whereas the winter windrose shows a higher percentage of winds from the southwest sector. The spring windrose shows a very similar pattern to the annual windrose. On an annual basis, the percentage of calms is 12.9%.

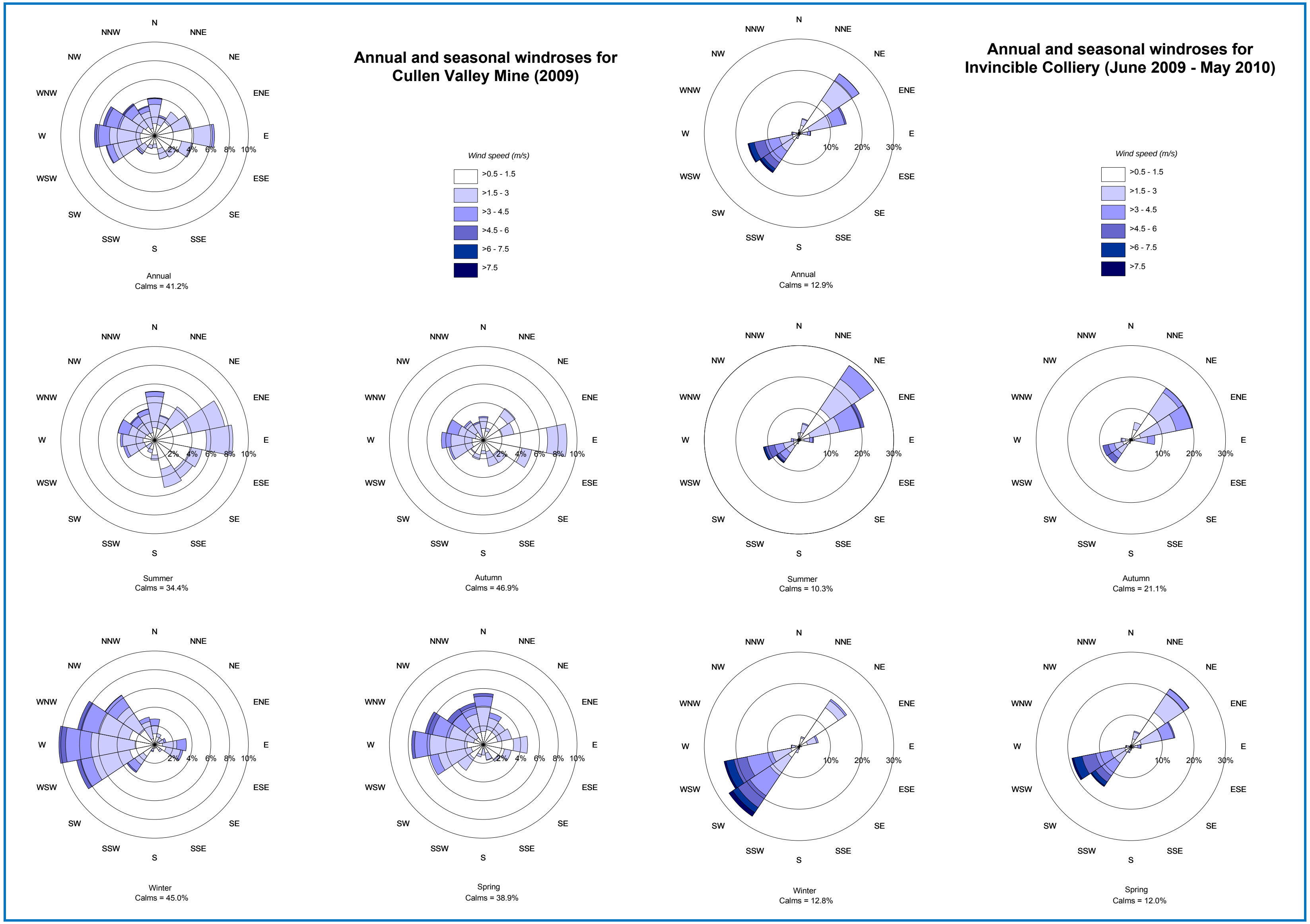


Figure 6.2: Annual and seasonal windroses at Cullen Valley Mine and Invincible Colliery

6.2 Local Climate Conditions

The Bureau of Meteorology (BoM) collects climatic information in the vicinity of the study area. A range of climatic information collected from Lithgow (Birdwood St) (located approximately 27 km from the Modifications), is presented in **Table 6.1** (**BoM, 2010**). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures experienced at Lithgow are 18.2°C and 6.4°C respectively. On average January is the hottest month, with an average maximum temperature of 25.5°C. July is the coldest month, with average minimum temperature of 0.7°C.

The annual average relative humidity reading collected at 9 am from the Lithgow site is 70% and at 3 pm the annual average is 58%. The month with the highest relative humidity on average is June with a 9 am average of 82%. The month with the lowest relative humidity is December with a 3 pm average of 50%.

Rainfall data collected at Lithgow shows that January is the wettest month, with an average rainfall of 94.3 mm over 8.3 rain days. The average annual rainfall is 858.5 mm with an average of 95.8 rain days.

Table 6.1: Climate Information for Lithgow (Braidwood Street)

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean maximum temperature (C)	25.5	24.7	22.4	18.4	14.3	11.1	10.4	12.0	15.4	18.7	21.5	24.5	18.2
Mean minimum temperature (C)	11.9	12.1	10.1	6.7	3.9	1.8	0.7	1.3	3.4	6.0	8.1	10.4	6.4
Mean rainfall (mm)	94.3	83.8	83.9	62.7	63.0	67.6	67.6	63.4	58.9	67.7	70.0	76.1	858.5
Mean number of days of rain	8.3	7.6	8.4	7.0	7.6	8.8	8.4	8.3	7.9	8.2	7.7	7.6	95.8
Mean 9am temperature (C)	18.7	17.8	15.8	12.4	8.5	5.6	4.7	6.4	10.0	13.5	15.7	18.1	12.3
Mean 9am relative humidity (%)	64	70	73	76	81	82	79	73	64	60	60	61	70
Mean 3pm temperature (C)	23.9	22.9	20.8	17.4	13.3	10.0	9.3	10.8	13.7	17.0	19.7	22.7	16.8
Mean 3pm relative humidity (%)	54	58	60	59	66	67	66	56	54	51	53	50	58

6.3 Existing Air Quality

6.3.1 Introduction

Air quality standards and criteria refer to pollutant levels that include the contribution from specific projects and existing sources of dust. To assess impacts against all the relevant air quality standards and criteria it is necessary to have information on existing dust concentration and deposition levels in the area in which the Modifications are likely to contribute to these levels. It is important to note that the existing air quality conditions (that is, background conditions) will be influenced by the existing mining operations at Cullen Valley Mine and Invincible Colliery.

An air quality monitoring program was established in 2008 to monitor dust deposition and dust concentration (as PM_{10}) in the vicinity of the Modifications. The locations of the current monitoring sites in place for existing Coalpac operations are shown on **Figure 6.1** and include:

- Two High Volume Air Samplers (HVAS) monitoring PM_{10} (one at Cullen Valley Mine and one at Invincible Colliery); and
- 10 dust deposition gauges (five for Cullen Valley Mine and five for Invincible Colliery).

The following sections provide an analysis and summary of the dust monitoring data.

6.3.2 PM_{10} Concentrations

Figure 6.3 shows the location of the Cullen Valley HVAS and Invincible Colliery HVAS used to monitor PM_{10} concentrations in the area from February 2008 to October 2013. Both monitors are located within the existing mining lease boundaries held by Coalpac and within close proximity to sensitive receptors. The areas of the Modification Boundary outside of existing mining areas at Invincible Colliery and Cullen Valley Mine are predominantly forest and woodland, with surrounding escarpments within the Ben Bullen State Forest that are also densely vegetated.

It is important to note that the HVAS monitors measures particulate matter from the approved mines in addition to non-mining sources. Non-mining sources of particulate matter in the local area would include traffic on unsealed roads, local agricultural activities, domestic coal and woodfired heaters, animal grazing associated with farming activities and to a lesser extent traffic from the other local roads and other sources such as bushfires and domestic coal/wood-fired heating.

It can be seen from **Figure 6.3** that there are three occasions where the 24-hour average PM_{10} concentration has recorded a level above the EPA criterion of 50 µg/m^3. Each of these elevated concentrations was measured at the Invincible Colliery HVAS.

It should be noted that during this monitoring period, a number of anomalous events such as severe dust storms and bushfires occurred. These events have been removed from the dataset as per the information on the BoM website. The three values above the 50 µg/m^3 as in **Table 6.2** are not known to result from any nearby regional events reported by BoM. There were dust storms in the South West Slopes and the Upper Western regions of NSW recorded in the days preceding both the November and December 2009 peaks, so these elevated values may have been due to residual airborne dust from those events. Alternatively, there may have been a local dust generating source on those particular days. Regardless of the source, and to remain conservative, these three elevated values have been retained in the dataset and used to estimate background concentrations.

Table 6.2 provides a summary of the PM_{10} concentration data presented in **Figure 6.3**. Both **Figure 6.3** and **Table 6.2** show that the annual average PM_{10} concentrations at both sites are well below the EPA annual average criterion of 30 µg/m^3. From the information presented in **Table 6.2**, a reasonable estimate of background PM_{10} would be 10.5 µg/m^3. This value will be used in the cumulative annual PM_{10} assessment presented in **Section 10.3**.

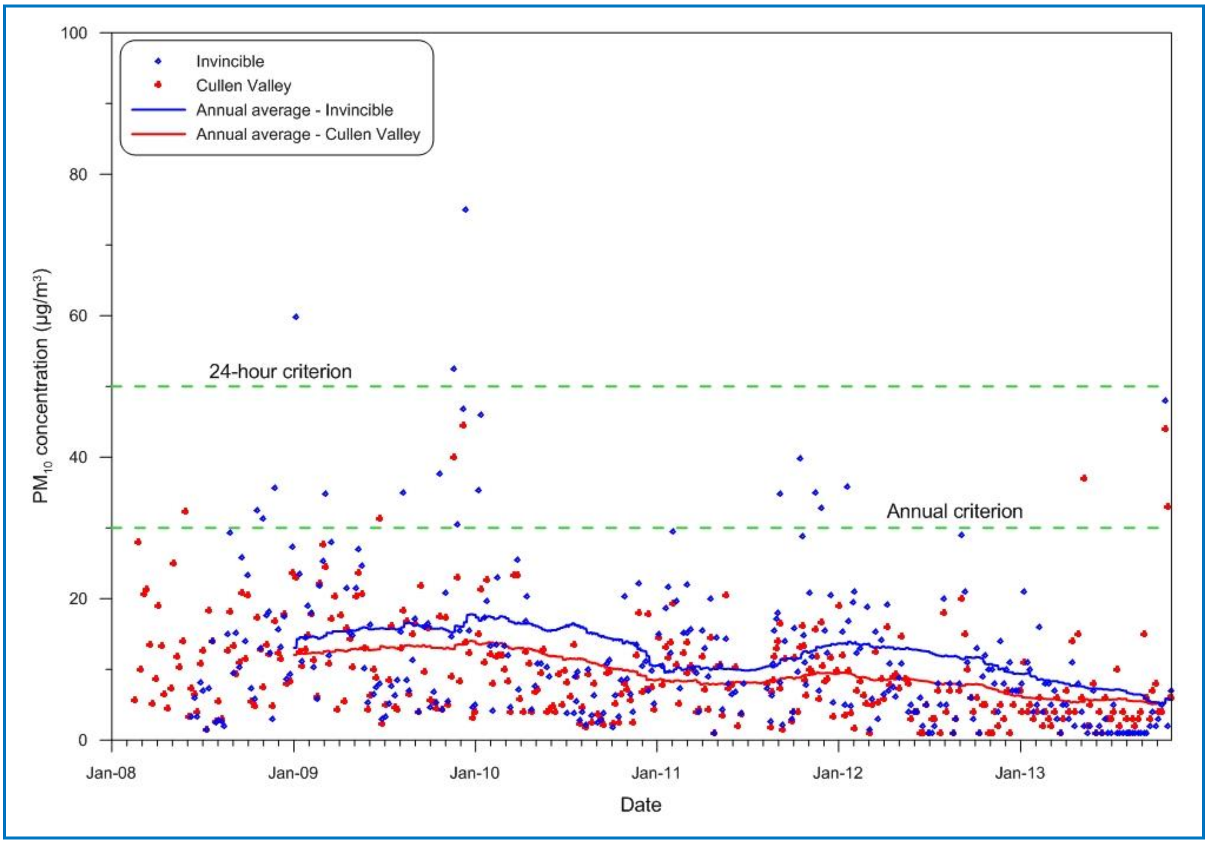


Figure 6.3: HVAS PM_{10} Concentrations Measured at Cullen Valley Mine and Invincible Colliery

Table 6.2: Annual average PM_{10} concentrations at each HVAS monitoring site (µg/m³)

HVAS Site	2008	2009	2010	2011	2012	2013	Average
HVAS 1 (Invincible)	13.0	17.7	10.5	13.6	9.3	5.7*	**11.5**
HVAS 2 (Cullen Valley)	12.0	13.9	8.5	9.4	6.2	6.4*	**9.5**
Average of all data							**10.5**

* Data available until 31 October 2013

6.3.3 $PM_{2.5}$ Concentrations

There are no $PM_{2.5}$ monitoring data available in the vicinity of the Invincible Colliery or Cullen Valley Mine. As part of an intensive monitoring program in the Hunter Valley, established in 2011, the Upper Hunter Air Quality Monitoring Network (UHAQMN) includes three sites with co-located $PM_{2.5}$ and PM_{10} monitors. These sites are Muswellbrook, Singleton and Camberwell. While the Hunter Valley may not be representative of the area surrounding Cullen Valley Mine and Invincible Colliery in terms of the magnitude of dust levels, the relationships between PM_{10} and $PM_{2.5}$ may be comparable given the similarities in local land uses, that is, mining and agriculture as well as power stations.

Of the three $PM_{2.5}$ monitoring sites in the UHAQMN, Muswellbrook and Singleton are significantly affected by wood smoke, particularly in the winter months. This is supported by the Upper Hunter Fine Particle Characterisation Study (**OEH, 2013**), which found that wood smoke accounted for an average of approximately 30% of $PM_{2.5}$ in Muswellbrook, peaking at approximately 62% in winter. Similarly, in Singleton, wood smoke accounts for an average of approximately 14% of total $PM_{2.5}$, peaking at around 38% in winter. It is likely that $PM_{2.5}$ levels in the township of Cullen Bullen would also be affected by wood smoke, although there is no monitoring data to confirm this.

An analysis of the available data at all three UHAQMN $PM_{2.5}$ sites, suggests the ratios of $PM_{2.5}$:PM_{10} as listed in **Table 6.3**. To remain conservative in the assessment of $PM_{2.5}$ for the Modifications, a ratio of 0.47 has been assumed to apply across the Coalpac modelling domain. Given an annual average PM_{10} concentration of 10.5 µg/m³, this equates to an estimated annual average $PM_{2.5}$ background of approximately 4.9 µg/m³.

Table 6.3: Annual average PM_{10} and $PM_{2.5}$ concentrations measured at the UHAQMN sites

UHAQMN Monitoring Site	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		Average
	2011	2012	2011	2012	$PM_{2.5}$:PM_{10}
Muswellbrook	19.3	21.8	9.1	10.1	**0.47**
Singleton	19.8	22.3	7.6	8.0	**0.37**
Camberwell	Monitoring commenced in late 2011	26.4	Monitoring commenced in late 2011	7.5	**0.28**

6.3.4 TSP Concentrations

No TSP concentration data are available in the vicinity of the Invincible Colliery or Cullen Valley Mine. However, annual average TSP concentrations can be estimated from the PM_{10} measurements by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**).

Use of this relationship indicates that the annual average TSP concentration is approximately 26 µg/m³ which is well below the EPA annual average assessment criterion of 90 µg/m³.

6.3.5 Dust Deposition

Figure 6.1 shows the locations of the 11 dust deposition gauges that are a part of Coalpac's air quality monitoring network for Invincible Colliery and Cullen Valley Mine. A number of these gauges are located within the Modification Boundaries, or on adjoining Coalpac owned land. It is noted that one dust deposition gauge (DG DD3) located at the Invincible Colliery was decommissioned in 2013. The data from this site are still shown here for completeness.

Data have been made available from June 2008 to October 2013 and the annual averages for each dust gauge summarised in **Table 6.4**. These results show that, at all dust gauge monitoring locations the annual average dust deposition levels are well below the EPA criterion of 4 g/m²/month.

It is interesting to note that all gauges recorded the highest annual average dust deposition level in 2009. As discussed previously, there were a number of anomalous weather events including a series of dust storms during the spring of 2009 that would have been captured by the dust deposition measurements. For example, all dust deposition gauges on the 2nd of October 2009 recorded levels between 8.6 g/m²/month and 26.9 g/m²/month which were likely due to regional dust storms at that time.

Table 6.4: Annual average dust deposition data (g/m²/month)

Deposition Gauge	2008	2009	2010	2011	2012	2013	Average
DM1 (Invincible)	1.2	1.5	1.4	1.1	1.0	0.8	**1.2**
DM2 (Invincible)	0.6	1.1	0.9	0.7	1.1	0.6	**0.8**
DM3 (Invincible)	0.7	1.4	0.9	0.4	0.6	0.4	**0.7**
DM4 (Invincible)	0.7	1.2	0.6	0.4	0.5	0.4	**0.6**
DM5 (Invincible)	0.8	1.5	1.2	0.7	0.9	0.6	**1.0**
DM6 (Invincible)	0.7	1.2	-	-	-	-	**1.0**
DM Doble (Cullen Valley)	1.1	1.1	0.5	0.3	0.5	1.3	**0.8**
DM Crane (Cullen Valley)	0.7	1.2	0.5	0.5	0.7	0.5	**0.7**
DM Office (Cullen Valley)	0.8	1.3	0.7	0.5	0.5	0.6	**0.7**
DM Hillcroft (Cullen Valley)	0.7	1.2	0.5	1.2	1.0	0.6	**0.9**
DM Railway (Cullen Valley)	1.0	1.4	0.7	1.6	0.5	0.6	**1.0**
Average of all data	**0.8**	**1.3**	**0.8**	**0.7**	**0.7**	**0.6**	**0.8**

6.3.6 Estimated Background Levels

From the information presented in the preceding sections, estimates of annual average background levels have been made. These levels represent the contributions from all sources other than the proposed Modifications and include both mining and non-mining sources. The following values will be used in the annual average cumulative assessment presented in **Section 10.3**:

- Annual average $PM_{2.5}$ – 4.9 µg/m³;
- Annual average PM_{10} – 10.5 µg/m³;
- Annual average TSP – 26 µg/m³; and
- Annual average dust deposition – 1 g/m²/month.

It is noted that the monitoring data provide a conservative indication of background levels given that the data include contributions from the existing Cullen Valley Mine and Invincible Colliery mining operations producing at more than 1.5 million ROM tonnes per annum.

7 METHODOLOGY

7.1 Approach to Assessment

The overall approach to the assessment follows the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**EPA, 2005**) using the Level 2 assessment methodology. The Approved Methods specify how assessments based on the use of air dispersion models should be completed. They include guidelines for the preparation of meteorological data to be used in dispersion models and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the Modifications.

The air dispersion modelling conducted for this assessment is based on an advanced modelling system using the models TAPM and CALMET/CALPUFF.

The modelling system works as follows:

- TAPM is a prognostic meteorological model that generates gridded three-dimensional meteorological data for each hour of the model run period.
- CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates fine resolution three-dimensional meteorological data based upon observed ground and upper level meteorological data, as well as observed or modelled upper air data generated for example by TAPM.
- CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

Output from TAPM, plus local observational weather station data were entered into CALMET, a meteorological pre-processor endorsed by the US EPA and recommended by the NSW EPA for use in complex terrain and non-steady state conditions (that is, conditions that change in time and space). From this, a 1-year representative meteorological dataset suitable for use in the 3-dimensional plume dispersion model, CALPUFF, was compiled. **Figure 7.1** presents an overview of the modelling system and details on the model configuration and data inputs are provided in the following sections.

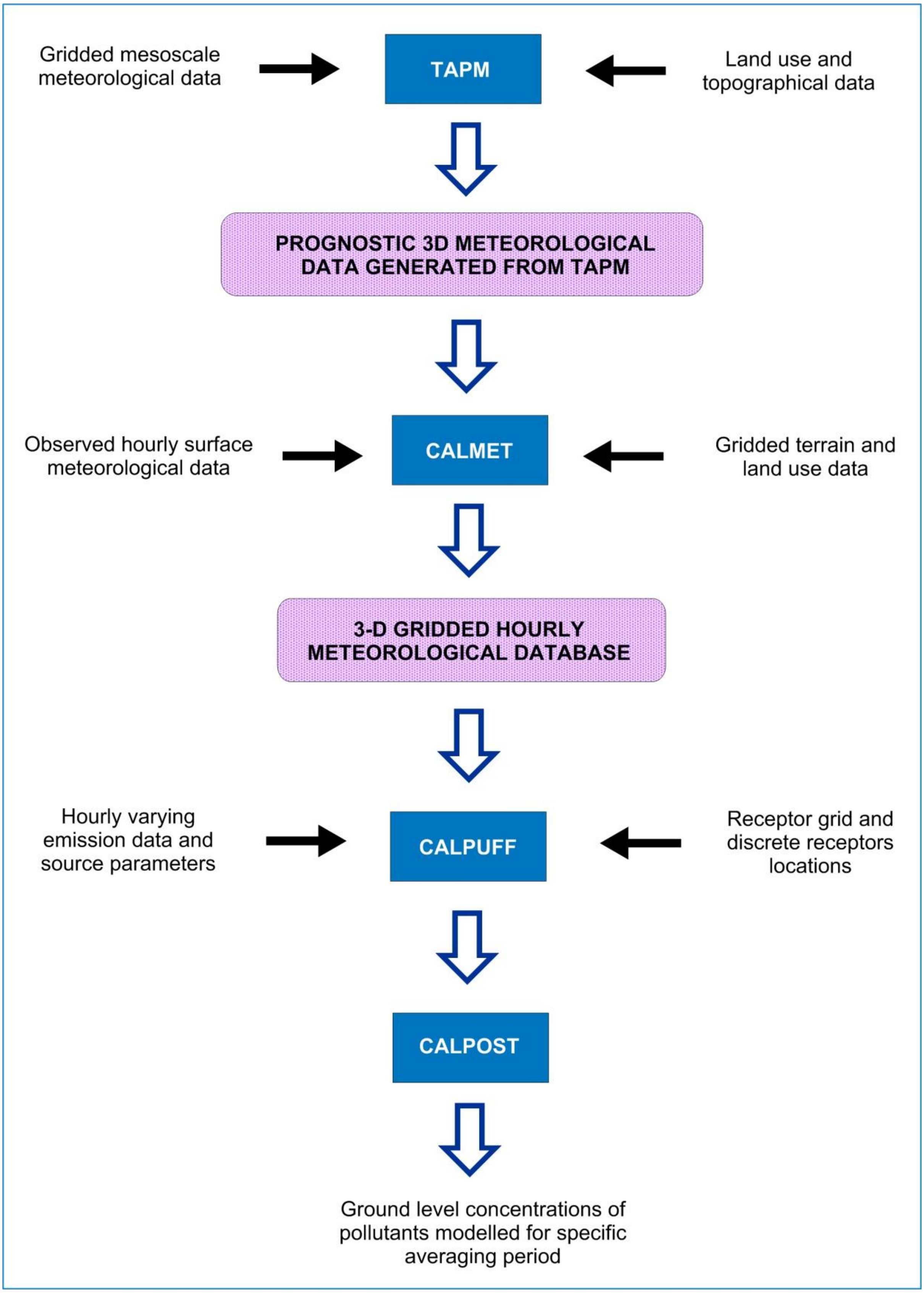


Figure 7.1: Overview of modelling methodology

7.2 TAPM

The Air Pollution Model, or TAPM, is a three dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research. Detailed description of the TAPM model and its performance is provided elsewhere. The Technical Paper by **Hurley (2005)** describes technical details of the model equations, parameterisations, and numerical methods. A summary of some verification studies using TAPM is also given in **Hurley et al. (2005)**.

TAPM solves the fundamental fluid dynamics and scalar transport equations to predict meteorology and (potentially) pollutant concentrations. It consists of coupled prognostic meteorological and air pollution concentration components. The model predicts airflow important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses.

Upper air data were generated over the Modifications area using TAPM. The TAPM-generated data and observed surface meteorological data were then entered into the CALMET diagnostic meteorological model, which is discussed below.

7.3 CALMET

CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are used in the CALPUFF dispersion model.

The hourly TAPM-generated data and observed data for the period of analysis were used as input to the CALMET pre-processor to create a fine resolution, three-dimensional meteorological field for input into the dispersion model. CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict girded meteorological fields for the region.

Terrain data has been sourced from the Shuttle Terrain Mission dataset. The spatial resolution of these data is 100 m.

Hourly surface meteorological data from the following surface meteorological stations were input into CALMET for 2009 and are as follows:

- The Cullen Valley Mine meteorological station (part of the Coalpac monitoring network);
- The Invincible Colliery meteorological station (part of the Coalpac monitoring network);
- Mount Piper Power Station meteorological station (approximately 5 km south of the Modifications);
- BoM Bathurst Airport meteorological station (approximately 38 km southwest of the Modifications); and
- BoM Mount Boyce meteorological station (approximately 44 km southeast of the Modifications).

The BoM surface stations (required for cloud cover) are up to 45 km from Invincible Colliery and Cullen Valley Mine. To use these observed data for the generation of meteorological data files a large computational grid domain is required. However, due to computational limitations, a coarse resolution would then be needed which may result in neglecting local terrain effects.

To overcome this problem, CALMET was run in two stages. The first stage was to run the model over a large outer domain (75 km by 67.5 km) with a coarse resolution (1.5 km) using the observations from the five surface meteorological stations listed above with any gaps in the data (relative humidity and pressure) supplied by TAPM. The second stage involved using the output from stage one as input for

CALMET over a much smaller inner domain (20 km by 20 km) and finer resolution (100 m) with the Modifications at the centre. This finer resolution domain allowed any effects due to local terrain to be captured.

The finer resolution CALMET domain was then run for the modelling year to capture the specific terrain effects (e.g. pit terrain) in that operational year. There are five main land uses represented across the domain and these are shown in **Figure 7.2** for each grid square. The dominant land uses are forestry and agricultural land, with barren land category used to represent active mining areas, existing mining disturbance and land occupied for the local power stations.

Table 7.1 summarises the inputs used for both the TAPM and CALMET models. **Figure 7.3** shows the different modelling domains used for both meteorological and dispersion modelling.

Table 7.1: Meteorological Parameters used for TAPM and CALMET

TAPM (v 4.0.4)	
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grid points	25 x 25 x 25
Year of analysis	2009
Centre of analysis	Coalpac Modifications (33⁰16' S, 150⁰2' E)
CALMET (v. 6.327)	
Meteorological grid domain	20 km x 20 km (fine resolution)
Meteorological grid resolution	0.1 km (fine resolution)
Surface meteorological stations	Cullen Valley Meteorological Station
	- Wind speed
	- Wind direction
	- Temperature
	- Relative humidity
	Invincible Meteorological Station
	- Wind speed
	- Wind direction
	- Temperature
	- Relative humidity
	Mount Piper Power Station Meteorological Station
	- Wind speed
	- Wind direction
	- Temperature
	- Relative humidity
	Bathurst Airport AWS
	(Bureau of Meteorology, Station No. 063291)
	- Wind speed
	- Wind direction
	- Temperature
	- Relative humidity
	- Cloud Amount
	- Cloud Height
	Mount Boyce AWS
	(Bureau of Meteorology, Station No. 063292)
	- Wind speed
	- Wind direction
	- Temperature
	- Relative humidity
	- Cloud Amount
	- Cloud Height
	TAPM
	- Wind speed
	- Wind direction
	- Temperature
	- Relative humidity
	- Cloud Amount
	- Cloud Height
	- Sea Level Pressure
Upper air	Data extracted from TAPM

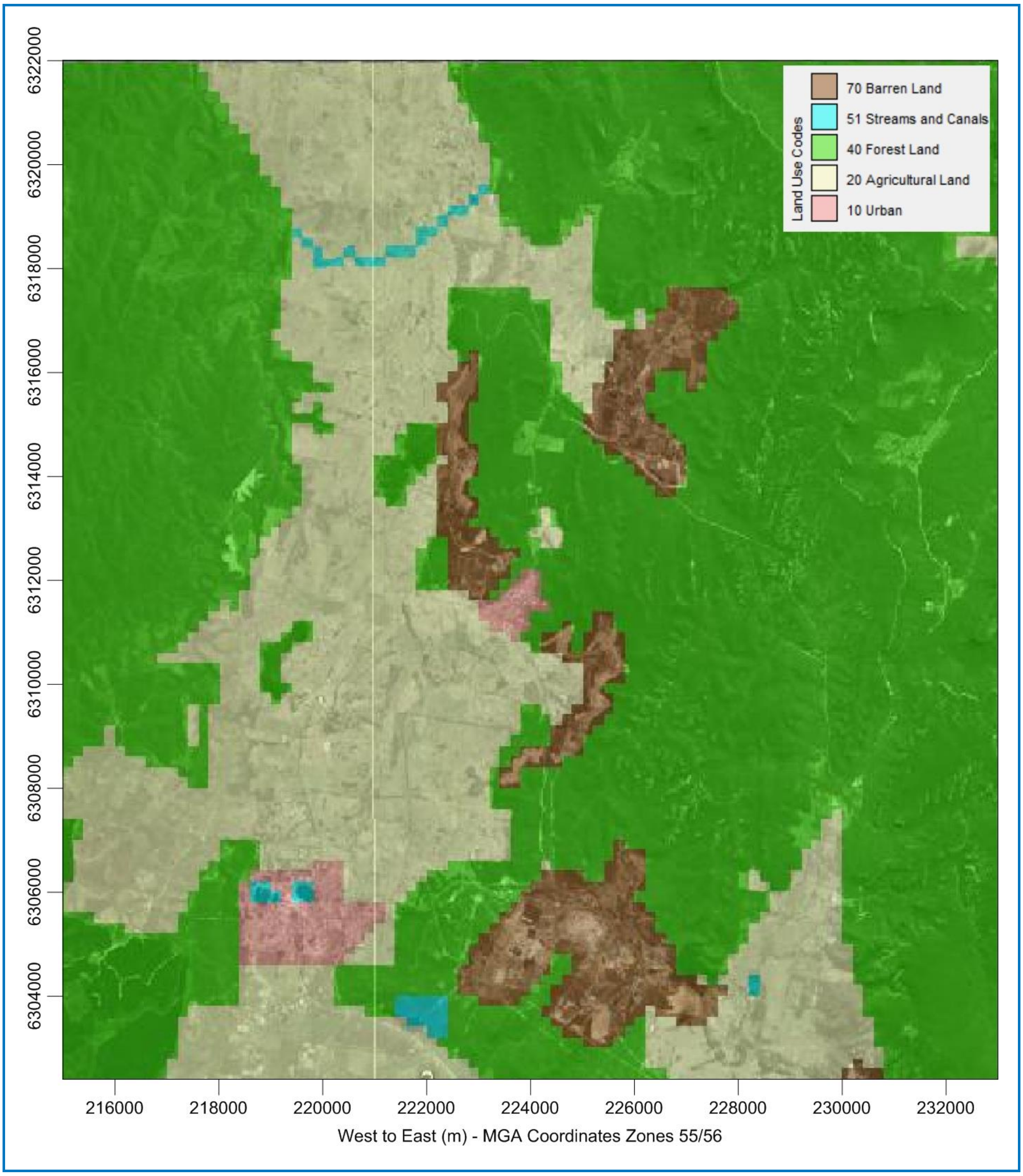


Figure 7.2: Landuse categories used in the model

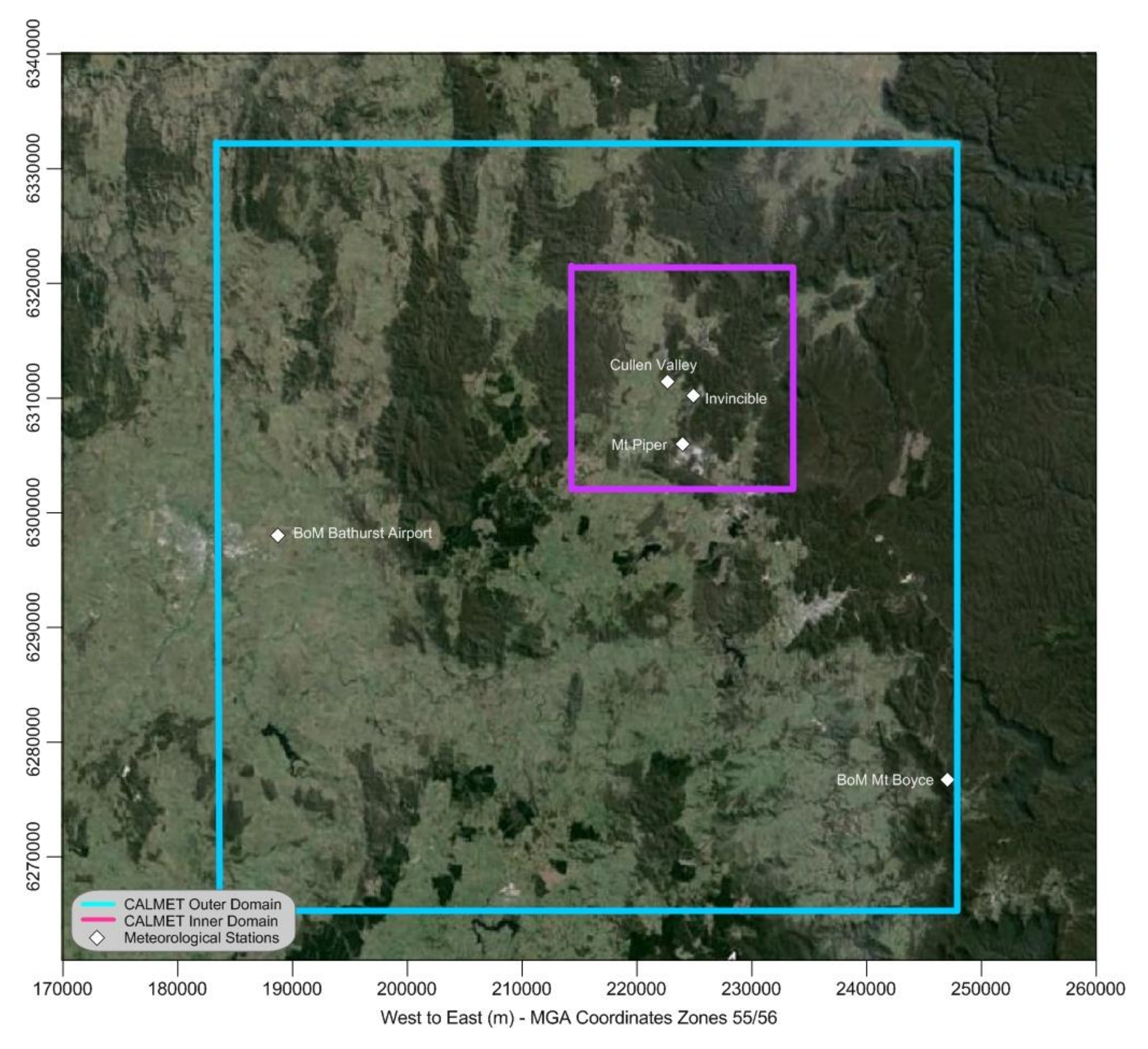


Figure 7.3: Modelling domains used for meteorological and dispersion modelling

7.3.1 Wind Speed and Direction

Figure 7.4 presents the annual and seasonal windroses made from CALMET indicative of each mining location proposed for the Modifications.

CALMET was run for each mining area, taking into account the terrain (due to mining) in the worst case modelling year. Points at each mine site have been extracted for this worst case operational scenario in order to provide an indication of wind patterns at that site. These CALMET windroses are provided for illustrative purposes (to show effects of local terrain at each point) and are not directly comparable with the meteorological data collected at the Cullen Valley Mine and Invincible Colliery sites as shown in **Figure 6.2**.

Figure 7.4 shows a similar pattern of winds between the two modelled mining areas, with prominent winds from the western and eastern quadrants. The Invincible Colliery windrose shows a higher prominence of winds from the east in summer and autumn and a higher percentage of winds from the west in winter. For both sites, the spring windrose is most similar to the annual windrose.

Figure 7.4: Annual and seasonal windroses extracted for Cullen Valley Mine and Invincible Colliery

7.3.2 Comparison of measured and modelled wind data

The Cullen Valley site windroses from measured meteorological data (**Figure 6.2**) shows a very similar annual pattern to the Cullen Valley CALMET windrose shown in **Figure 7.4** with prominent winds from the western and easterly quadrants. **Figure 7.4** however, shows a higher percentage of winds from the north on an annual basis. Winds from the west are also more prominent in the CALMET data. On an annual basis, the percentage of calms in the CALMET data is 3.7% compared with 41.2% in the Cullen Valley meteorological station data. A potential reason for this would be the sheltered location of the metrological station in proximity to complex terrain to the east.

The Invincible site windroses shown in **Figure 6.2** have been compiled from data collected between June 2009 and May 2010 as data for all of 2009 were not available. This windrose is presented to show the general pattern in the area only. The Invincible meteorological station windroses are less similar to the CALMET data than at the Cullen Valley location. The Invincible meteorological station data show more prominent winds from the west south-west and north east sectors. The reason for this difference is most likely that the Invincible Colliery station is located at the southern end of a valley surrounded by elevated terrain causing higher wind flow patterns from the north east and west south-west. The CALMET windrose shown in **Figure 7.4** is representative of the mine location and therefore modelled differing terrain. The general overall pattern for this mine location is similar with prominent winds from the north eastern sector in summer and autumn and prominent winds from the south western sector in winter. On an annual basis, the percentage of calms in the CALMET data is 2.8% compared with 12.9% in the Invincible Colliery meteorological station data.

7.3.3 Analysis of CALMET meteorological conditions

7.3.3.1 Wind Speed

The frequency distribution of hourly averaged wind speed at each mining area is shown in **Figure 7.5** and indicates a similar distribution of wind speeds at both locations, with the Invincible site showing greater occurrence of low winds between 1.5 – 2.5 m/s and a lower occurrence of wind speeds around 6 m/s. The annual average wind speed for Cullen Valley is estimated to be approximately 3.3 m/s and slightly lower at approximately 3 m/s at Invincible.

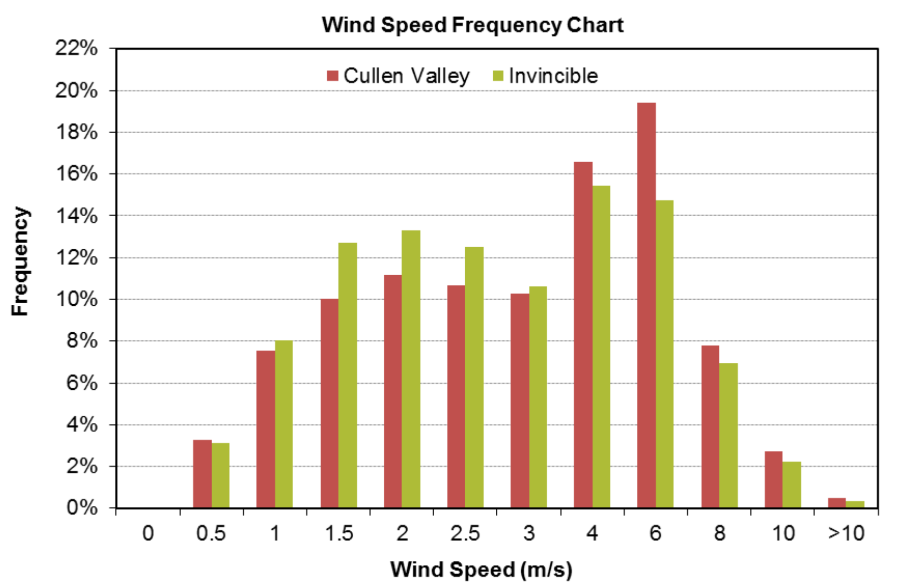


Figure 7.5: Wind speed distribution for indicative mine locations (2009)

7.3.3.2 Mixing Height

Mixing height is the height to which the air is mixed by turbulence and is variable in space and time. It typically increases during fair-weather daytime over land from tens to hundreds of metres around sunrise up to one to four kilometres in the mid-afternoon, depending on the location, season and day-to-day weather conditions.

The frequency of mixing heights in the meteorological datasets developed for this study is shown in **Figure 7.6**. Average mixing heights during the night and early morning hours are generally lower than 300 m, increasing after sunrise to an average maximum of just over 3,000 m by mid-afternoon in response to convective mixing from solar heating of the earth's surface. The relatively rapid decrease in mixing height around the time of sunset can be clearly seen.

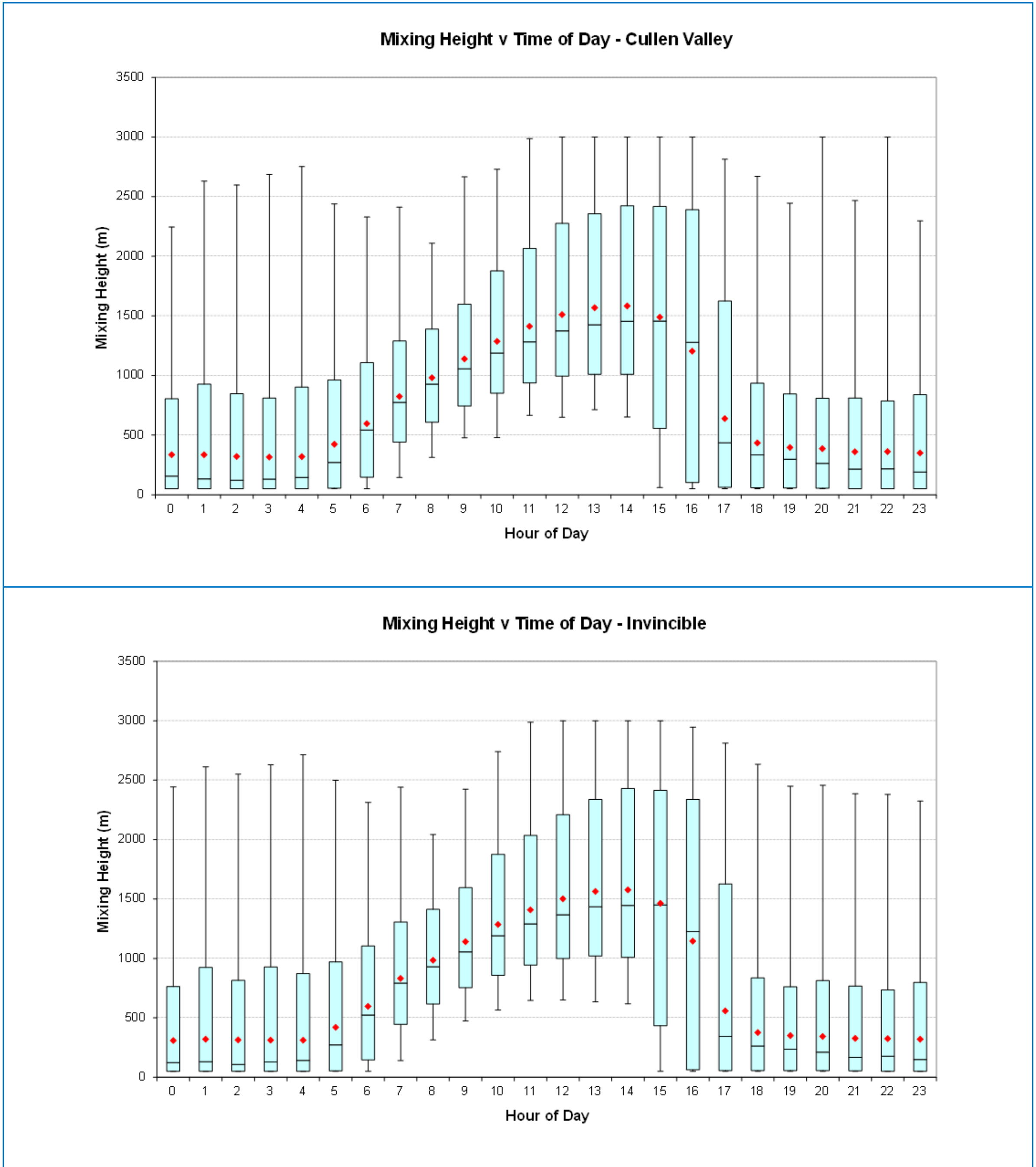


Figure 7.6: Hourly mixing height statistics for each indicative mine site

7.4 CALPUFF

CALPUFF is the dispersion module of the CALMET/CALPUFF suite of models. It is a multi-layer, multi species, non-steady-state puff dispersion model[a] that can simulate the effects of time-varying and space-varying meteorological conditions on pollutant transport, transformation and removal. The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across released puffs and takes into account the complex arrangement of emissions from point, area, volume and line sources (**Scire *et al.*, 2000**).

Each dust generating activity was represented by a series of volume sources situated according to their location, as shown in **Section 9.1**. The plume dimensions were determined using an initial lateral spread (sigma (σ) y) of 10 m and initial vertical spread (sigma (σ) z) of 2 m. All sources were given a release height of 2 m. Model predictions were made across the domain at gridded receptors at a spacing of 200 m x 200 m, as well as at 171 discrete receptors representing privately and mine-owned residences.

[a] Gaussian plume models are considered steady-state because the plume equation is independent of time, that is, dispersion from the source to receptor is instantaneous for each hour of meteorological data. CALPUFF however, 'remembers' the plume from the previous hour taking into account residual concentrations at each grid point from the hours before and is therefore non-steady-state.

8 BEST PRACTICE MANAGEMENT

8.1 Introduction

In 2010 the NSW EPA commissioned a report to investigate potential best practice measures to either prevent or minimise particulate matter (PM) emissions (**Donnelly et al., 2010**) from open cut coal mines in NSW. The aim of the report was to identify the major sources of particulate matter from coal mines as well as the current emission controls that were being adopted. The report then went on to recommend international control measures and estimate the likely emission reductions and feasibility of adopting such measures for the NSW mining industry.

As part of an EPA initiative for state wide mining operations, the NSW EPA issued a notice of a variation to the Invincible Colliery Environment Protection Licence (EPL) 1095 in August 2011, and to the Cullen Valley Mine EPL 10341 in December 2011. The notices required that site-specific reviews of Best Management Practice (BMP) at each site be conducted to identify the most practicable means to reduce particulate matter, as part of the Pollution Reduction Program (PRP). These reports for Invincible Colliery and Cullen Valley Mine were submitted in February and June 2012, respectively.

The BMP reviews followed the process outlined in the OEH's *Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline* (**OEH, 2011**), referred to as the OEH Guideline. The review required Coalpac to:

- Quantify TSP, PM_{10} and $PM_{2.5}$ for all on-site activities,
- Rank these to find the top four emission activities for each particle size group,
- Identify best management practice control measures that could be applied to these top four activities,
- Calculate the reductions that may be achieved by applying these controls, and
- Determine which of the control measures are practicable and feasible and a timeframe in which they may be implemented.

The top four sources of PM_{10} emissions at both sites were identified as:

1. Wheel generated dust from unpaved roads;
2. Wind erosion on stockpiles;
3. Wind erosion on overburden areas; and
4. Loading coal to trucks.

9 EMISSIONS TO AIR

9.1 Source Locations

Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. So, for each source and for each hour, an emission rate was determined which depended on the level of activity and, in some cases, the wind speed. Dust generating activities were represented by a series of volume sources situated according to the location of activities for the modelled scenarios. The source locations for each site are shown in **Figure 9.1**.

Not every activity will occur at each source location and some source locations will see significantly more activities than others. For example, in the active pit area a variety of activities will be taking place simultaneously, such as drilling, blasting, loading to trucks, haulage and wind erosion. The source locations in the pit will therefore include a proportion of emissions from some, or all, of these activities.

Table 9.1 and **Table 9.2** list all activities that have been modelled at each site, together with the source numbers that have been allocated to those activities. The locations of those source numbers are shown in **Figure 9.1**.

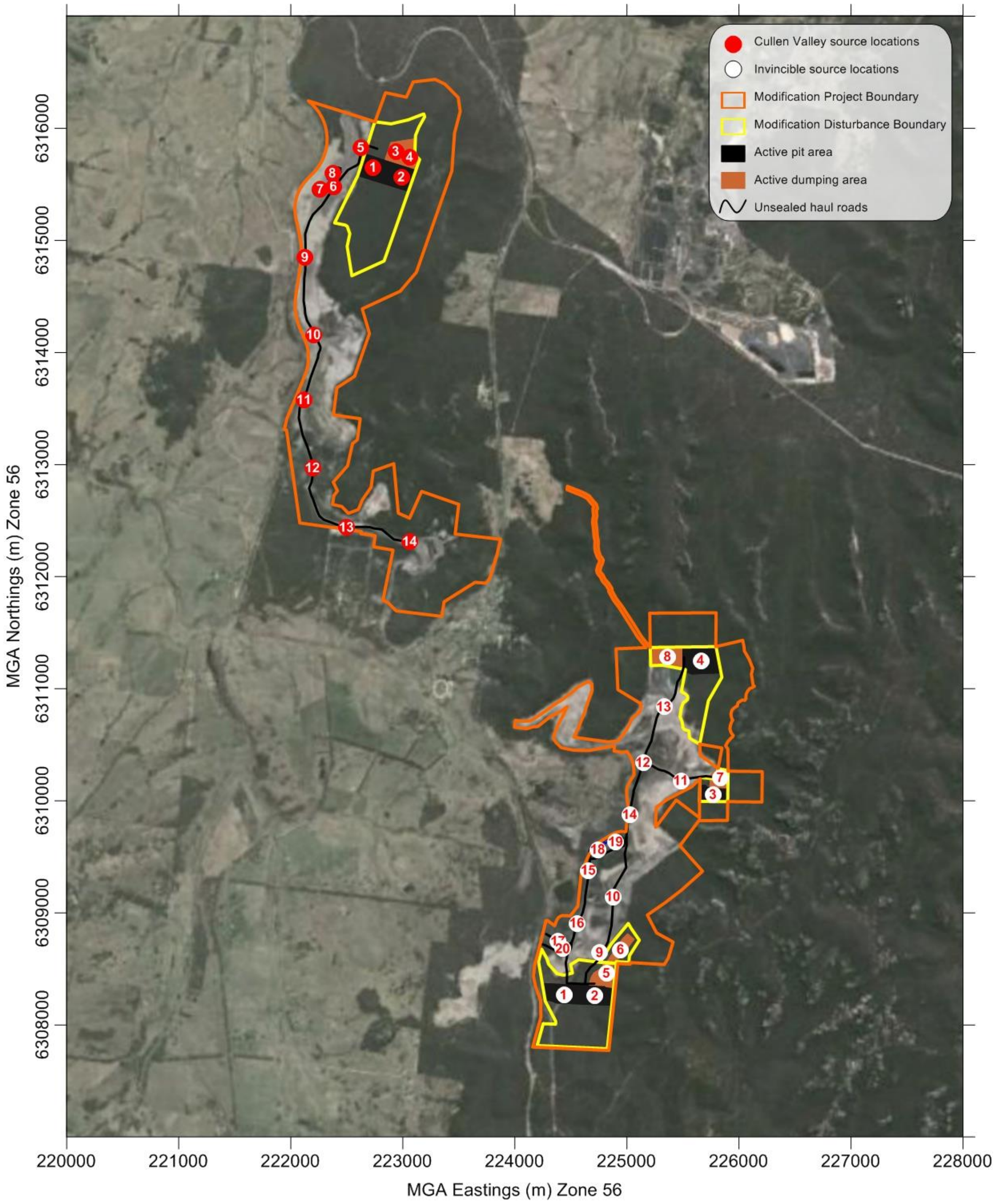


Figure 9.1: Location of sources for Cullen Valley Mine and Invincible Colliery Modifications

Table 9.1: Activity and associated source allocation for Cullen Valley Mine

Activity	Source Location Number (see Figure 9.1)
Topsoil Removal	1, 2
Drilling overburden	1, 2
Blasting overburden	1, 2
Dozers in pit, push to fill	1, 2
Loading overburden	1, 2
Hauling overburden to dump	1, 2, 3, 4
Unloading overburden to dump	3, 4
Dozers on overburden	3, 4
Loading coal into trucks	1, 2
Hauling coal to ROM crusher stockpile	1, 2, 3, 4, 5, 6
Hauling coal to ROM to CHPP	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14
Unloading coal to ROM crusher stockpile	8
Rehandle coal to crusher	8
Crushing	8
Loading crushed coal to stockpile	7
Loading crushed coal to trucks	7
Hauling crushed coal off-site	6, 7, 8, 9, 10, 11, 12, 13, 14
Wind erosion on active mining area	1, 2
Wind erosion on active dump area	3, 4
Wind erosion on main ROM stockpiles	7, 8
Grading roads	1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14

* The highwall miner is not specifically included as an individual source. Dust emissions from the coal mined by the highwall is captured by the loading, hauling and dumping of that coal which will be significantly more than from the extraction of the coal.

Table 9.2: Activity and associated source allocation for Invincible Colliery

Activity	Source Location Number (see Figure 9.1)
Topsoil Removal	1, 2, 3, 4
Drilling overburden	1, 2, 3, 4
Blasting overburden	1, 2, 3, 4
Dozers in pit, push to fill	1, 2, 3, 4
Loading overburden (Pit 221 - Southern)	1, 2
Loading overburden (Pit 223 - Eastern)	3
Loading overburden (Pit 224 - Northern)	4
Hauling to overburden dump (Pit 221)	1, 2, 5, 6
Hauling to overburden dump (Pit 223)	3, 7
Hauling to overburden dump (Pit 224)	4, 8
Unloading overburden to dump (Pit 221)	5, 6
Unloading overburden to dump (Pit 223)	7
Unloading overburden to dump (Pit 224)	8
Dozers on overburden	5, 6, 7, 8
Loading coal into trucks (Pit 221)	1, 2
Loading coal into trucks (Pit 223)	3
Loading coal into trucks (Pit 224)	4
Hauling coal to ROM crusher stockpile (Pit 221)	1, 2, 9, 10, 18, 19
Hauling coal to ROM crusher stockpile (Pit 223)	3, 7, 11, 12, 13, 18, 19
Hauling coal to ROM crusher stockpile (Pit 224)	4, 12, 13, 14, 18, 19
Hauling coal ROM to CHPP (Pit 221)	1, 2, 17, 20
Hauling coal ROM to CHPP (Pit 223)	3, 7, 11, 12, 14, 15, 16, 17, 20
Hauling coal ROM to CHPP (Pit 224)	4, 12, 13, 14, 15, 16, 17, 20
Unloading coal to ROM crusher stockpile	18
Rehandle coal to crusher	18
Crushing	18
Loading crushed coal to stockpile	19
Loading crushed coal to trucks	19
Hauling crushed coal off-site	15, 16, 17, 18, 19, 20
Unloading CV coal at CHPP	17, 20
Unloading INV coal at CHPP	17, 20
Loading washed product coal to stockpiles	20
Loading product coal to trucks	20
Hauling rejects to dump	5, 6
Wind erosion on active mining area (Pit 221)	1, 2
Wind erosion on active mining area (Pit 223)	3
Wind erosion on active mining area (Pit 224)	4
Wind erosion on dumps area (Pit 221)	5, 6
Wind erosion on dumps area (Pit 223)	7
Wind erosion on dumps area (Pit 224)	8
Wind erosion on main ROM and product stockpiles	18, 19, 20
Grading roads	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

* The highwall miner is not specifically included as an individual source. Dust emissions from the coal mined by the highwall is captured by the loading, hauling and dumping of that coal which will be significantly more than from the extraction of the coal.

9.2 Mining Operations

The operation of the each Modification was analysed and estimates of dust emissions for the key dust generating activities were made. Emission factors developed by the US EPA were applied to estimate the amount of dust produced by each activity.

The mine plans for the Modification were analysed and detailed emissions inventories prepared for one key operating scenario. The operational year chosen was Year 2, nominally 2016. This modelled year is considered to be representative of worst-case operations where combined coal and waste production are highest and where operations are located closest to the township of Cullen Bullen and other residential receivers.

A control factor of 80% has been applied to wheel generated dust on unsealed haul roads, in line with the recent PRP requirements for NSW coal mines. Further discussion on controlling dust on haul roads is found in **Section 9.3**. Further detail on the emission factors and calculations is provided in **Appendix A**.

The site specific parameters described in **Section 9.4** were used to populate the relevant emission factor equations. **Table 9.3** and **Table 9.4**, summarise the quantities of TSP estimated to be released by each activity of the Modifications.

Table 9.3: Estimated TSP emissions for Cullen Valley Mine (kg/y)

Activity	TSP Emission
Topsoil Removal	51
Drilling overburden	7,670
Blasting overburden	7,778
Dozers in pit, push to fill	6,958
Loading overburden	9,260
Hauling overburden to dump	44,528
Unloading overburden to dump	9,260
Dozers on overburden	6,958
Loading coal into trucks	42,238
Hauling coal to ROM crusher stockpile	6,075
Hauling coal to ROM to CHPP	3,797
Unloading coal to ROM crusher stockpile	38,014
Rehandle coal to crusher	19,007
Crushing	196
Loading crushed coal to stockpile	257
Loading crushed coal to trucks	257
Hauling crushed coal off-site	28,858
Wind erosion on active mining area	8,375
Wind erosion on active dump area	4,744
Wind erosion on main ROM stockpiles	758
Grading roads	2,991
Total	**248,029**

Table 9.4: Estimated PM_{10} emissions for Invincible Colliery (kg/y)

Activity	TSP Emission
Topsoil Removal	29
Drilling overburden	7,670
Blasting overburden	7,778
Dozers in pit, push to fill	7,002
Loading overburden (Pit 221 - Southern)	4,427
Loading overburden (Pit 223 - Eastern)	429
Loading overburden (Pit 224 - Northern)	4,533
Hauling to overburden dump (Pit 221)	35,089
Hauling to overburden dump (Pit 223)	1,359
Hauling to overburden dump (Pit 224)	25,150
Unloading overburden to dump (Pit 221)	4,427
Unloading overburden to dump (Pit 223)	429
Unloading overburden to dump (Pit 224)	4,533
Dozers on overburden	10,503
Loading coal into trucks (Pit 221)	35,017
Loading coal into trucks (Pit 223)	3,400
Loading coal into trucks (Pit 224)	22,913
Hauling coal to ROM crusher stockpile (Pit 221)	12,943
Hauling coal to ROM crusher stockpile (Pit 223)	1,183
Hauling coal to ROM crusher stockpile (Pit 224)	8,967
Hauling coal ROM to CHPP (Pit 221)	634
Hauling coal ROM to CHPP (Pit 223)	214
Hauling coal ROM to CHPP (Pit 224)	1,661
Unloading coal to ROM crusher stockpile	55,197
Rehandle coal to crusher	27,598
Crushing	344
Loading crushed coal to stockpile	361
Loading crushed coal to trucks	55,197
Hauling crushed coal off-site	17,334
Unloading CV coal at CHPP	3,493
Unloading INV coal at CHPP	6,133
Loading washed product coal to stockpiles	85
Loading product coal to trucks	7,219
Hauling rejects to dump	1,744
Wind erosion on active mining area (Pit 221)	8,541
Wind erosion on active mining area (Pit 223)	2,759
Wind erosion on active mining area (Pit 224)	6,132
Wind erosion on dumps area (Pit 221)	4,932
Wind erosion on dumps area (Pit 223)	2,059
Wind erosion on dumps area (Pit 224)	4,284
Wind erosion on main ROM and product stockpiles	788
Grading roads	2,991
Total	**407,482**

9.3 Dust Control on Haul Roads

Preliminary emissions estimations indicated that of the potential dust sources from the Modifications, emissions from the hauling of overburden and ROM coal contributes more than any other source group to short-term PM_{10} impacts at the closest residential receivers. For this assessment, a level 80% control has been applied to haul road emission estimations from both sites.

A control level of 80% is supported by **Sinclair Knight Merz (2005)** who derived an equation that shows control benefits for increased watering up to 95%. This finding is confirmed by **Buonicore and Davis (1992)** who state that a level of control of 90% is expected to be achieved by increasing the application rate of water and/or through the use of dust suppressants, such that the moisture content of surface material is approximately 8% (refer to **Figure 9.2**).

The above observations are further reinforced within **US EPA (2006)**. **Figure 9.3** presents the relationship between the instantaneous control efficiency due to watering and the resulting increase in surface moisture. The moisture ratio M (shown on the x-axis) is calculated by dividing the surface moisture content of the watered road by the surface moisture content of the uncontrolled road.

US EPA (2006) states that as the watered surface dries, both the ratio M, and the predicted instantaneous control efficiency (shown on the y-axis), decrease. The figure shows that between the uncontrolled surface moisture content and a value twice as large, a small increase in moisture content results in a large increase in control efficiency. Beyond that, control efficiency grows slowly with increased moisture content. For example, if the uncontrolled surface moisture content was 2%, and the addition of water increased this to 4%, a 75% reduction in emissions could be expected. However, control efficiency increasing the surface moisture content further to 6% would only result in an additional 5% control.

Notwithstanding the above, it is clear from **Figure 9.3**, that while returns diminish between 70 – 100%, theoretical control efficiencies from the application of water alone may reach up to 95%. A conservative assumption of 80% has been made for this assessment. This is equivalent to the control factor currently required by the NSW EPA in the latest Pollution Reduction Programs (PRPs) issued to NSW coal mines in their varied EPLs.

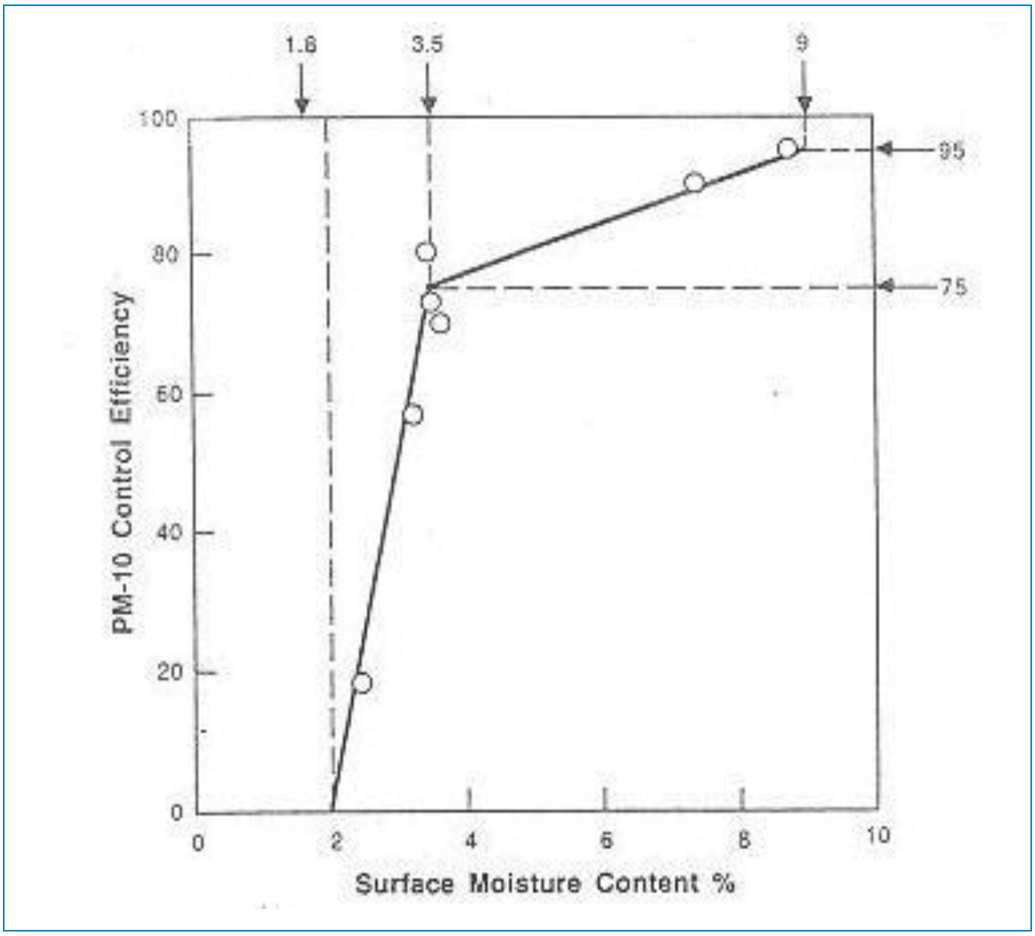


Figure 9.2: Watering Control Effectiveness for Unpaved Roads (Buonicore and Davis, 1992)

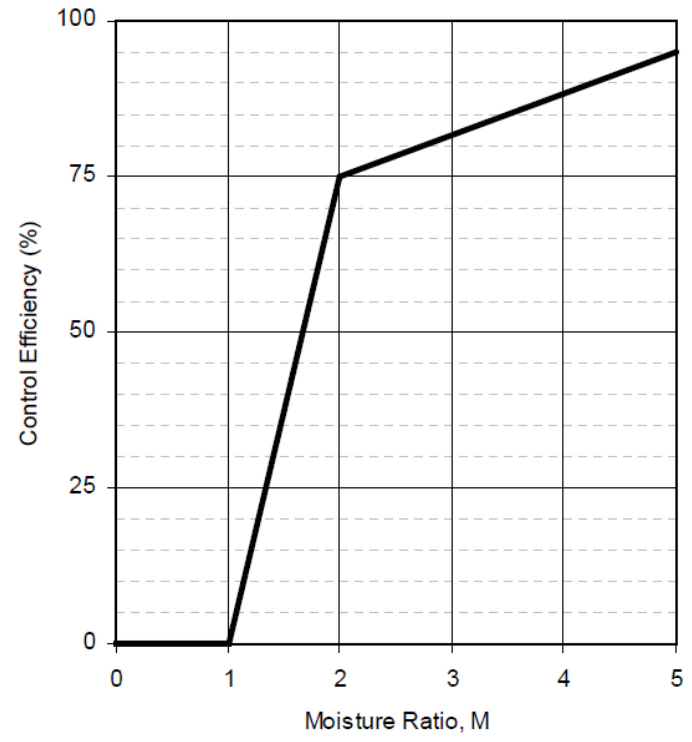


Figure 9.3: Watering Control Effectiveness for Unpaved Travel Surfaces (US EPA, 2006)

9.4 Site Specific Parameter Measurements

Many of the emission factor equations used to determine particulate emissions from operational activities, require values for the silt and moisture content of the various materials handled. In January 2013, a number of samples were taken at both the Cullen Valley Mine and Invincible Colliery. These samples were analysed for silt and moisture content in accordance with the methods outlined in **US EPA (1993)** and used to inform the emissions inventories. **Table 9.5** summarises the results and the full analysis report is shown in **Appendix B**.

Table 9.5: Measured silt and moisture contents

Area	Cullen Valley Mine	Invincible Colliery	Cullen Valley Mine	Invincible Colliery
	Moisture content (%)		Silt content (%)	
Haul roads	N/A	N/A	2.8	3.9
ROM coal	6.8	8.0	3.4	2.5
Product coal	N/A	5.3	N/A	N/A
Overburden	4.0	5.2	3.7	3.8
Topsoil	5.6	7.4	6.3	5.4

9.5 Windblown dust emissions

Windblown dust emissions arise from erosion of exposed areas such as the pit or active dumping or rehabilitation areas. The amount of particle lift-off is dependent on a number of factors which include the threshold friction velocity (the wind velocity necessary to initiate soil erosion).

The current USEPA AP-42 Compilation of Air Pollutant Emission Factors (Fifth Edition) emission factor for industrial wind erosion is outlined in Chapter 13.2.5 (**US EPA, 2006**). It is also only applicable to dry exposed materials with limited erosion potential. The calculated emissions represent intermittent events, valid for a time period as long as (or longer than) the period between surface disturbances.

Site specific measurements for threshold friction velocity (TFV) were made at Cullen Valley Mine and Invincible Colliery in January 2013, and the results are shown in **Table 9.6**.

Table 9.6: Measurements of threshold friction velocity from Mount Owen

Area measured	Threshold friction velocity
Cullen Valley Mine	
Overburden Dump Pit 105	100 cm/s
Overburden Dump Pit 106	100 cm/s
Invincible Colliery	
ROM Coal Inpit A	100 cm/s
ROM Coal Inpit B	76 cm/s
Overburden Dump (average)	72 cm/s

Applying the site-specific measurements (**Table 9.6**) to this emission estimation approach results in almost no wind initiated dust lift-off emissions from exposed areas, which is unrealistic. The USEPA AP-42 Chapter 11.9 (Western Surface Coal Mining) emission factor for wind erosion of exposed areas (0.85 t/ha/y or 0.1 kg/ha/h) has therefore been adopted as it represents a more realistic value for wind erosion and is accepted practice for these assessments.

9.6 Consideration of Cumulative Impacts

9.6.1 Existing Background Levels

In addition to the Cullen Valley Mine and Invincible Colliery, other sources will contribute to ground level concentrations and dust deposition levels in the area surrounding the proposed Modifications. Estimating the background allowance for these other sources is difficult and depends on local land use and the associated emission sources, as well as climate, soil type etc.

Conservative estimates of annual average background levels were made in **Section 6.3** and are presented again here.

- Annual average $PM_{2.5}$ – 4.9 µg/m^3;
- Annual average PM_{10} – 10.5 µg/m^3;
- Annual average TSP – 26 µg/m^3; and
- Annual average dust deposition – 1 g/m^2/month.

These estimates are conservative as they will include a contribution from the existing Cullen Valley Mine and Invincible Colliery operations. There will therefore be an element of double counting as far as these contributions are concerned.

10 MODELLING RESULTS

10.1 Introduction

The EPA air quality criteria used for identifying which properties are likely to experience air quality impacts are specified in the EPA Approved Methods and have been applied in this assessment. It is important to note that there are currently no impact assessment criteria for $PM_{2.5}$. The predicted concentrations have been compared with the NEPM advisory reporting standards for $PM_{2.5}$.

The EPA impact assessment criteria and the NEPM advisory reporting standards for $PM_{2.5}$ were discussed in **Section 5**.

Section 10.2 presents results for the Modifications alone and **Section 10.3** presents an annual average cumulative assessment. A separate cumulative assessment of 24-hour average PM_{10} and $PM_{2.5}$ is provided in **Section 10.4**.

Contour plots of particulate concentrations and deposition levels as presented in **Section 10.2** show the areas that are predicted to be affected by dust at different levels. It is important to note that the contour figures are presented to provide a visual representation of the predicted impacts. To produce the contours it is necessary to make interpolations, and as a result the contours will not always match exactly with predicted impacts at any specific location. The actual predicted particulate concentrations/levels at nearby receivers are presented in tabular form in **Appendix C** and **Appendix D**.

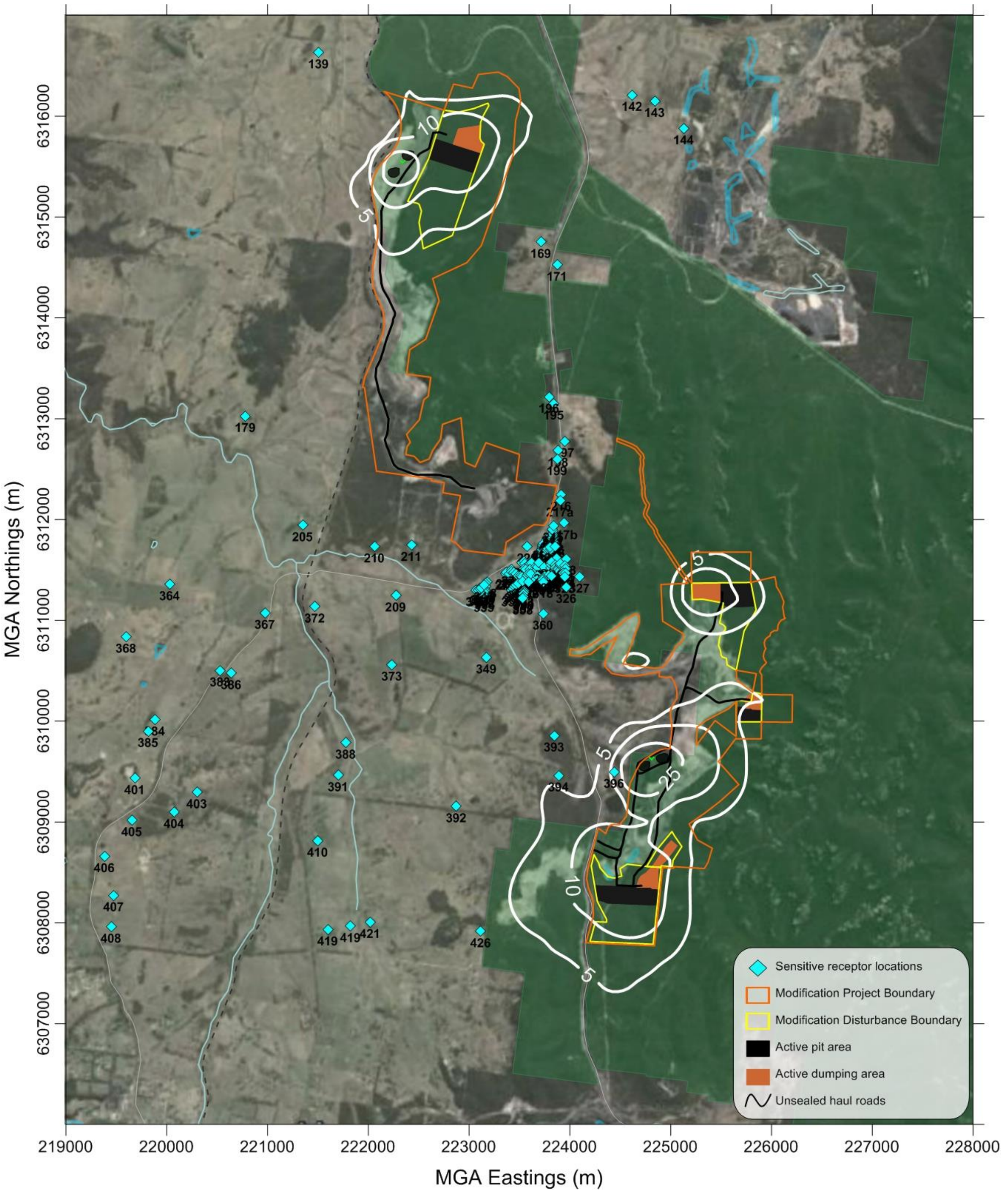
10.2 Modifications Only Assessment

A summary of the predicted concentration and deposition levels at all sensitive receptors due to the Modifications alone in Year 2, is presented in **Appendix C**. **Figure 10.1** to **Figure 10.6** show these predictions across the modelling domain.

With the exception of dust deposition, predictions are not compared to EPA criteria as these criteria are cumulative. However, the 24-hour PM_{10} predictions can be compared to the DP&I acquisition criterion of 50 µg/m^3 at individual residences.

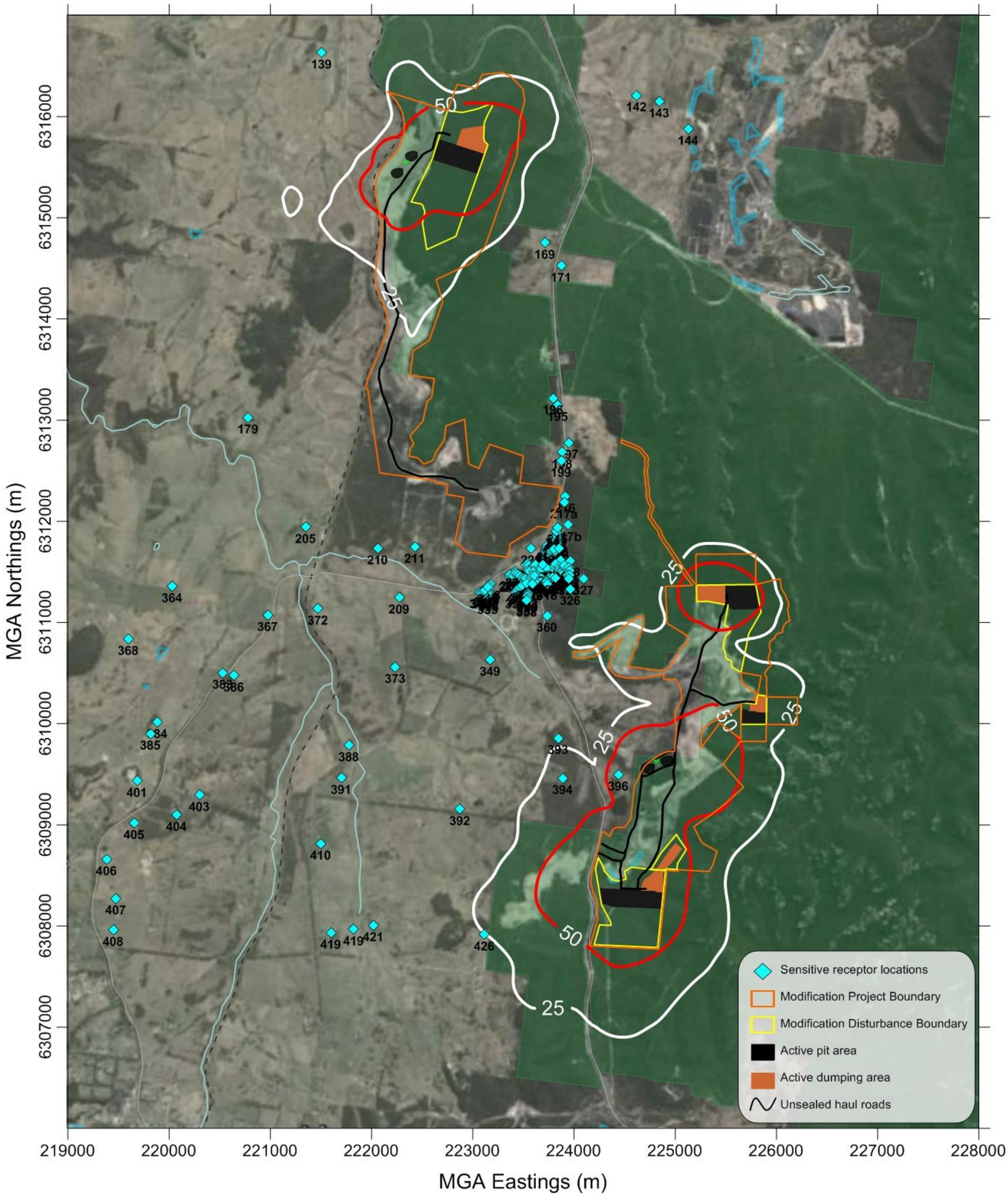
Figure 10.2 shows that there are no privately owned residences that are predicted to exceed the 24-hour average PM_{10} criterion of 50 µg/m^3 in Year 2. The dust deposition levels are also predicted to be well below the EPA incremental criterion of 2 g/m^2/month at all private residences.

The Coalpac-owned residence 396 is estimated to exceed both the 24-hour average PM_{10} and annual average dust deposition criteria for the Modifications alone.



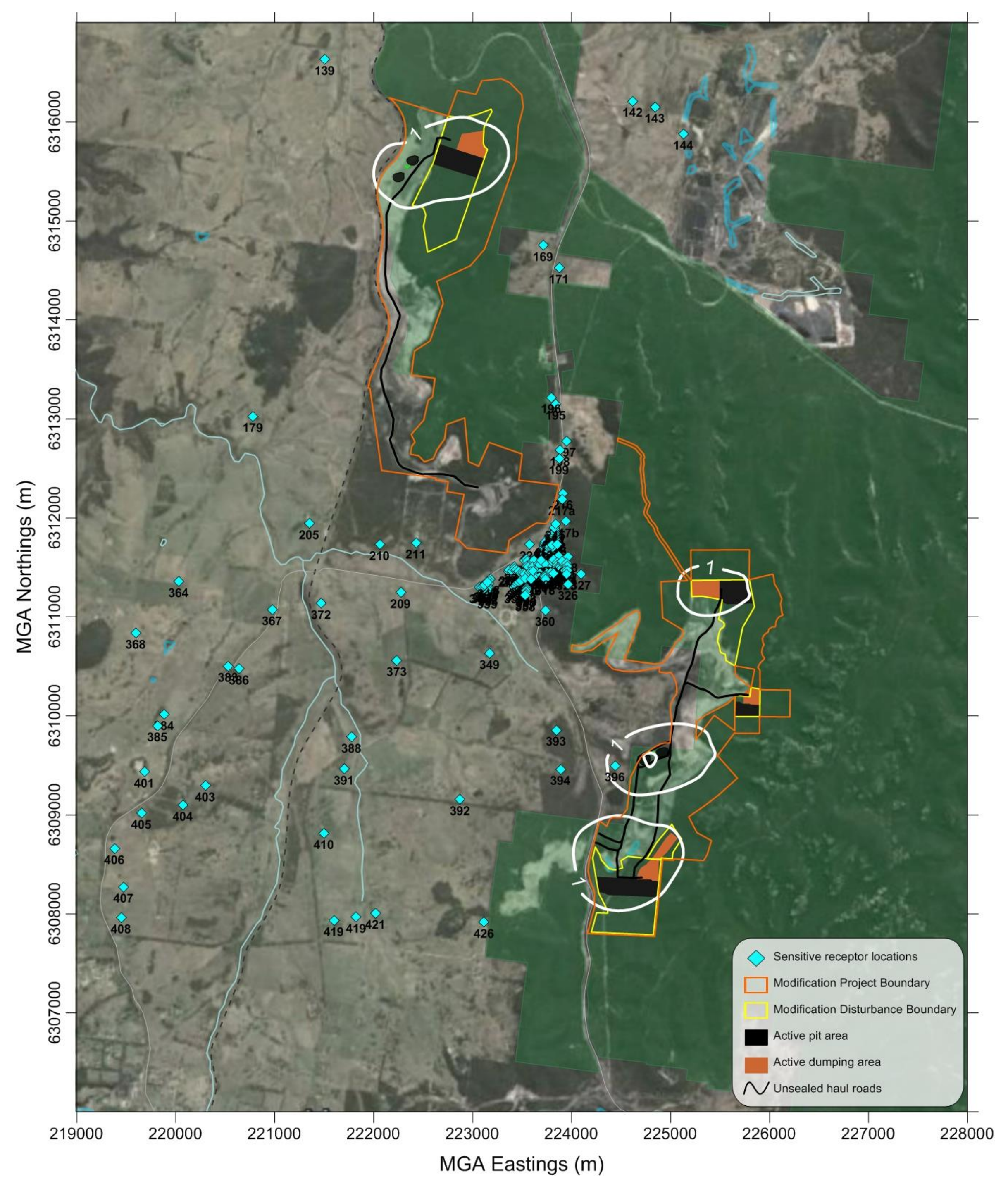
Species: PM2.5	Location: Coalpac	Scenario: Modifications Only	Percentile: N/A	Averaging Time: 24-hour
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.1: Predicted maximum 24-hour average $PM_{2.5}$ concentrations – Modifications Only



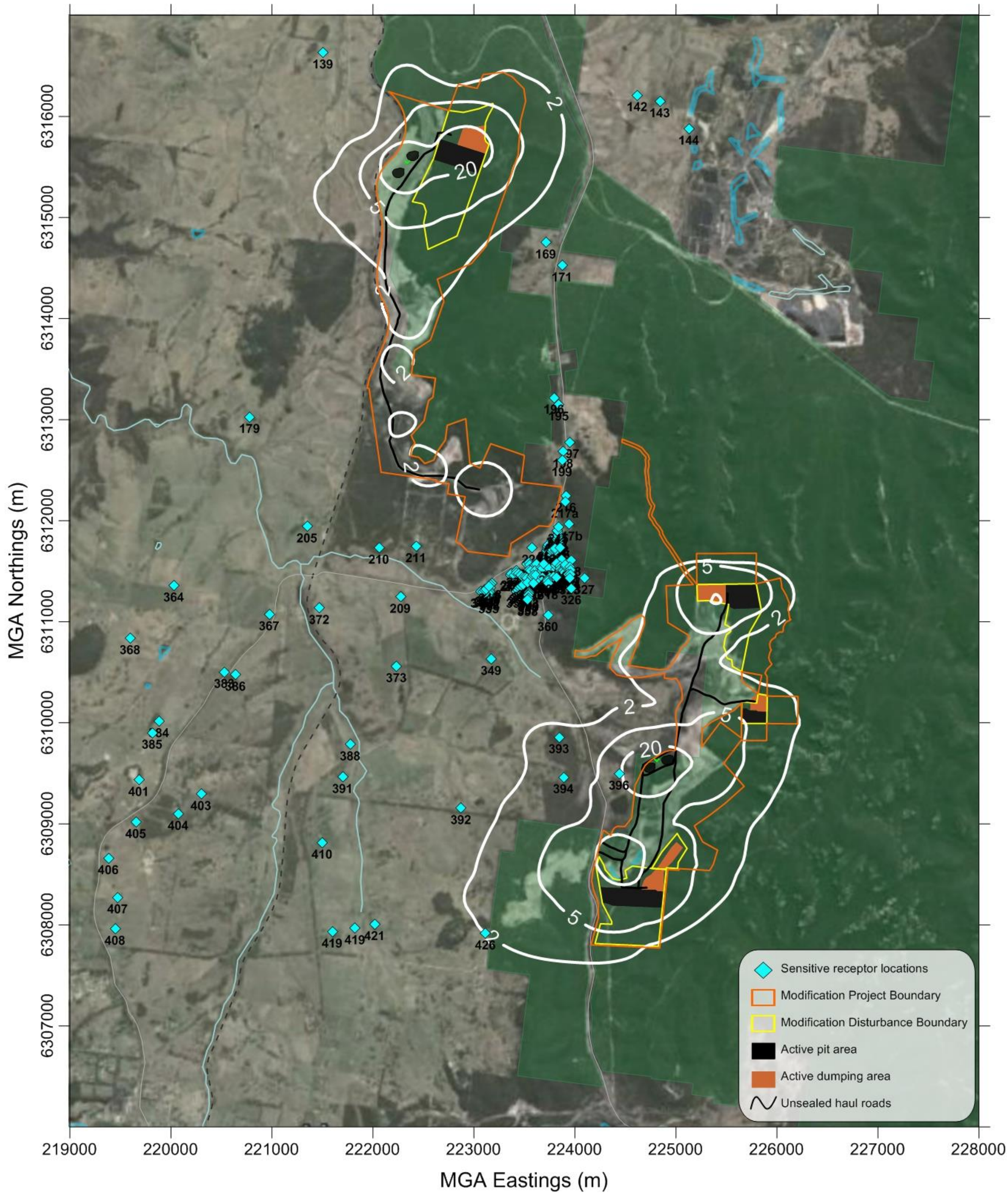
Species: PM10	Location: Coalpac	Scenario: Modifications Only	Percentile: N/A	Averaging Time: 24-hour
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** 50 (acquisition)	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.2: Predicted maximum 24-hour average PM_{10} concentrations – Modifications Only



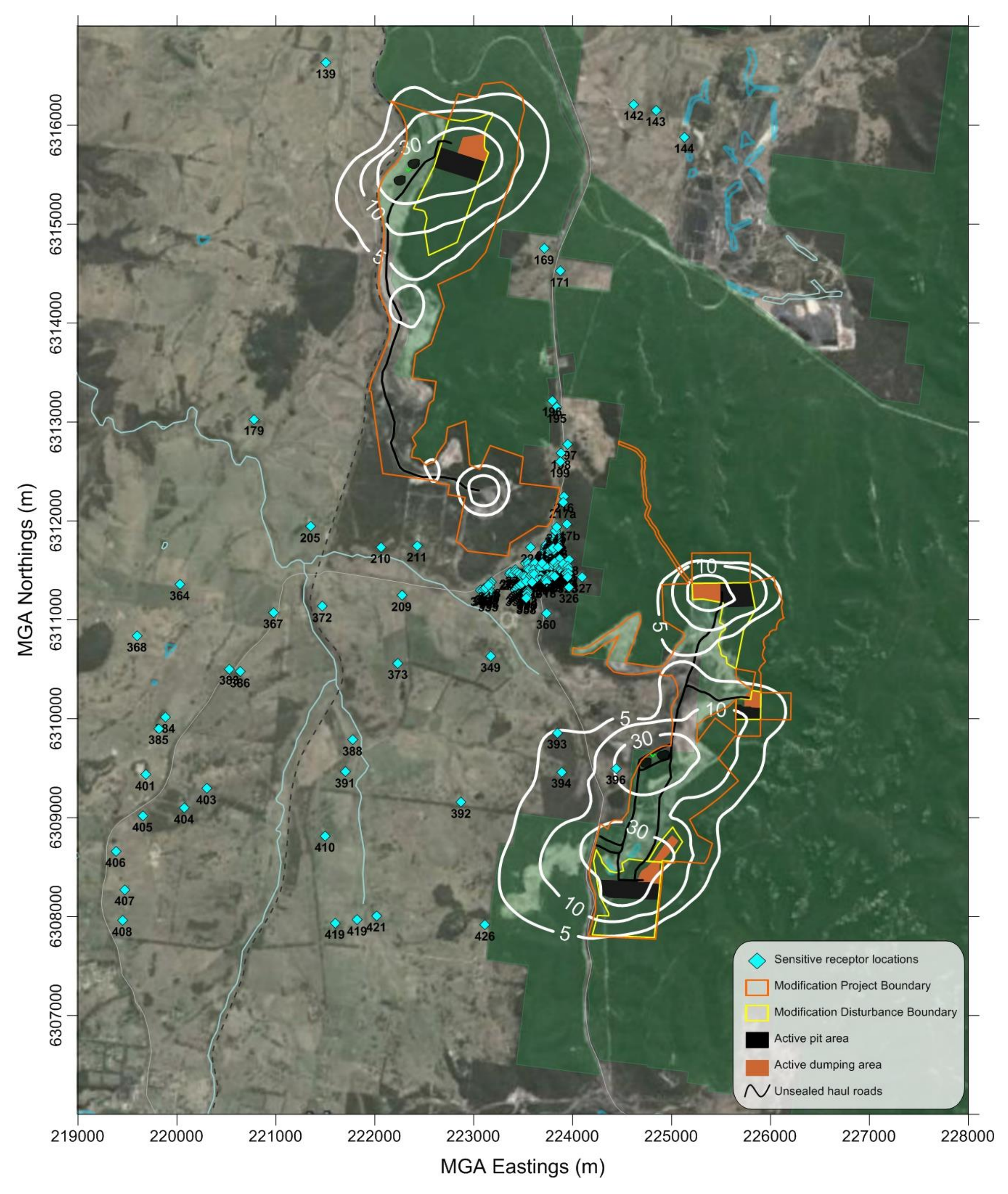
Species: PM2.5	Location: Coalpac	Scenario: Modifications Only	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.3: Predicted annual average $PM_{2.5}$ concentrations – Modifications Only



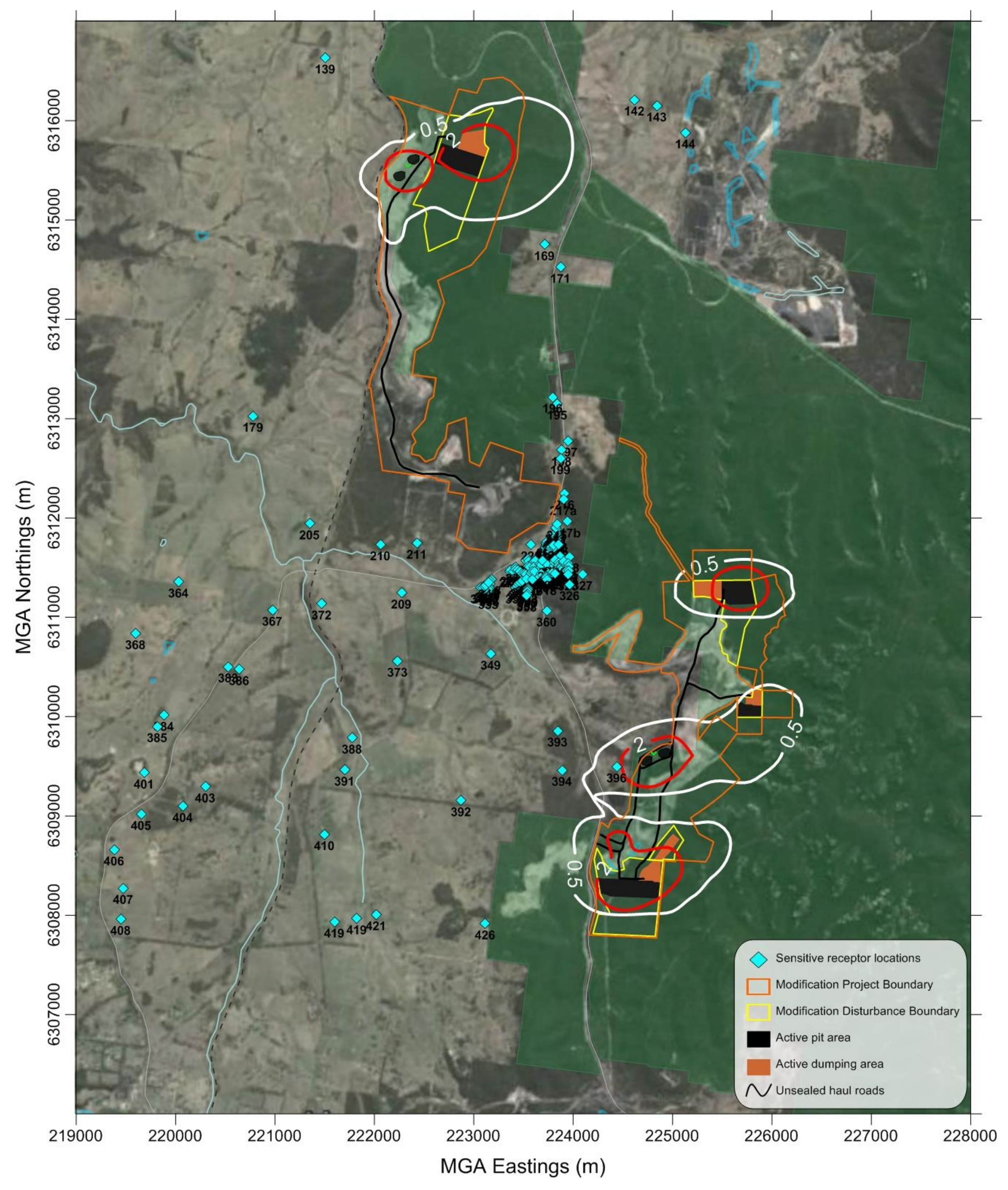
Species: PM10	Location: Coalpac	Scenario: Modifications Only	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.4: Predicted annual average PM_{10} concentrations – Modifications Only



Species: TSP	Location: Coalpac	Scenario: Modifications Only	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.5: Predicted annual average TSP concentrations – Modifications Only



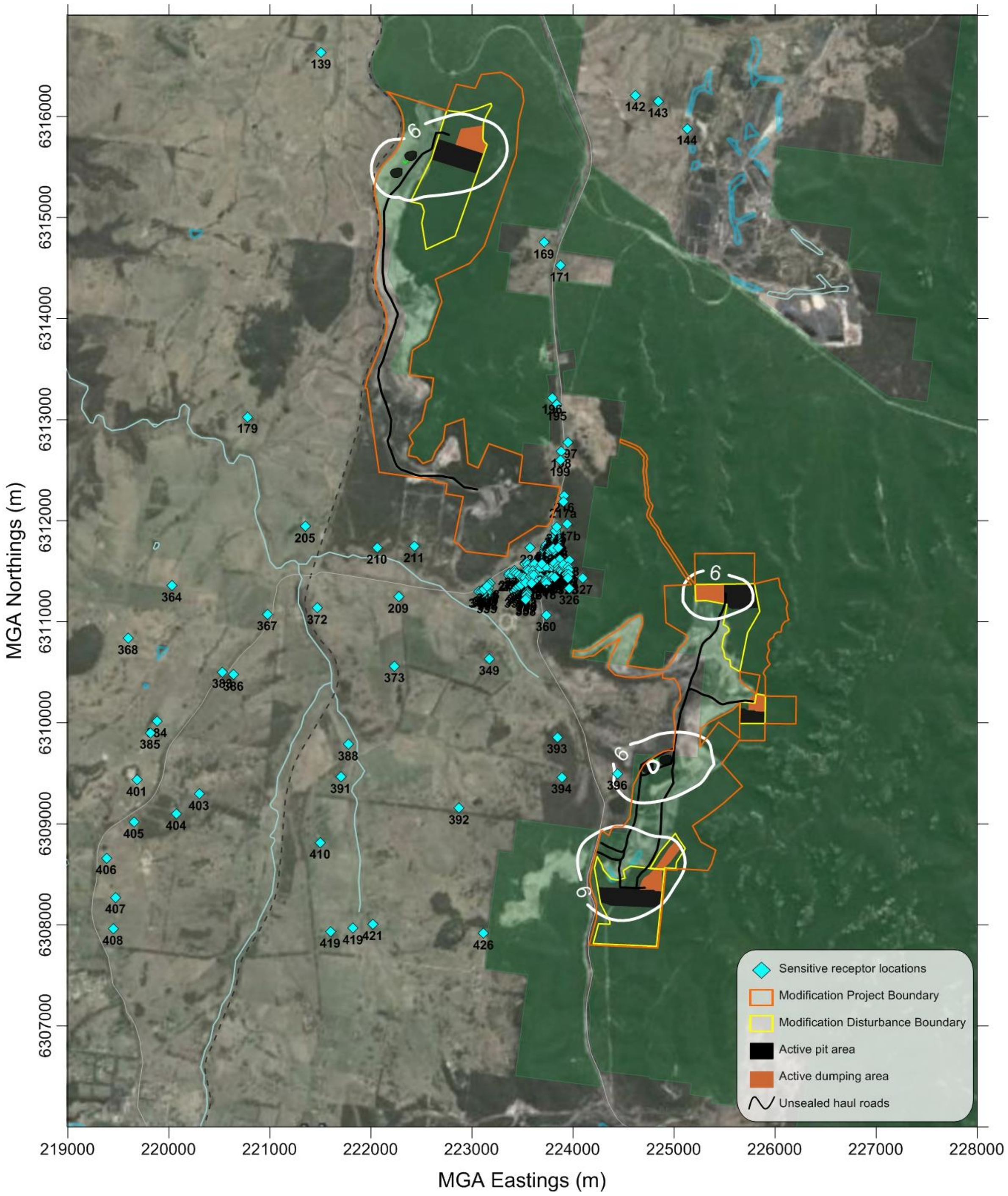
Species: Deposition	Location: Coalpac	Scenario: Modifications Only	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** g/m²/month	**Guideline:** 2	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.6: Predicted annual average dust deposition – Modifications Only

10.3 Cumulative Annual Average Assessment

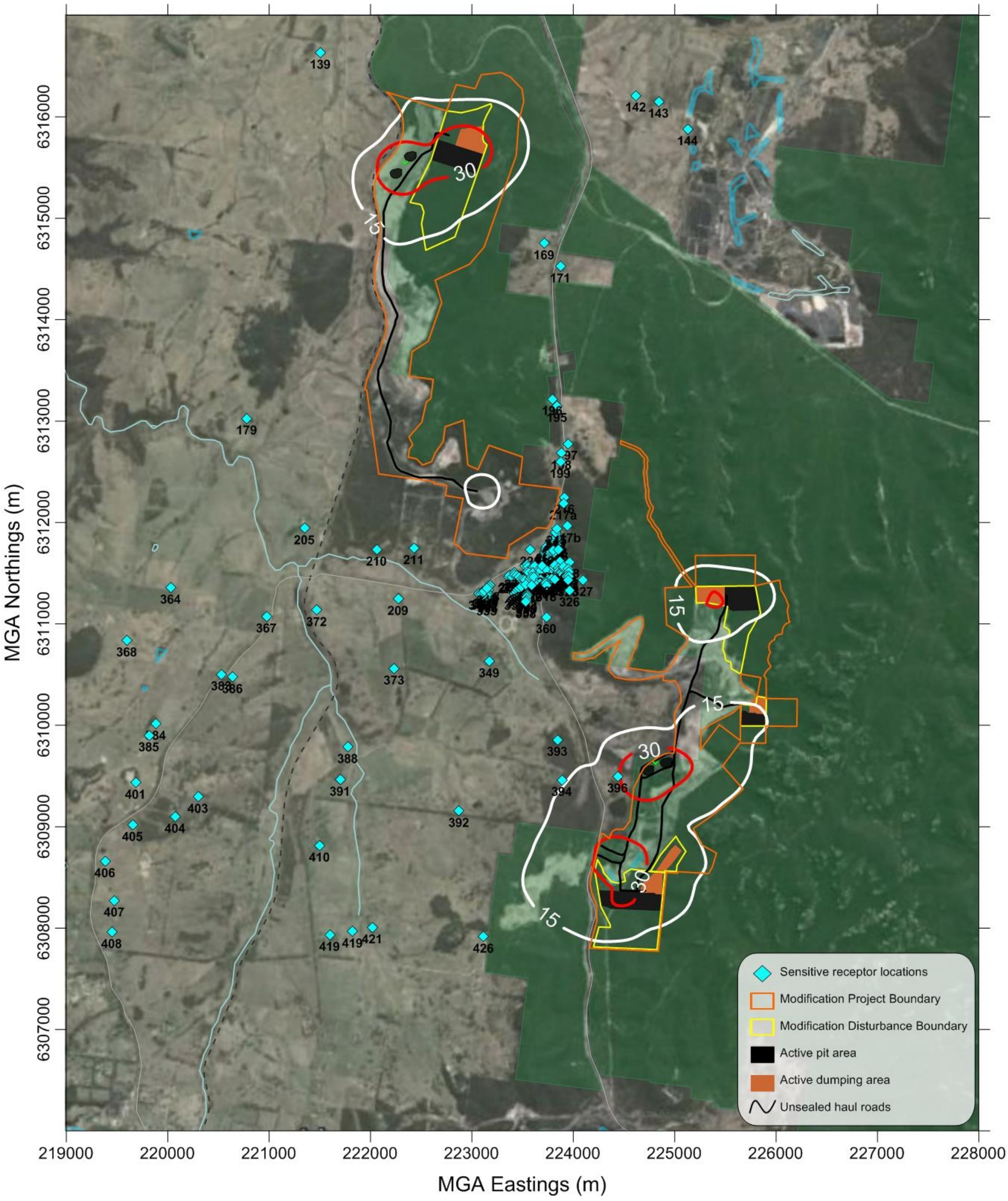
A summary of the predicted cumulative concentration and deposition levels at all sensitive receptors is presented in **Appendix D**. **Figure 10.7** to **Figure 10.10** show these predictions across the modelling domain for each particle size group. These plots include the emissions from the Modifications and other sources using the background estimates identified in **Section 9.6.1**. It is noted that the monitoring data provide a conservative indication of background given that the data include contributions from the Cullen Valley Mine and Invincible Colliery's current mining operations producing more than 1.5 Mt ROM per year.

There are not predicted to be any exceedances of the cumulative criteria for PM_{10}, TSP or dust deposition, at any privately owned or Coalpac owned residences.



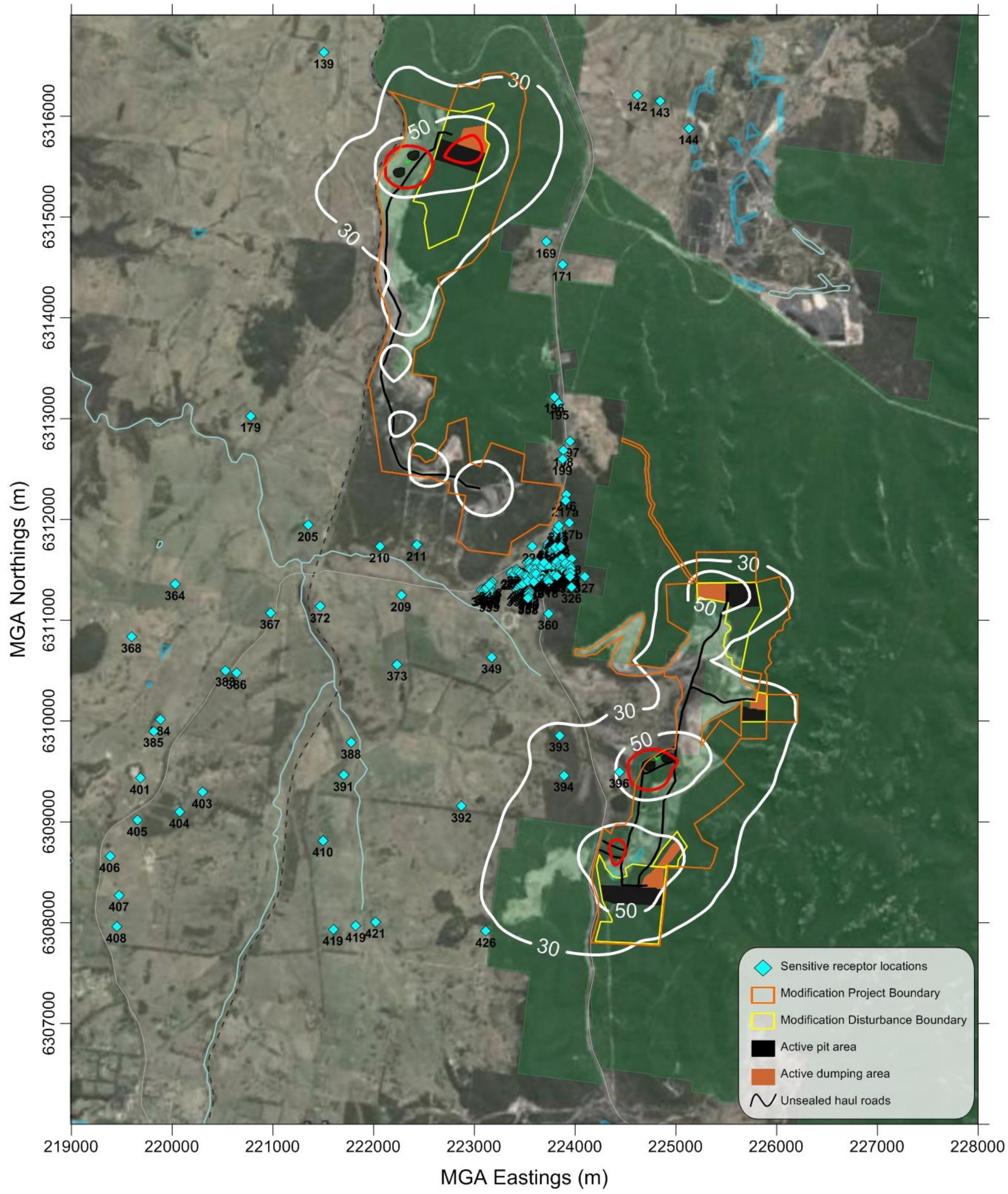
Species: PM2.5	Location: Coalpac	Scenario: Cumulative	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** N/A	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.7: Predicted annual average $PM_{2.5}$ concentrations – Cumulative



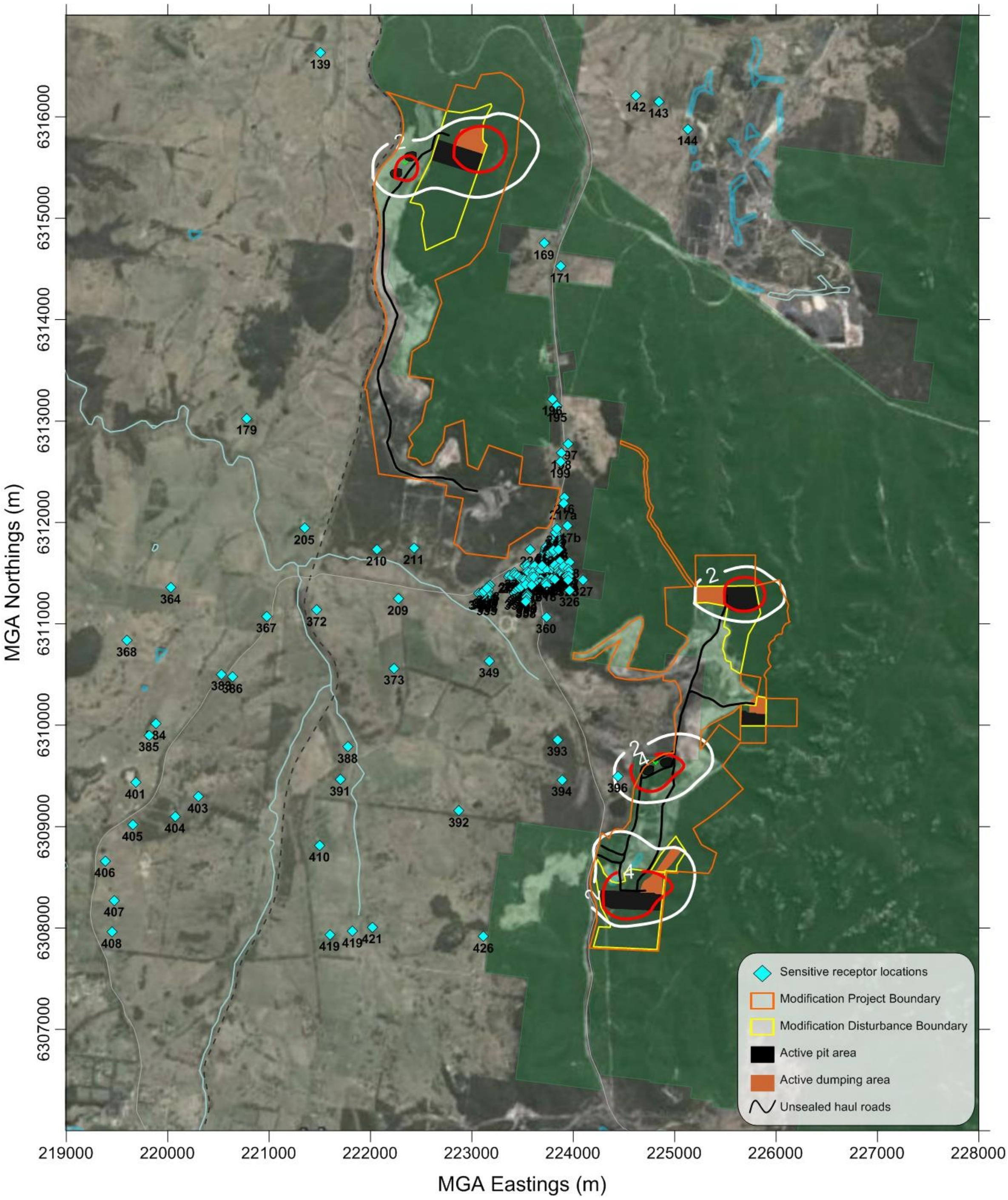
Species: PM10	Location: Coalpac	Scenario: Cumulative	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** 30	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.8: Predicted annual average PM_{10} concentrations – Cumulative



Species: TSP	Location: Coalpac	Scenario: Cumulative	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** 90	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.9: Predicted annual average TSP concentrations – Cumulative



Species: Deposition	Location: Coalpac	Scenario: Cumulative	Percentile: N/A	Averaging Time: Annual
Model Used: CALPUFF	**Units:** g/m²/month	**Guideline:** 4	**Met Data:** 2009	**Plot:** J. Barnett

Figure 10.10: Predicted annual average dust deposition – Cumulative

10.4 Cumulative 24-hour Average Assessment

10.4.1 Introduction

Difficulties in predicting cumulative 24-hour impacts are compounded by the day-to-day variability in ambient dust levels and the spatial and temporal variation in any other anthropogenic activity and natural events e.g. agricultural activity, dust storms, bushfires etc., and including mining in the future. Experience shows that in many cases the worst-case 24-hour average PM_{10} concentrations are strongly influenced by other sources in an area, such as bushfires and dust storms, which are essentially unpredictable. Mining operations also contribute to elevated 24-hour average PM_{10} concentrations, however, they are likely to be more localised. The variability in 24-hour average PM_{10} concentrations can be clearly seen in the data collected at the Coalpac HVAS monitors located at Invincible Colliery and Cullen Valley Mine area (**Figure 6.3**).

Due to the difficulties outlined above, cumulative air quality impacts have been evaluated using a statistical approach (Monte Carlo Simulation). As Cullen Valley Mine and Invincible Colliery are existing operations, PM_{10} concentrations measured within their vicinity will already include contributions from the current operations. The assessment will therefore be conservative.

A number of private receptors were selected for cumulative analysis based on their proximity to operations, prevailing wind directions and the magnitude of their Modifications mine-only predictions (see **Section 10.2**). These include a total of 17 residences, eleven privately owned and six owned by Coalpac. The locations of these receptors relative to mining operations are shown in **Figure 10.11**.

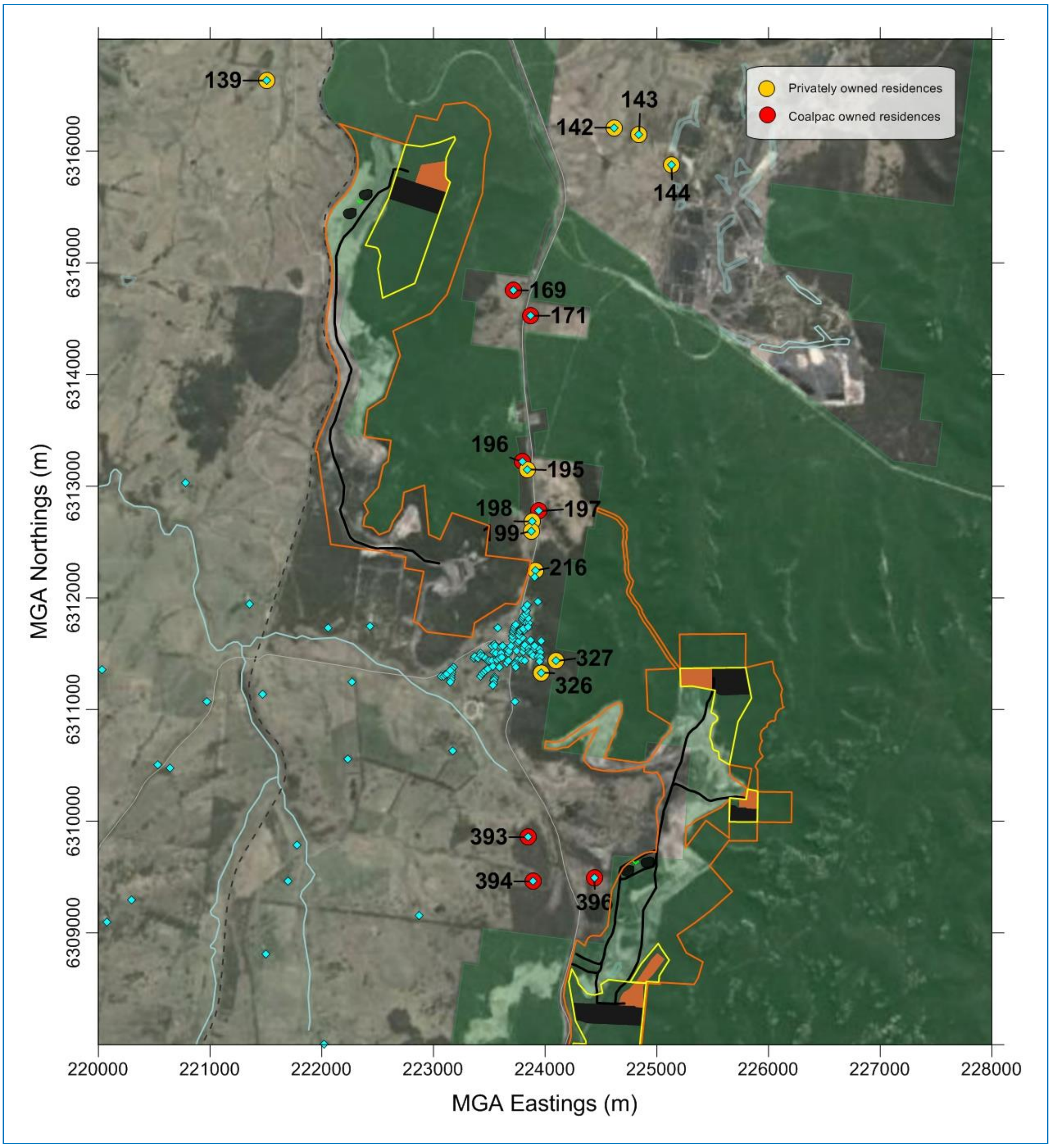


Figure 10.11: Selected Receptors for Monte Carlo Simulation

10.4.2 Monte Carlo Simulation

The Monte Carlo Simulation is a statistical approach that combines the frequency distribution of one data set (in this case, background 24-hour average PM concentrations) with the frequency distribution of another data set (modelled concentrations at a given receptor). This is achieved by randomly and repeatedly sampling and combining values within the two data sets to create a third, 'cumulative' data set and associated frequency distribution.

To generate greater confidence in the statistical robustness of the results, the Monte Carlo Simulation was repeated 250,000 times for each of the chosen receptors. In other words, the same 1-year set of predicted (modelled) 24-hour concentrations due to the Modifications at each receptor, were added to 250,000 variations of the randomly selected background concentrations (that is, a different random background concentration is selected each time).

For the PM_{10} assessment, the HVAS data were used to represent background levels. For the $PM_{2.5}$ assessment, these same data were used but adjusted using the 0.47 $PM_{2.5}$:PM_{10} ratio calculated in **Section 6.3.3**. Individual 24-hour predictions for the Modifications were then added to a random value from the above data set. This process is repeated thousands of times yielding the 'cumulative' data set, which is then presented as a frequency distribution.

The process assumes that a randomly selected background value would have a chance equal to that of any other background value from the data set of occurring on the given 'model day'. An analysis of the Monte Carlo method shows that over sufficient repetitions, this yields a good statistical estimate of the combined and independent effects of varying background and Modifications contributions.

The results of this Monte Carlo analysis for the privately owned residences are presented graphically in **Figure 10.12** to **Figure 10.15**.

The plots show the statistical probability of 24-hour average PM_{10} and $PM_{2.5}$ concentrations being above the EPA PM_{10} criterion of 50 µg/m^3 and $PM_{2.5}$ ARS of 25 µg/m^3, respectively. **Figure 10.12** shows there is one estimated exceedance of 50 µg/m^3 due to background levels. No additional exceedances of the 24-hour average PM_{10} criterion are predicted due to the Modifications, at any of the nearest privately owned residences.

Figure 10.13 shows that the Modifications contributions to cumulative 24-hour $PM_{2.5}$ concentrations are almost negligible, with the cumulative curves almost identical to the background curve. There are no additional exceedances of the 24-hour average $PM_{2.5}$ ARS of 25 µg/m^3 at privately owned residences due to the Modifications.

Figure 10.14 and **Figure 10.15** show the results of the Monte Carlo analysis for Coalpac-owned residences for PM_{10} and $PM_{2.5}$, respectively. There are estimated to be some additional exceedances of 50 µg/m^3 (24-hour average PM_{10}) at the nearest Coalpac owned residences 393, 394 and 396 only. There are no additional exceedances of the 24-hour average $PM_{2.5}$ ARS predicted at any of the other Coalpac-owned residences.

It should also be noted that there are no residences, private or Coalpac-owned, that are expected to exceed the DP&I 24-hour average PM_{10} acquisition criteria of 150 µg/m^3.

The actual number of exceedances per year due to cumulative impacts cannot be predicted precisely and would depend on actual Modification activities, activities at other mining sites, weather conditions, the implementation of controls, and background levels in the future.

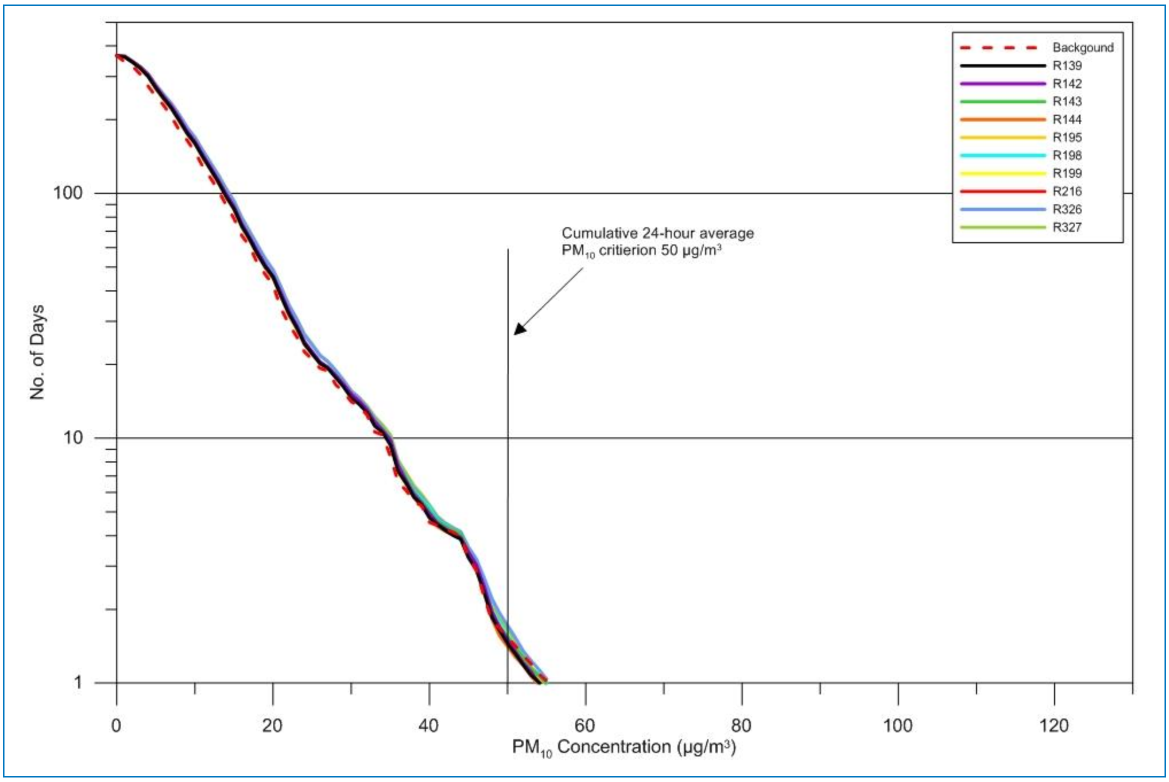


Figure 10.12: Statistical estimate of number of days exceeding 24 hour average PM_{10} average concentrations at privately owned residences – Monte Carlo simulation

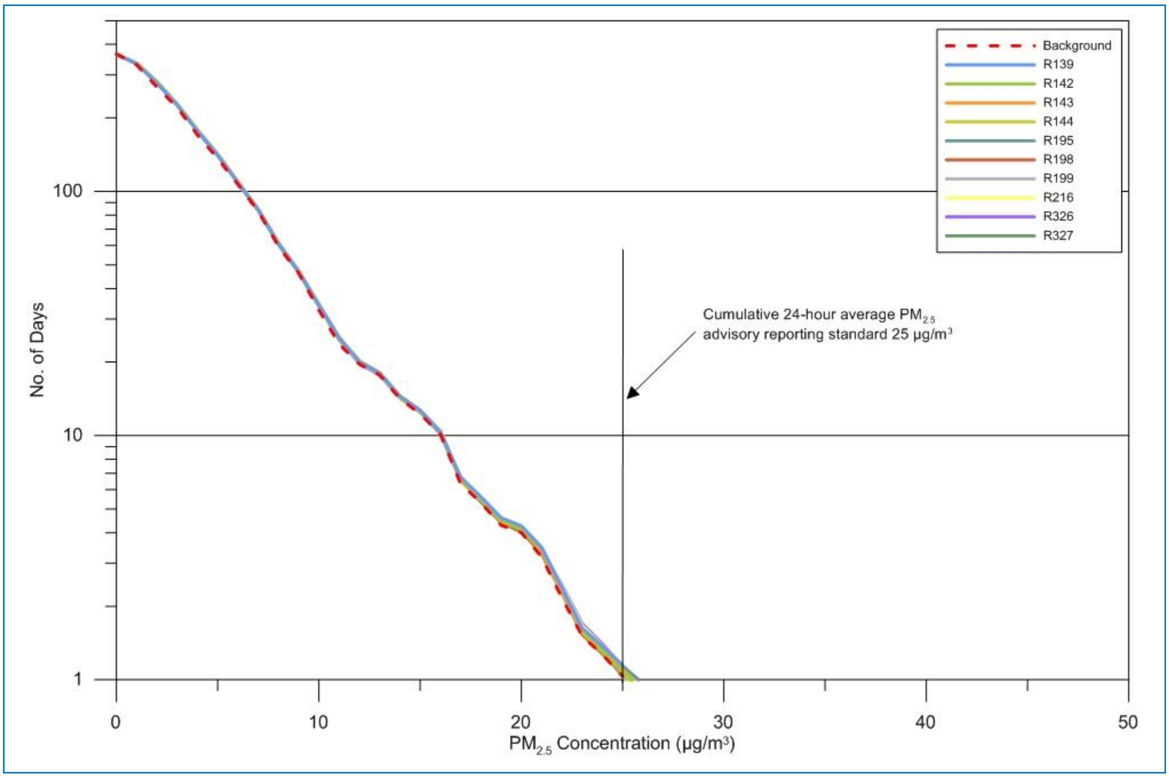


Figure 10.13: Statistical estimate of number of days exceeding 24 hour average $PM_{2.5}$ average concentrations at privately owned residences – Monte Carlo simulation

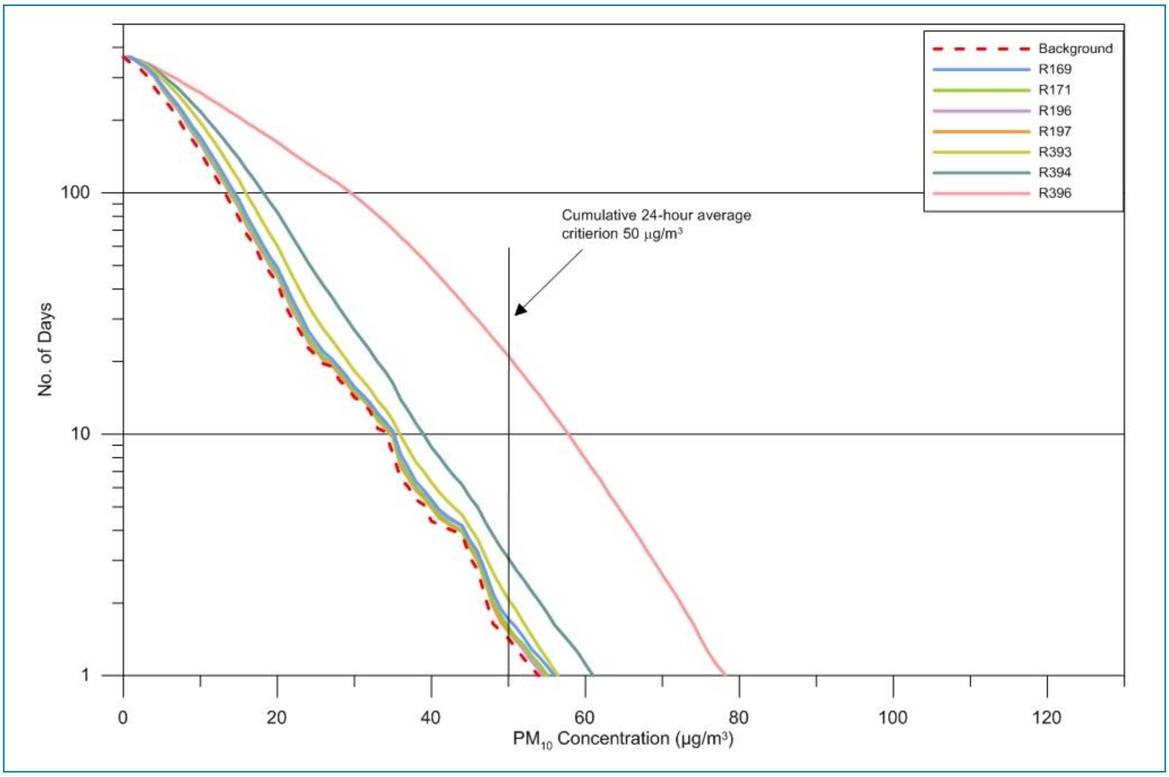


Figure 10.14: Statistical estimate of number of days exceeding 24 hour average PM_{10} average concentrations at Coalpac owned residences – Monte Carlo simulation

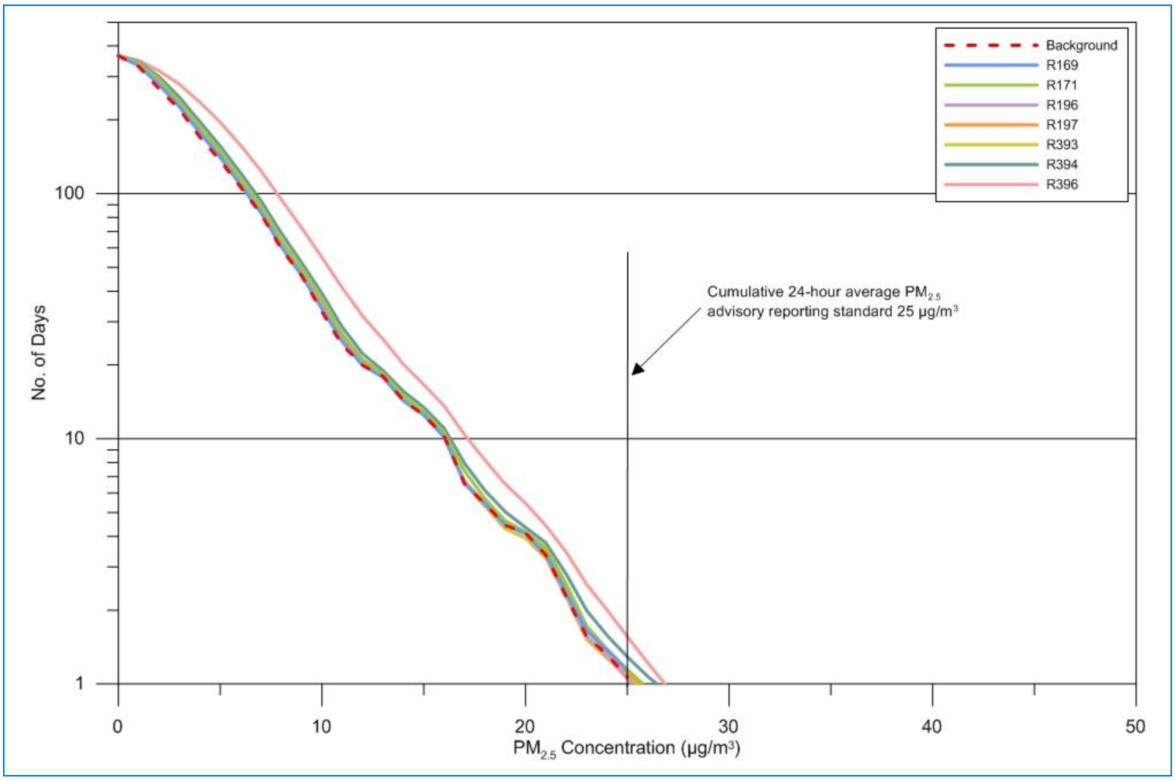


Figure 10.15: Statistical estimate of number of days exceeding 24 hour average $PM_{2.5}$ average concentrations at Coalpac owned residences – Monte Carlo simulation

10.5 Assessment of Impacts on Private Land

This section provides a summary of sensitive receptors predicted to exceed the assessment criteria on more than 25 percent of privately owned land, including vacant land.

Tables C1 and **D1** (in **Appendix C** and **Appendix D**, respectively), list the predicted impacts at individual residences.

An additional assessment has been conducted to identify privately-owned land, including vacant land, where more than 25% of the land is predicted to experience dust levels above the relevant EPA criteria. Blocks of land that have the same owner and are contiguous have been considered as a single area. For reference, the block numbers associated with each owner are provided in **Appendix E**.

The modelling shows that there is only one private receptor (Hyrock NSW Pty Ltd (Industrial) (Block ID 395)) that is predicted to experience dust impacts on more than 25% of the land area for the maximum 24-hour average PM_{10} concentration. There are no receptors predicted to experience dust impacts on more than 25% of the land for the cumulative annual average PM_{10} concentration.

10.6 Comparison of Modification Dispersion Modelling Results to Existing Approval Conditions

The Cullen Valley Mine and Invincible Colliery currently operate under existing approval conditions which include the following requirement:

"The Proponent shall ensure that dust and particulate emissions generated by the project do not cause additional exceedances of the criteria listed in Tables 4 to 6 at any residence on privately-owned land, or on more than 25 percent of any privately-owned land."

These criteria above relate to those shown in **Section 5** of this report. **Section 10.2** and **Section 10.3** have shown that there are no private receptors with predicted PM concentrations and dust deposition levels above these impact assessment criteria and therefore no anticipated change to existing approval requirements as a result of the Modification.

The revised assessment has however shown that one private receptor (Hyrock NSW Pty Ltd (Industrial) (Block ID 395)) is predicted to experience dust impacts on more than 25% of the land area for the maximum 24-hour average PM_{10} concentration.

11 DUST MANAGEMENT AND MITIGATION MEASURES

It is necessary for open cut mining developments (such as Invincible Colliery and Cullen Valley Mine) to take reasonable and practicable measures to prevent or minimise dust emissions and also impacts at sensitive receptors.

Table 11.1 below lists the dust mitigation control measures currently adopted at the Cullen Valley Mine and Invincible Colliery. It is noted that Coalpac are committed to increasing the watering rate on unsealed road from Level 1 currently to Level 2 watering for the Modifications.

Table 11.1: Summary of dust mitigation measures employed at the mine sites

Mining Activity	Control measures employed at the site
Drilling	Water sprays while drilling.
Hauling on unsealed roads	Currently applying Level 1 watering to unsealed roads but to increase to Level 2 for the Modification.
Truck wash facility	Washing trucks as they leave the site.
Minimising haulage distances	The most practical direct haulage routes are specified for all vehicle movements to minimise travel distances.
Minimising pre-strip clearing areas	The clearing of pre-strip areas is kept to a minimum so vegetation can be retained as long as possible.
Coal and overburden loading and dumping	These operations are modified during periods of adverse weather conditions such as high winds. Low drop heights.
Crushing and screening	Enclosure and water sprays.
Wind erosion on coal stockpiles	Wind breaks.
Wind erosion of exposed areas	Level 1 watering.
Material transfer of coal (transfer points)	Some transfer points are enclosed and some include manually operated water sprays.

11.1 Construction Phase Dust Control

As described in **Section 3**, the Modifications will include some minor construction activities such as excavation of exposed areas and pipeline construction.

From an air quality perspective it is important to consider the potential emissions that would occur during construction. While dust emissions from construction activities can have impacts on local air quality, impacts are typically of a short duration and relatively easy to manage through commonly applied dust control measures.

Procedures for controlling dust impacts during construction will include, but not necessarily be limited to the following:

- Watering haul roads – 75% control;
- Rehabilitation / cover crops where possible;
- Modifying working practices by limiting excavation during periods of high winds;
- Limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing;
- All vehicles on-site would be confined to designated routes with speed limits enforced;
- Trips and trip distances would be controlled and reduced where possible, for example by coordinating delivery and removal of materials to avoid unnecessary trips; and
- When conditions are excessively dusty and windy, a water cart/truck (for water spraying of travel routes) would be used.

12 GREENHOUSE GAS ASSESSMENT

12.1 Introduction

The Director-General's Environmental Assessment Requirements identifies Greenhouse Gases as a key issue for the Modifications. The DGRs for greenhouse gas assessment require:

- Qualitative assessment of the potential Scope 1, 2 and 3 greenhouse gas emissions of the Modifications.
- A qualitative assessment of the potential impacts of these emissions on the environment.
- An assessment of all reasonable and feasible measures that would be implemented to minimise greenhouse gas emissions of the Modifications and ensure energy efficiency.

12.2 Greenhouse Gas Emission Estimates

12.2.1 National Greenhouse and Energy Reporting Framework

Federal parliament passed the *National Greenhouse and Energy Reporting Act 2007* (the NGER Act) in September 2007 (**OLDP, 2007**). The NGER Act establishes a mandatory obligation on corporations which exceed defined thresholds to report GHG emissions, energy consumption, energy production and other related information.

The NGER Act is one of a number of legislative instruments related to greenhouse reporting, which together form the National Greenhouse and Energy Reporting (NGER) framework.

- The *National Greenhouse and Energy Reporting Regulations 2008* (**OLDP, 2008a**) which provides the necessary details that allow compliance with, and administration of, the *NGER Act*.
- The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (**OLDP 2008b**) which provides methods and criteria for calculating Greenhouse Gas emissions and energy data under the *NGER Act*.
- The *National Greenhouse and Energy Reporting (Audit) Determination 2009* (**OLDP, 2009**) which sets out the requirements for preparing, conducting and reporting on greenhouse and energy audits.

The NGER Act is seen as an important first step in the establishment of a domestic emissions trading scheme. This intention is explicitly stated in the objectives for the NGER Act, as follows:

- Establish a baseline of emissions for participants in a future Australian emissions trading scheme.
- Inform the Australian public.
- Meet international reporting obligations.
- Assist policy formulation of all Australian governments while avoiding duplication of similar reporting requirements.

Corporate and facility reporting thresholds for GHG emissions and energy consumption or energy production are provided in **Table 12.1**. Emissions are measured in terms of tonnes of "carbon dioxide – equivalent" (CO_2-e). The implication therefore is that emissions of more potent GHGs (e.g. methane) are normalised to their equivalent Global Warming Potential (GWP) of CO_2.

Table 12.1: NGER reporting thresholds

Corporate Threshold		Facility Threshold	
GHG Emissions (kt CO_2-e)	Energy Usage (TJ)	GHG Emissions (kt CO_2-e)	Energy Usage (TJ)
50	200	25	100

Source: **DCCEE (2007)**

Currently, reporting under the NGER Act applies to 'constitutional corporations'. Reporting is required if the corporation meets the following criteria:

- They are a controlling corporation (a constitutional corporation that does not have a holding company in Australia.
- The controlling corporation has operational control over one or more facilities.
- The controlling corporation's group meets or is likely to meet a reporting threshold (either facility and/or corporate threshold.

Under paragraph 51(xx) of the Australian Constitution, the Australian Parliament has power to make laws with respect to foreign corporations and trading or financial corporations formed within the limits of the Commonwealth. These corporations are known as 'constitutional corporations'.

Since 1 July 2012 NGER has been the vehicle by which "liable entities" under the *Clean Energy Act 2011* (CEA) calculate their liability under the Federal government's carbon pricing mechanism. Under the *Clean Energy Act 2011*, an entity has a liability where:

- Scope 1 emissions of 25,000 tonnes or more; or
- Is a large gas consuming facility.

As the Modifications are anticipated to have Scope 1 emissions greater than 25,000 tonnes $CO_{2\text{-}e}$ in a financial year, emissions are required to be reported to NGER, and, assuming the *Clean Energy Act 2011* is not repealed by the time the mine is operational, a portion of emissions will be liable under this legislation.

12.2.2 Current and Proposed Legislation

12.2.2.1 Introduction

GHG emissions in Australia are currently collectively managed at a national level, through initiatives implemented by the former Australian Labor Party (ALP) Government (carbon tax and emission trading scheme). The recently elected coalition government is seeking to repeal this legislation and replace it with their Direct Action Plan, whereby funding is provided to existing polluters in order to achieve carbon emission reductions. The following sections provide an overview of the current and proposed GHG legislation.

12.2.2.2 The Current Clean Energy Legislative Package

On 10 July 2011, the then Australian Government released its *Clean Energy Legislation Package*, which incorporates a Carbon Pricing Mechanism. Under this policy, since 1 July 2012, the eligible industries (liable entities) in Australia are required to pay for every tonne of carbon pollution released to the atmosphere (**Australian Government, 2011**). The Australian Senate gave final approval for the *Clean Energy Legislative Package* on 8 November 2011. The *Clean Energy Legislative Package* is expected to cut pollution by a minimum of 5% below 2000 levels by 2020 and by 80% below 2000 levels by 2050.

The legislation:

- Implements the carbon pricing mechanism for Australia to reduce carbon pollution and move to a clean energy future;
- Sets out how the carbon pricing mechanism will be run, and what businesses will have to do to meet its requirements; and
- Links the carbon price to the Carbon Farming Initiative and to schemes overseas.

The intended purposes and mechanisms of the clean energy legislative package are shown in **Figure 12.1.**

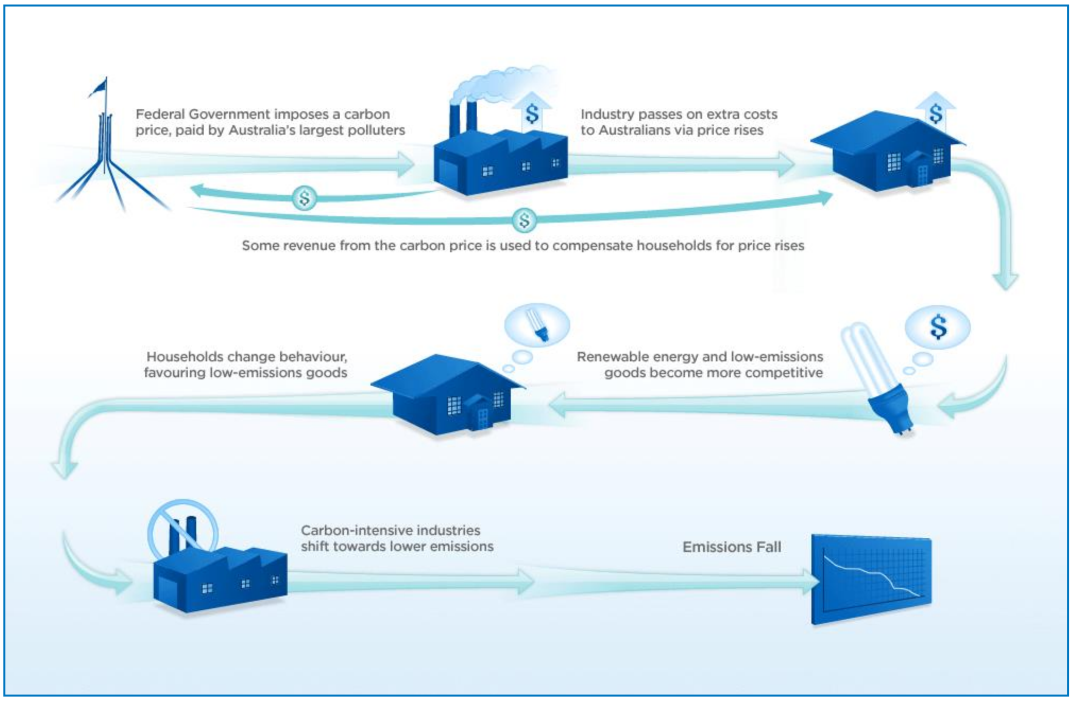


Figure 12.1: "The Big Picture" – Clean Energy Legislative package

The threshold for facilities is identical to that employed for NGER reporting (i.e., 25,000 kt CO_2-e/year or more – excluding emissions from transport fuels and some synthetic greenhouse gases) is used to identify whether a facility will be covered by the carbon pricing mechanism. Also, the threshold for the *Clean Energy Act 2011* only applies to scope 1 emissions.

Furthermore, on 1 July 2012, as part of the *Clean Energy Consequential Amendments Act 2011*, the definition of operational control in the NGER Act changed so that all reference to corporations was replaced with "liable entities" or persons.

12.2.2.2.1 *Coverage*

The coverage of the *Clean Energy Legislative Package* is summarised as follows:

- Applies to scope 1 emission sources (i.e. direct emissions).
- Threshold test is 25,000 tonnes of CO_2-e per year of total emissions
- The *Clean Energy Act 2011* applies to four greenhouse gases:
  - Carbon dioxide
  - Methane
  - Nitrous oxide
  - Perfluorocarbons
- Carbon liability, in relation to mining operations, applies to:
  - Fugitive emissions (excluding emissions from decommissioned underground mines)
  - Combustion of fossil fuels.

Scope 2 emissions from electricity usage, as well as agriculture and land sector emissions are excluded. Similarly, transport fuel for household and light commercial vehicles and fuel used by agriculture, forestry and fisheries are not covered.

The carbon pricing mechanism will consist of two stages, a fixed price period followed by a flexible cap and trade emissions trading scheme.

12.2.2.2.2 *Fixed Price Period*

For the first three years, a fixed price stage is proposed to operate with the price of all carbon permits set by the Australian Government. The carbon price will start at AUD23 per tonne and rise by 5% a year (an intended real increase of 2.5% at an expected inflation rate of 2.5%, the mid-point of the RBA inflation target), resulting in a carbon price of AUD24.15 per tonne in 2013-14 and AUD25.40 per tonne in 2014-15 (**Australian Government, 2011**). During this fixed price period, businesses will be able to acquire as many permits at the set price as required to meet their obligations.

During the fixed price stage, eligible Australian carbon credit units (ACCUs) produced from Australian projects under the Carbon Farming Initiative (CFI), will be accepted as currency as an alternative to purchasing Australian Permits. The CFI will produce carbon credits eligible for local and international compliance (e.g., Emission Trading Scheme – ETS) and voluntary markets (e.g. National Carbon Offset Standard – NCOS) (**Carbon Neutral, 2011**). However, Australia's carbon price will not be linked to international carbon markets during the fixed price period.

12.2.2.2.3 *Flexible Cap and Trade Emissions Scheme*

Subsequent to this three year period, it has been proposed that a flexible cap and trade emissions trading scheme will commence.

Before the flexible price period commences, it was proposed that the Australian Government will set annual caps on pollution for the first *five years which* will be extended each year to assist businesses planning their strategy for compliance. The first five years will be announced in the 2014 Budget and legislated in Regulations.

During the first three years of the flexible cap and trade emissions scheme, a "price collar" will be in place as follows:

- Price floor: AUD15 (4% p.a. rise)
- Price ceiling: AUD20 above international price (5% p.a. rise)
- 'Top-up' fee applies to surrender of international carbon units

12.2.2.3 Carbon Credits (Carbon Farming Initiative) 2011

On 23 August 2011, the then Australian Government passed the legislation required to implement the Carbon Faming Initiative (CFI). The CFI is a government carbon offset scheme through which participants can design and implement emissions abatement and sequestration projects to receive 'carbon credits' for the resulting emissions reductions.

The CFI broadly aims to provide financial incentives for farmers, forest growers, landholders and landfill operators to develop projects that will reduce or sequester GHG emissions.

There are broadly two categories of offset projects that may be implemented under the CFI:

- **Emissions avoidance projects** – a project that avoids the emission of GHGs.
- **Carbon sequestration projects** – a project that removes CO_2 from the atmosphere and stores it in living biomass such as forests or in soil.

Each tonne of CO_2-e that is reduced or stored by a CFI project will be awarded one 'Australian carbon credit unit' (ACCU).

Some emissions avoidance projects and some carbon sequestration projects are eligible under international emissions accounting guidelines, such as the Kyoto Protocol, and some are not. These different types result in broadly two kinds of ACCUs that will be produced under the CFI:

- **Compliance ACCUs** (called 'Kyoto ACCUs' in the CFI Act) will be issued when the project relates to activities/emissions that are within Australia's Kyoto Protocol emissions reporting inventory.

Compliance ACCUs will be able to be used in the Australian Carbon Price Mechanism from 1 July 2012 onwards.

- **Voluntary ACCUs** (called 'non-Kyoto ACCUs' in the CFI Act) will be issued when the project relates to activities/emissions that are outside of Australia's Kyoto Protocol emissions reporting inventory. Voluntary ACCUs will be able to be used in both the Australian and international voluntary carbon markets.

The types of projects and credits issued under the CFI are shown in **Table 12.2**.

Table 12.2: Types of project and credits available

	Compliance Market	Voluntary Market
Carbon Sequestration	**Forestry** ➢ Afforestation & reforestation ➢ Avoided deforestation	**Forestry** ➢ Reforestation of non-Kyoto lands ➢ Forest management **Land Management** ➢ Revegetation ➢ Rangeland restoration ➢ Enhanced soil carbon
Emissions Avoidance	**Land Management** ➢ Enteric fermentation ➢ Agricultural soils (N_2O gases) ➢ Manure management ➢ Agricultural burning ➢ Rice cultivation ➢ Savannah fire management **Waste** ➢ Legacy waste landfill ➢ Legacy waste diversion from landfill	**Land Management** ➢ Introduced or feral animal management

12.2.2.4 Proposed GHG Legislation

12.2.2.4.1 *Repeal of the Carbon Tax*

In October 2013, the newly appointed coalition government released a *Repeal of the Carbon Tax: Exposure Draft Legislation and Consultation Paper* which states their intention that the carbon tax (i.e. carbon pricing mechanism) be abolished. This is anticipated to occur in July 2014 following an introduction of the carbon tax repeal bills when the new government sits in Parliament in November 2013.

Liable businesses will continue to pay all carbon tax liabilities incurred up to 30 June 2014 under the current carbon pricing mechanism. For entities subject to the carbon pricing mechanism, compliance obligations will continue up to 2 February 2015, which is the final date by which liabilities must be paid under the carbon tax.

12.2.2.4.2 *Proposed Direct Action Plan of the Environment and Climate Change*

The policy proposed by the coalition government is the *Direct Action Plan* (**LPA, 2010**). This policy remains in force after the introduction of the Clean Energy Legislative Package (**LPA, 2011**).

The centrepiece of this policy is the replenishment of soil carbons – a large CO_2 abatement through bio-sequestration (currently soil carbons are not recognised under the Kyoto Protocol; however future global agreements on CO_2 reductions may include them).

The policy will also introduce an Emissions Reduction Fund to facilitate 140 million tonnes of CO_{2-e} abatement per annum by 2020. The fund is intended to aid projects that:

- Will reduce CO_2 emissions.
- Will not result in price increases for consumers.
- Will deliver additional practical environmental benefits.
- Will protect Australian jobs.
- Would not proceed without fund assistance.

A particular target of the policy is the nation's oldest and most inefficient power generation facilities, which will have the ability to use the fund to introduce programs to increase efficiency, or switch to less carbon intensive fuels, such as natural gas.

The *Direct Action Plan* is essentially a 'baseline and credit' approach, where:

- If businesses reduce their emissions below their baseline they have the opportunity to offer the abatement for sale to the government
- While no penalties are proposed for businesses that remain at their baseline levels of emissions, financial penalties are proposed for those businesses that emit more than their baseline levels.

The Coalition have claimed that the *Direct Action Plan* would match the 5% emission reductions outlined in the Australian Governments formally proposed CPRS legislation (**LPA, 2010**) (now deferred); however no emission reduction target was specified.

Whilst it is currently uncertain as to whether this legislation will be passed, it remains good protocol that carbon emissions are established. This is since carbon quantification (and ultimately carbon pricing) is likely to occur in some form in the future regardless of any short term changes in government.

12.3 Referenced Documentation

The GHG assessment is guided by, and makes reference to the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (the "NGER Measurement Determination") incorporating the National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2012 (No. 1).

The National Greenhouse and Energy Reporting Regulations 2008 (the NGER Regulations) describe the detailed requirements for reporting under the NGER Act. The NGER Regulations were amended in March 2009 and again in December 2009. The March 2009 amendments made a number of minor technical changes and clarifications. The December 2009 amendments introduced significant new provisions to enable the greenhouse and energy audit framework and aligned the NGER Regulations with the latest version of the NGER Measurement Determination.

The National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (the NGER Technical Guidelines) have been intended to support reporting under the NGER Act 2007. They have been designed to assist corporations in understanding and applying the NGER Measurement Determination.

The NGER Technical Guidelines are reporting year specific, and outline calculation methods and criteria for determining GHG emissions, energy production, energy consumption and potential GHG emissions embodied in natural gas. Unless otherwise stated, the latest published NGER Technical Guidelines at the time of writing (National Greenhouse and Energy Reporting (Measurement) Technical Guidelines July 2012) have been referenced.

As the NGER Technical Guidelines are derived from the NGER Measurement Determination, where there is a perceived contradiction between the NGER Technical Guidelines and NGER Measurement Determination, the NGER Measurement Determination takes precedence.

12.4 Emissions Inventory Scopes

GHG emissions have been estimated based upon the methods outlined in the following documents:

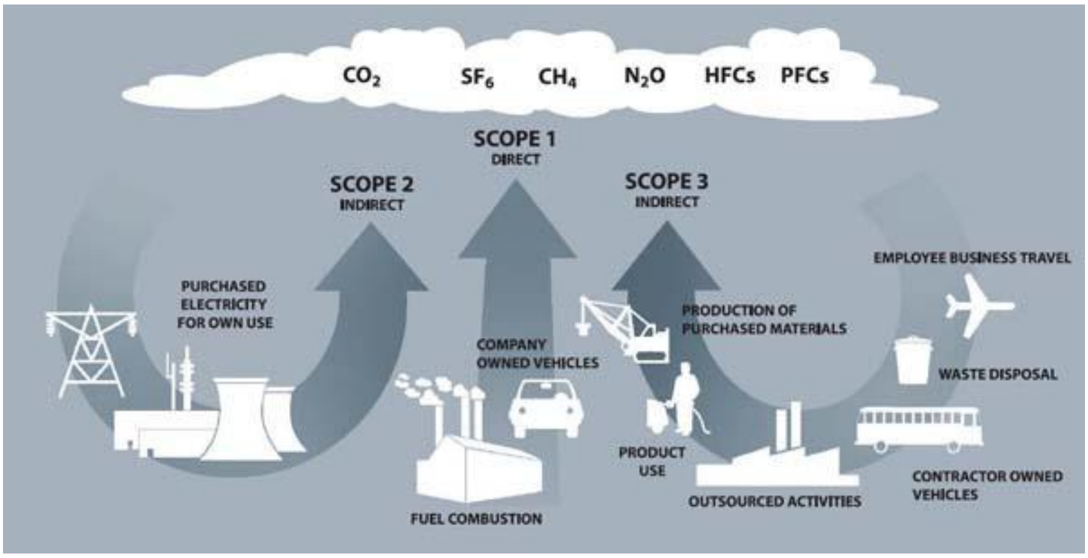
- The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Greenhouse Gas Protocol The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition (**WRI/WBCSD, 2004**) (GHG Protocol).
- National Greenhouse and Energy Reporting (Measurement) Determination 2008.
- The Commonwealth Department of Climate Change and Energy Efficiency (DCCEE) National Greenhouse Accounts (NGA) Factors 2013 (**DCCEE, 2013**).

The World Resources Institute / World Business Council for Sustainable Development Greenhouse Gas Protocol (the GHG Protocol) originally documented the different scopes for GHG emission inventories. The GHG Protocol is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. This corporate accounting and reporting standard is endorsed by the Australian Department of Climate Change and Energy Efficiency.

The GHG Protocol defines three scopes for developing inventories leading to reporting of emissions. These scopes help to delineate direct and indirect emission sources, improve transparency, and provide a degree of flexibility for individual organisations to report based on their organisational structure, business activities and business goals.

Three scopes of emissions (also shown in **Figure 12.2**) are defined in the GHG Protocol:

- Scope 1' emissions:
  - direct GHG emissions occurring from sources owned or controlled by the company – for example vehicle fleet and direct fuel combustion. Any negative emissions (sequestration), for example from a plantation owned by the entity, would also be included in Scope 1.
- 'Scope 2' emissions:
  - indirect GHG emissions from purchasing electricity or heat from other parties; and
- 'Scope 3' emissions:
  - indirect emissions which occur due to the company's business activities, but from sources not owned or controlled by the company - for example emissions from employee business-related air travel. The principal Scope 3 emission for the Modifications will be associated with combustion of the product coal that it will produce.



Source: **WRI/WBCSD, 2004**

Figure 12.2: Overview of Scopes and Emissions Across a Value Chain

Under the NGER Act, Scope 1 and 2 emissions must be accounted for by the organisation. Reporting of Scope 3 is optional.

The Modifications' major GHG sources are anticipated to comprise of the following Scope 1 sources:

- Fuel consumption (diesel) during mining operations – Scope 1.
- Release of fugitive CH4 during mining – Scope 1.
- Indirect emissions resulting from the consumption of purchased electricity - Scope 2.
- Indirect emissions associated with the production and transport of fuels – Scope 3.
- Indirect emissions associated with transmission and distribution losses from electricity supply – Scope 3.
- Emissions from coal transportation – Scope 3.
- Emissions from the burning of the product coal – Scope 3.

Emissions from the shipping of product coal are not included in this assessment due to the difficulties in emission estimates, including uncertainty in export markets and destination of product into the future and limited data on emission factors and / or fuel consumption for ocean going vessels.

12.5 Greenhouse Gas Emission Estimates

12.5.1 Introduction

The following sections present the GHG calculations and resultant estimated emissions from each of the GHG scopes as described in **Section 12.4**. All GHG calculations have been made using the relevant equations and emissions factors given within the NGER Measurement Determination. Data provided by Coalpac has been used as input into these equations.

12.5.2 On-site fuel consumption

Greenhouse gas emissions from diesel consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of GHG from diesel combustion	(t CO_2-e)
Q	=	Estimated combustion of diesel	(GJ)[1]
EF	=	Emission factor (Scope 1 or Scope 3) for diesel combustion	(kg CO_2-e/GJ)[2]

[1] GJ = giga joules
[2] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The quantity of diesel consumed (Q) in each year is based on a derived diesel intensity rate (megalitres per million tonnes per annum of run of mine coal [ML/Mtpa ROM]) derived from the 2009 Coalpac average diesel consumption (7.62 megalitres [ML]) and ROM rate of 1.5 Mtpa. The quantity of diesel consumed in GJ is then calculated using an energy content factor for diesel of 38.6 gigajoules per kilolitre (GJ/kL). Greenhouse gas emission factors and energy content for diesel were sourced from the NGA Factors (**DCCCEE, 2013**). The estimated annual and project total GHG emissions from diesel usage are presented in **Table 12.3**.

Table 12.3: Estimated CO_2-e (tonnes) for On-site Diesel Consumption

Year	ROM (Mtpa)	Emission Factor (kg CO_2-e/GJ		Energy Content (GJ/kL)	Emissions (t CO_2-e)		Total
		Scope 1	Scope 3		Scope 1	Scope 3	
Year 1	1.8	69.9	5.3	38.6	25,025	1,897	26,923
Year 2	2.2	69.9	5.3	38.6	30,466	2,310	32,776
Year 3	2.3	69.9	5.3	38.6	30,823	2,337	33,160
Year 4	2.4	69.9	5.3	38.6	33,355	2,529	35,884
Total	**8.8**				**119,670**	**9,074**	**128,743**

12.5.3 Electricity

Greenhouse gas emissions from electricity usage were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from electricity usage	(tCO_2-e/annum)
Q	=	Estimated electricity usage	(kWh/annum)[1]
EF	=	Emission factor (Scope 2 or Scope 3) for electricity usage	(kgCO_2-e/kWh)[2]

[1] kWh/annum = kilowatt hours per annum
[2] kgCO_2-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

The quantity of electricity used each year is based on a derived intensity rate (kWh/Mtpa ROM) derived from the 2009 annual electricity consumption provided by Coalpac (1,483,306 kilowatt hours [kWh]) and ROM rate of 1.5 Mtpa for 2009). Greenhouse gas emission factors were sourced from the NGA Factors (**DCCEE, 2013**). The estimated annual and project total GHG emissions from electricity usage are presented in **Table 12.4**.

Table 12.4: Estimated CO_2-e (tonnes) for On-site Electricity Use

Year	ROM (Mtpa)	Emission Factor (kg CO_2-e/kWh)		Emissions (t CO_2-e)		Total
		Scope 2	Scope 3	Scope 2	Scope 3	
Year 1	1.8	0.87	0.19	2,368	517	2,885
Year 2	2.2	0.87	0.19	2,883	630	3,512
Year 3	2.3	0.87	0.19	2,916	637	3,553
Year 4	2.4	0.87	0.19	3,156	689	3,845
Total	**8.8**			**11,322**	**2,473**	**13,795**

12.5.4 Fugitive Emissions

Fugitive emissions were estimated based on the using the following equation:

$$E_{co2-e} = Q \times EF$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from fugitive emissions	(t CO_2-e/annum)
Q	=	ROM coal extracted during the year	(t)
EF	=	Site Specific Emission Factor	(t CO_2-e/tonne)

A site specific emission factor for fugitive methane has been derived based on measurements of gas content for boreholes samples taken for each coal seam by GeoGAS and CSG Partners. These data are shown in their raw format in **Appendix F**. Measurements of less than 0.3 m^3/t were below the adopted Limit of Detection (see **Geos Mining Memorandum, 2011**) and were therefore treated as 0 m^3/t.

The measured gas content in m^3/t was converted to t CO_2-e / t using the measured % gas composition (reported for CH_4 and CO_2) and using the conversion factors reported in the NGERs Technical Guidelines (**DCC, 2009**) to convert from m^3 to CO_2-e tonnes, as follows:

- For methane – $6.784 \times 10^{-4} \times 21$
- For CO_2 – 1.861×10^{-3}

The derived site specific emission factor and estimated annual and project total GHG emissions from fugitive emissions are presented in **Table 12.5**.

Table 12.5: Estimated CO_2-e (tonnes) for Fugitive Emissions

Year	ROM (Mtpa)	Site Specific EF (t CO_2-e/t)	Total Emission (t CO_2-e)
Year 1	1.8	0.001	1,242
Year 2	2.2	0.001	1,512
Year 3	2.3	0.001	1,529
Year 4	2.4	0.001	1,655
Total	**8.8**		**5,937**

12.5.5 Explosives

Emissions from explosive usage were estimated based on the using the following equation:

$$E_{co2-e} = Q \times EF$$

where:

E_{CO2-e}	=	Emissions of greenhouse gases from explosives	(tCO_2-e/annum)
Q	=	Quantity of explosive used (assumed ANFO)	(t)
EF	=	Scope 1 emission factor	(tCO_2-e/tonne explosive)

Greenhouse gas emission factors were sourced from the Australian Greenhouse Office (AGO) Factors and Methods Workbook – December 2006. It is noted that the AGO Factors and Methods were replaced by the NGA Factors (**DCCEE, 2013**), however the emission factor for explosives was dropped from the latest version. Emissions from explosives do not have to be reported under NGERS.

The estimated annual and project total GHG emissions from explosive usage are presented in **Table 12.6**.

Table 12.6: Estimated CO_2-e (tonnes) for Explosive Use

Year	ROM (Mtpa)	Emission Factors (t CO_2 / tonne product) ANFO	Scope 1 Emissions (t CO_2-e)
Year 1	1.83	0.167	251
Year 2	2.23	0.167	306
Year 3	2.260	0.167	309
Year 4	2.445	0.167	335
Total	**8.8**		**1,201**

12.5.6 Other Scope 3 Emissions

12.5.6.1 Staff Transportation

Emissions from staff transport to/from the Modifications were based on the following assumptions:

- Conservative assumption of 120 full time employees.
- Maximum of a 60 km return trip per employee (conservatively assumed as the average of distances for staff over a variety of suburbs).
- Conservatively assumed that each employee travels individually and in a Ford Falcon with a fuel consumption rate equivalent to that of an urban area (N.B: Vehicle type assumed to be the highest fuel consumer in the top 20 list of popular vehicles in Australia; see http://www.greenvehicleguide.gov.au/GVGPublicUI/SearchResults.aspx.
- Conservatively assumed that each employee travels 365 days a year to work.
- Each car is powered by unleaded petrol.

- The estimated annual and project total GHG emissions from staff transportation are presented in **Table 12.7**.

Table 12.7: Estimated CO_2-e (tonnes) for Staff Transportation

Year	Diesel (kL)	Emission Factor (kg CO_2-e/GJ		Energy Content (GJ/kL)	Emissions (t CO_2-e)		Total
		Scope 1	Scope 3		Scope 1	Scope 3	
Year 1	486	2.3	0.2	38.6	43	4	47
Year 2	486	2.3	0.2	38.6	43	4	47
Year 3	486	2.3	0.2	38.6	43	4	47
Year 4	486	2.3	0.2	38.6	43	4	47
Total	**1,945**				**172**	**15**	**187**

12.5.6.2 Burning Product Coal

Greenhouse gas emissions from the burning of product coal were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EC \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from coal combustion	(t CO_2-e)
Q	=	Quantity of product coal burnt	(GJ)
EC	=	Energy Content Factor for black coal	(GJ/t)[1]
EF	=	Emission factor for coal combustion	(kg CO_2-e/GJ)

[1] GJ/t = gigajoules per tonne

The quantity of coal burnt in Mtpa is converted to GJ using an energy content factor for coal of 23 GJ/t. The greenhouse gas emission factor was sourced from the NGA Factors (**DCCEE, 2013**). The energy content factor was calculated and provided by Coalpac as site-specific data (**Communication with Hansen Bailey, 2011**).

The emissions associated with burning of the product coal are presented in **Table 12.8**.

Table 12.8: Scope 3 Emissions for Product Coal

Year	Product Coal (Mtpa)	Energy Content (GJ/t)	EF (kg CO_2 e/GJ)	Scope 3 Emissions (t CO_2-e)
Year 1	1.8	23	88	3,638,407
Year 2	2.2	23	88	4,474,558
Year 3	2.2	23	88	4,474,559
Year 4	2.2	23	88	4,474,559
Total	**8.4**			**17,062,083**

12.6 Summary of Greenhouse Gas Emissions

A summary of the annual GHG emissions is provided in **Table 12.9**.

Table 12.9: Summary of Estimated CO_2-e (tonnes) – All Scopes

Year	Scope 1 Emissions (t CO_2-e)					Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)			
	Diesel	Fugitive Methane	Staff Travel	Blasting	*Total*	Electricity	Staff Transport	Diesel	Electricity	Energy Production
1	25,025	1,242	43	251	*26,561*	2,368	4	1,897	517	3,638,407
2	30,466	1,512	43	306	*32,327*	2,883	4	2,310	630	4,474,558
3	30,823	1,529	43	309	*32,704*	2,916	4	2,337	637	4,474,559
4	33,355	1,655	43	335	*35,388*	3,156	4	2,529	689	4,474,559
Total	**119,670**	**5,937**	**172**	**1,201**	**126,980**	**11,322**	**15**	**9,074**	**2,473**	**17,062,083**

12.7 Greenhouse Gas Emissions Intensity

The estimated Scope 1 GHG emissions intensity of the Proposal is approximately 0.015 t CO_2-e/t saleable coal. The estimated emissions intensity of the Proposal is comparable with the emissions intensity of existing open-cut coal mines in Australia (**Deslandes, 1999**).

Figure 12.3 (derived from **Deslandes, 1999**) shows the GHG intensity of the Proposal compared to other Australian coal mines. The emissions intensity is well below the range for gassy underground mines and low for open cut mines.

The largest source of scope 1 GHG emissions are diesel emissions (94.1%) followed by emissions from fugitive methane (52.4%) (refer **Table 12.9**).

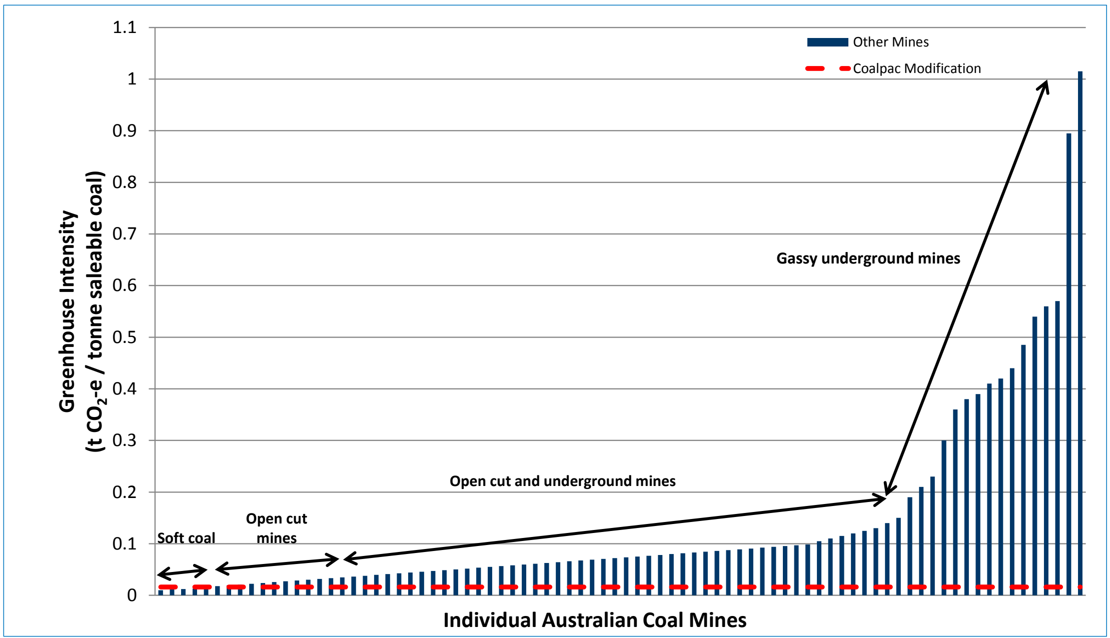


Figure 12.3: GHG Intensity Comparison

12.8 Impact on the Environment

According to the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report, global surface temperature has increased by 0.89°C ± 0.2°C during the 100 years ending 2012 (**IPCC, 2013**). The IPCC has determined "most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations". "Very likely" is defined by the IPCC as greater than 90% probability of occurrence (**IPCC, 2013**).

Climate change projections specific to Australia have been determined by the CSIRO, based on the following global emissions scenarios predicted by the IPCC (**CSIRO, 2007**):

- A1F1 (high emissions scenario) – assumes very rapid economic growth, a global population that peaks in mid-century and technological change that is fossil fuel intensive.
- A1B (mid emissions scenario) – assumes the same economic and population growth as A1F1, with a balance between fossil and non-fossil fuel intensive technological changes.
- B1 (low emissions scenario) – assumes the same economic and population growth as A1F1, with a rapid change towards clean and resource efficient technologies.

For the global emissions scenarios described above, the projected changes in annual temperature relative to 1990 levels for Australian cities for 2030 and 2070 are presented in **Table 12.10** as determined by the CSIRO (2007). The towns/cities presented in **Table 12.10** are those closest to the Modifications for which results are available.

Table 12.10: Projected Changes in Annual Temperature (relative to 1990)

Location	2030 - A1B (mid-range emissions scenario)	2070 - B1 (low emissions scenario)	2070 - A1F1 (high emissions scenario)
	Temperature (°C)		
Brisbane	0.7 - 1.4	1.1 - 2.3	2.1 - 4.4
Dubbo	0.7 - 1.5	1.2 - 2.5	2.2 - 4.8
St George (Queensland)	0.7 - 1.6	1.2 - 2.7	2.4 - 5.2
Sydney	0.6 - 1.3	1.1 - 2.2	2.1 - 4.3

Notes: Range of values represents the 10th and 90th percentile results.
For 2030, only A1B results are shown as there is little variation in projected results for the global emission scenarios A1B, B1 and A1F1 (CSIRO, 2007).

Source: CSIRO (2007) Climate Change in Australia – Technical Report 2007, Commonwealth Scientific and Industrial Research Organisation.

The CSIRO also details projected changes to other meteorological parameters (for example rainfall, potential evaporation, wind speed, relative humidity and solar radiation) and the predicted changes to the prevalence of extreme weather events (for example droughts, bush fires and cyclones).

The potential social and economic impacts of climate change to Australia are detailed in the Garnaut Climate Change Review (**Garnaut, 2008**), which draws on IPCC assessment work and the CSIRO climate projections. The Garnaut review details the negative and positive impacts associated with predicted climate change with respect to:

- Agricultural productivity.
- Water supply infrastructure.
- Urban water supplies.
- Buildings in coastal settlements.
- Temperature related deaths.
- Ecosystems and biodiversity.
- Geopolitical stability and the Asia Pacific region.

The Modifications' contributions to projected climate change, and the associated impacts, would be in proportion with its contribution to global GHG emissions. Average annual scope 1 emissions from the

Modifications (0.03 million tonnes [Mt] CO_2-e) would represent approximately 0.01% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (**Commonwealth of Australia, 2011**). On this basis the Modifications would have a very small impact on National and Global Greenhouse Gas Emissions.

A comparison of predicted annual GHG emissions from the Modifications with global, Australian and NSW emissions inventories are presented in **Table 12.11**.

Table 12.11: Comparison of Greenhouse Gas Emissions

Geographic coverage	Source coverage	Timescale	Emission Mt CO_2-e	Reference
Modifications	Scope 1 only	Average annual	0.03	This report.
Global	Consumption of fossil fuels	Total since industrialisation 1750 - 1994	865,000	IPCC (2007a). Figure 7.3 converted from Carbon unit basis to CO_2 basis. Error is stated greater than ±20%.
Global	CO_2-e emissions	2005	35,000	Based on Australia representing 1.5% of global emissions (Commonwealth of Australia, 2011). Australian National Greenhouse Gas Inventory (2005) taken from http://www.ageis.greenhouse.gov.au/
Global	CO_2-e emission increase 2004 to 2005	2005	733	IPCC (2007a).From tabulated data presented in Table 7.1 on the basis of an additional 733 Mt/a. Data converted from Carbon unit basis to CO2 basis.
Australia	1990 Base	1990	547.7	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/
Australia	Kyoto target	Average annual 2008 - 2012	591.5	Based on 1990 net emissions multiplied by 108% Australia's Kyoto emissions target.
Australia	Total	2009	564.5	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/
NSW	Total	2009	160.5	Taken from the National Greenhouse Gas Inventory (2009) http://www.ageis.greenhouse.gov.au/

The commitment from the Australian Government to reduce GHG emissions is proposed to be achieved through the introduction of the Australian Government's proposed *Direct Action Plan*. This would involve a 'baseline and credit' approach whereby businesses that reduce their emissions below their baseline have the opportunity to offer abatement for sale to the government (**LPA, 2010**).

12.9 Greenhouse Gas Management

Coalpac has plans and standards to minimize energy usage and GHG emissions from its operations, including those proposed for the Modifications. Reasonable and feasible measures will be implemented on-site to minimise greenhouse gas emissions of the Modifications and ensure that Invincible Colliery and Cullen Valley Mine are energy efficient. These measures include objectives, commitments, procedures and responsibilities for:

- Monitoring and improving energy use and efficiency and reducing GHG emissions from the mining, and processing of coal.
- Consideration of the use of alternative fuels where economically and practically feasible.
- Review of mining practices to minimise double handling of materials and ensuring that coal and overburden haulage is undertaken using the most efficient routes.
- Ongoing scheduled and preventative maintenance to ensure that diesel and electrically powered plant operate efficiently.
- Develop targets for greenhouse gas emissions and energy use onsite and monitor and report against these.

Coalpac has already committed to ensuring that certain GHG measures continue to be implemented for the Modifications. These site specific measures are listed in **Table 12.12** and will continue to be implemented at Invincible Colliery and Cullen Valley Mine during the life of the Modifications, along with consideration of the reasonable and feasible measures listed above.

Table 12.12: Greenhouse Gas Management Measures

Management Measure	Implementation Date
Ensuring that there is a dedicated number of trucks for each digging unit (i.e. front-end-loader and excavator) to minimise truck wait time.	Ongoing
Ensuring that dump trucks are fully loaded for each load prior to hauling to maximise productivity and efficiency with regard to the amount of fuel used per unit of material moved. This is measured by the number of buckets loaded into each truck.	Ongoing
Review haul road maintenance and materials used in main haul roads to reduce rolling resistance and decrease fuel consumption.	Ongoing

13 CONCLUSIONS

Pacific Environment has completed an Air Quality Assessment for the proposed Modifications.

Cullen Valley Mine and Invincible Colliery mine plans for the 'worst-case' emission year (Year 2) have been analysed and detailed emissions inventories have been prepared. Dispersion modelling was conducted to predict the ground level concentrations for all relevant pollutants.

Cumulative impacts were also considered, taking into account other non-modelled sources using conservative estimates of background levels. Model predictions at privately owned residential and other Coalpac owned receptors were compared with applicable air quality criteria.

Dispersion modelling results indicate that PM_{10} concentrations were predicted to exceed the 24-hour average criterion of 50 µg/m^3 at one Coalpac owned receptor (396). There were no predicted exceedances of any of the annual average criteria at sensitive receptors.

A Monte Carlo Simulation was completed to assess cumulative PM_{10} and $PM_{2.5}$ 24-hour impacts at the nearest receptor locations. The analysis identified three Coalpac owned receptors (393, 394 and 396) that may potentially exceed the 24-hour average PM_{10} cumulative criteria of 50 µg/m^3. No additional exceedances of the advisory reporting standard for 24-hour $PM_{2.5}$ were predicted at those residences, and there were no predicted exceedances of the 24-hour average PM_{10} criterion of 150 µg/m^3.

This assessment has taken a conservative approach by considering the worst case operating conditions at Invincible Colliery and Cullen Valley Mine and assuming conservative background levels. Notwithstanding, dust controls will remain a key part of the operation. Day-to-day dust management will continue to form a significant part of the standard operating procedures at both sites to keep both emissions and resulting ground level concentrations as low as possible during the operations proposed for the Modifications.

14 REFERENCES

Australian Government (2011)
http://www.cleanenergyfuture.gov.au/clean-energy-future/securing-a-clean-energy-future/

BoM (2013)
Climatic Averages Australia, Bureau of Meteorology website
http://www.bom.gov.au/climate/averages/

Buonicore and Davis (1992)
"Air Pollution Engineering Manual", Air and Waste Management Association. Edited by Anthony J. Buonicore and Wayne T. Davis.

DCCEE (2013)
"National Greenhouse Account (NGA) Factors". Published by the Department of Climate Change and Energy Efficiency. July 2013. http://www.climatechange.gov.au/

Deslandes (1999)
"Energy/Greenhouse Benchmarking Study of Coal Mining Industry, a study undertaken for Mineral Resources and Energy Program, Australian Geological Survey Organisation & Energy Efficiency Best Practice Program". Department of Industry, Science and Resources.

Donnelly S-J, Balch A, Wiebe A, Shaw N, Welchman S, Schloss A, Castillo E, Henville K, Vernon A and Planner J (2010).
"NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and / or Minimise Emissions of Particulate Matter from Coal Mining", Prepared by Katestone Environmental Pty Ltd for NSW Office of Environment and Heritage, December 2010.

EPA (2005)
"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", August 2005

Hurley, P. (2008)
"TAPM V4. Part 1: Technical Description, CSIRO Marine and Atmospheric Research Paper".

Hurley, P., M. Edwards, et al. (2009)
"Evaluation of TAPM V4 for Several Meteorological and Air Pollution Datasets." Air Quality and Climate Change 43(3): 19.

LPA (2010)
"The Coalition's Direct Action Plan Policy", Liberal Party Australia, 2010.
http://www.liberal.org.au/~/media/Files/Policies%20and%20Media/Environment/The%20Coalitions%20Direct%20Action%20Plan%20Policy.ashx

LPA (2011)
"Tony Abbott's response to Labor's big new Carbon Tax", Liberal Party Australia, 2011.
http://www.saliberal.org.au/Video/TabId/144/VideoId/27/Tony-Abbotts-Response-To-Labors-Big-New-Carbon-Tax.aspx

NEPC (1998a)
"Ambient Air – National Environment Protection Measures for Ambient Air Quality" National Environment Protection Council, Canberra

NEPC (1998b)
"National Environmental Protection Measure and Impact Statement for Ambient Air Quality". National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.

NEPC (2003)
"Variation to the National Environment Protection (Ambient Quality) Measure for Particles as TSP", May 2003.

OEH (2011)
‘Coal Mine Particulate Matter Control Best Practice - Site-Specific Determination Guideline. November 2011’. New South Wales Office of Environment and Heritage, Sydney. November 2011. http://www.environment.nsw.gov.au/resources/air/20110813coalmineparticulate.pdf

OLDP (2007),
“National Greenhouse and Energy Reporting Act 2007”, Office of Legislative Drafting and Publishing, Attorney-General’s Department, Canberra, Australia

OLDP (2008)a
“National Greenhouse and Energy Reporting Regulations 2008”, Office of Legislative Drafting and Publishing, Attorney-General’s Department, Canberra, Australia

OLDP (2008)b
“National Greenhouse and Energy Reporting (Measurement) Determination 2008”, Office of Legislative Drafting and Publishing, Attorney-General’s Department, Canberra, Australia

OLDP (2009)
“National Greenhouse and Energy Reporting (Audit) Determination 2009”, Office of Legislative Drafting and Publishing, Attorney-General’s Department, Canberra, Australia

Phalen R.F, R.G. Cuddihy, G.L. Fisher, O.R. Moss, R.B. Schlessinger, D.L. Swift, H. C. Yeh (1991)
“Main Features of the Proposed NCRP Respiratory Tract Model,” *Radiat. Protect. Dosim. 38:179-184* (1991).

Scire, J.S., Strimaitis, D.G. & Yamartino, R.J. (2000)
A User’s Guide for the CALPUFF Dispersion Model (Version 5), Earth Tech, Inc., Concord.

US EPA (1985)
“Compilation of Air Pollutant Emission Factors”, AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711

US EPA (1987)
Update of fugitive dust emission factors in AP-42 Section 11.2, EPA Contract No. 68-02-3891, Midwest Research Institute, Kansas City, MO, July 1987.

US EPA (1993)
AP42 Emission Factor Database, “Appendix C.1 Procedures for sampling surface/bulk dust loading” and “Appendix C.2 Procedures for laboratory analysis of surface/bulk dust loading samples”.

US EPA (2006)
AP-42 Emission Factors Section 13.2.2 Unpaved Roads.

WRI/WBCSD (2004).
“The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition March 2004”.

Appendix A Emission Factor Equations and Calculations

The dust emission inventories have been prepared for each modelling year using the operational description of the proposed modification.

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below. With the exception of blasting, activities have been modelled for 24 hours per day.

Dust from wind erosion is assumed to occur over 24-hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This will mean that most wind erosion occurs during the day when wind speeds are highest.

Drilling overburden

Emissions from drilling were estimated using the US EPA AP42 emission factor given below.

$E_{TSP} = 0.59$ kg/blast

Blasting overburden

Emissions from blasting were estimated using the US EPA AP42 emission factor given below.

$E_{TSP} = 0.00022 \times A^{1.5}$ kg/blast

Where:
A = area to be blasted in m^2

Loading material / dumping overburden

Each tonne of material loaded will generate a quantity of dust that will depend on the wind speed and the moisture content. The equation below shows the relationship between these variables and the appropriate k-factor for each particle size fraction.

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

Where:
k = 0.74 for TSP
U = wind speed (m/s)
M = moisture content (%)

Hauling material / product on unsealed surfaces

The emission estimates of wheel generated dust are based the US EPA AP42 emission factor equation for unpaved surfaces at industrial sites, as shown below.

$E_{TSP} = (0.4536/1.6093) \times 4.9 \times (s/12)^{0.7} \times ((W/1.1023)/3)^{0.45}]$ kg/VKT

Where:
S = silt content of road surface
W = mean vehicle weight in metric tonnes

The mean vehicle weight used in the emissions estimates is an average of the loaded and unloaded gross vehicle mass, to account for one empty trip and one loaded trip.

A control factor of 85% has been applied for watering and the use of chemical suppressants on unpaved roads.

Dozers working on overburden

Emissions from dozers on overburden have been calculated using the US EPA AP-42 emission factor equation shown below.

$E_{TSP} = 2.6 \times (s^{1.2}/M^{1.3})$ kg/hour

Where:
S = silt content (%)
M = moisture (%)

Dozers working on coal

Emissions from dozers on coal have been calculated using the US EPA AP-42 emission factor equation shown below.

$E_{TSP} = 35.6 \times (s^{1.2}/M^{1.3})$ kg/hour

Where,
S = silt content (%)
M = moisture (%)

Loading/unloading coal

The US EPA AP42 emission factor equation is shown below.

$E_{TSP} = 0.580 / M^{1.2}$ kg/t

Where,
M = moisture (%)

Wind erosion

The default US EPA AP42 emission factors for wind erosion on exposed surfaces are shown below.

$E_{TSP} = 0.1$ kg/ha/h

Grading roads

Estimates of emissions from grading roads have been made using the US EPA AP42 emission factor equations as shown below.

$E_{TSP} = 0.0034 \times S^{2.5}$ kg/km

Where,
S = speed of the grader in km/h (taken to be 8 km/h)

The following tables provide a summary of the variables used to calculate TSP emissions for each modelling year. These variables include such things as haul road distances, silt and moisture contents vehicle payloads, vehicle weights and the volumes of material handled. Similar tables for PM_{10} and $PM_{2.5}$ can be provided if required, but will include the same variables. The differences between the particle size fractions are in the emission equations themselves which have been provided above.

Table A-1: TSP emission estimates for Cullen Valley Mine and Invincible Colliery

ACTIVITY	TSP emission in kg/y	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units	Control Assumed
CULLEN VALLEY MINE OPERATIONS																		
CV: Topsoil Removal - Dozers/Excavators stripping topsoil	51	20	h/y	2.6	kg/h	6.3	silt content in %	5.6	moisture content in %							0	% control	
CV: OB - Drilling Overburden	7,670	13,000	holes/y	0.59	kg/hole											0	% control	
CV: OB - Blasting Overburden	7,778	100	blasts/y	77.78	kg/blast	5,000	Area of blast in square metres	130	holes/blast							0	% control	
CV: OB - Dozers in pit, push to fill	6,958	2,430	h/y	2.863	kg/h	4.8	silt content in %	4.0	moisture content in %							0	% control	
CV: OB - Loading Overburden	9,260	11,032,967	t/y	0.0008	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	4.0	moisture content in %							0	% control	
CV: OB - Hauling to CV dump	44,528	11,032,967	t/y	0.0202	kg/t	150	t/load	175	Vehicle gross mass (t)	0.9	km/return trip	3.22	kg/VKT	2.8	% silt content	80	% control	
CV: OB - Unloading Overburden to dump	9,260	11,032,967	t/y	0.001	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	4.0	moisture content in %							0	% control	
CV: OB - Dozers on o/b	6,958	2,430	h/y	2.863	kg/h	4.8	silt content in %	4.0	moisture content in %							0	% control	
CV: CL - Loading coal into trucks	52,324	900,081	t/y	0.058	kg/t	6.8	moisture content in %									0	% control	
CV: CL - Hauling coal to ROM crusher stockpile	6,881	740,676	t/y	0.04645	kg/t	90	t/load	110	Vehicle gross mass (t)	1.6	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
CV: CL - Hauling coal to ROM to CHPP	8,330	159,405	t/y	0.26130	kg/t	90	t/load	110	Vehicle gross mass (t)	9.0	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
CV: CL - Unloading coal to ROM crusher stockpile	43,057	740,676	t/y	0.058	kg/t	6.8	moisture content in %									0	% control	
CV: CL - Rehandle coal to crusher	21,529	740,676	t/y	0.058	kg/t	6.8	moisture content in %									50	% control	Water sprays
CV: CL - Crushing	222	740,676	t/y	0.0006	kg/t											50	% control	Water sprays
CV: CL - Loading crushed coal to stockpile	291	740,676	t/y	0.0004	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	6.8	moisture content in %							0	% control	
CV: CL - Loading crushed coal to trucks	291	740,676	t/y	0.0004	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	6.8	moisture content in %							0	% control	
CV: CL - Hauling crushed coal off-site	32,686	740,676	t/y	0.22065	kg/t	90	t/load	110	Vehicle gross mass (t)	7.6	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
CV: WE - Active Mining Area	8,375	9.6	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
CV: WE - Dumps area	4,744	5.4	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
CV: WE - Main ROM stockpiles	758	1.7	ha	0.1	kg/ha/h	8,760	h/y									50	% control	Water sprays
CV: Grading roads	2,991	9,720	km	0.6	kg/km	8	speed of graders in km/h	1,215	h/y							50	% control	
INVINCIBLE COLLIERY OPERATIONS																		
IN: Topsoil Removal - Dozers/Excavators stripping topsoil	29	20	h/y	1.4	kg/h	5.4	silt content in %	7.4	moisture content in %							0	% control	
IN: OB - Drilling Overburden	7,670	13,000	holes/y	0.59	kg/hole											0	% control	
IN: OB - Blasting Overburden	7,778	100	blasts/y	77.78	kg/blast	5,000	Area of blast in square metres	130	holes/blast							0	% control	
IN: OB - Dozers in pit, push to fill	7,002	4,860	h/y	1.441	kg/h	3.8	silt content in %	5.4	moisture content in %							0	% control	
IN: OB - Loading Overburden (Pit 221 - Southern)	4,427	8,172,644	t/y	0.0005	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.4	moisture content in %							0	% control	
IN: OB - Loading Overburden (Pit 223 - Eastern)	429	791,219	t/y	0.0005	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.4	moisture content in %							0	% control	
IN: OB - Loading Overburden (Pit 224 - Northern)	4,533	8,368,269	t/y	0.0005	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.4	moisture content in %							0	% control	
IN: OB - Hauling to dump (Pit 221)	35,089	8,172,644	t/y	0.0215	kg/t	150	t/load	175	Vehicle gross mass (t)	1.0	km/return trip	3.22	kg/VKT	2.8	% silt content	80	% control	
IN: OB - Hauling to dump (Pit 223)	1,359	791,219	t/y	0.0086	kg/t	150	t/load	175	Vehicle gross mass (t)	0.4	km/return trip	3.22	kg/VKT	2.8	% silt content	80	% control	
IN: OB - Hauling to dump (Pit 224)	25,150	8,368,269	t/y	0.0150	kg/t	150	t/load	175	Vehicle gross mass (t)	0.7	km/return trip	3.22	kg/VKT	2.8	% silt content	80	% control	
IN: OB - Unloading Overburden to dump (Pit 221)	4,427	8,172,644	t/y	0.001	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.4	moisture content in %							0	% control	
IN: OB - Unloading Overburden to dump (Pit 223)	429	791,219	t/y	0.001	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.4	moisture content in %							0	% control	
IN: OB - Unloading Overburden to dump (Pit 224)	4,533	8,368,269	t/y	0.001	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.4	moisture content in %							0	% control	
IN: OB - Dozers on o/b	10,503	7,290	h/y	1.441	kg/h	3.8	silt content in %	5.4	moisture content in %							0	% control	
IN: CL - Loading coal into trucks (Pit 221)	37,797	786,246	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Loading coal into trucks (Pit 223)	6,180	128,549	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Loading coal into trucks (Pit 224)	25,693	534,472	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Hauling coal to ROM crusher stockpile (Pit 221)	13,513	684,489	t/y	0.09871	kg/t	90	t/load	110	Vehicle gross mass (t)	3.4	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Hauling coal to ROM crusher stockpile (Pit 223)	1,720	92,562	t/y	0.09291	kg/t	90	t/load	110	Vehicle gross mass (t)	3.2	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Hauling coal to ROM crusher stockpile (Pit 224)	9,572	457,893	t/y	0.10452	kg/t	90	t/load	110	Vehicle gross mass (t)	3.6	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Hauling coal ROM to CHPP (Pit 221)	886	101,757	t/y	0.04355	kg/t	90	t/load	110	Vehicle gross mass (t)	1.5	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Hauling coal ROM to CHPP (Pit 223)	1,087	35,987	t/y	0.15097	kg/t	90	t/load	110	Vehicle gross mass (t)	5.2	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Hauling coal ROM to CHPP (Pit 224)	2,668	76,580	t/y	0.17420	kg/t	90	t/load	110	Vehicle gross mass (t)	6.0	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Unloading coal to ROM crusher stockpile	59,367	1,234,944	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Rehandle coal to crusher	29,683	1,234,944	t/y	0.048	kg/t	8.0	moisture content in %									50	% control	Water sprays
IN: CL - Crushing	370	1,234,944	t/y	0.0006	kg/t											50	% control	Water sprays
IN: CL - Loading crushed coal to stockpile	388	1,234,944	t/y	0.0003	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	8.0	moisture content in %							0	% control	
IN: CL - Loading crushed coal to trucks	59,367	1,234,944	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Hauling crushed coal off-site	18,644	1,234,944	t/y	0.07549	kg/t	90	t/load	110	Vehicle gross mass (t)	2.6	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: CL - Unloading CV coal at CHPP	7,663	159,405	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Unloading INV coal at CHPP	10,303	214,324	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Loading washed product coal to stockpiles	158	280,297	t/y	0.0006	kg/t	1.838	average of (wind speed/2.2)^1.3 in m/s	5.3	moisture content in %							0	% control	
IN: CL - Loading product coal to trucks	13,475	280,297	t/y	0.048	kg/t	8.0	moisture content in %									0	% control	
IN: CL - Hauling rejects to dump	3,255	93,432	t/y	0.17420	kg/t	90	t/load	110	Vehicle gross mass (t)	6.0	km/return trip	2.61	kg/VKT	2.8	% silt content	80	% control	
IN: WE - Active Mining Area (Pit 221)	8,541	9.8	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
IN: WE - Active Mining Area (Pit 223)	2,759	3.2	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
IN: WE - Active Mining Area (Pit 224)	6,132	7.0	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
IN: WE - Dumps area (Pit 221)	4,932	5.6	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
IN: WE - Dumps area (Pit 223)	2,059	2.4	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
IN: WE - Dumps area (Pit 224)	4,284	4.9	ha	0.1	kg/ha/h	8,760	h/y									0	% control	
IN: WE - Main ROM and Product stockpiles	788	1.8	ha	0.1	kg/ha/h	8,760	h/y									50	% control	Water sprays
IN: Grading roads	2,991	9,720	km	0.6	kg/km	8	speed of graders in km/h	1,215	h/y							50	% control	

Appendix B Analysis Results for Site-Specific Parameterisation

Environmental - Dust Emissions

Client Coalpac Invincible
Job No 13-001
Report number 1597
Sample point Invincilble

Date sampled 25/01/2013
Date sample received 25/01/2013
Sampled in accordance with AS4264.1 NA
Sampled by: *** Macgeo

Sample date	Client Sample Identification	Moisture in Analysis* % EPA AP42 C2	Silt Content* % EPA AP42 C2	Velocity* cm/s EPA AP 42 13.2.5			Macgeo sample no.
25/01/2013	ROM COAL A	20.3	4.7	<43			L13-5886
25/01/2013	PRODUCT COAL STOCKPILE A	5.2	15.1	100			L13-5887
25/01/2013	ROM COAL INPIT A	10.0	2.9	100			L13-5888
25/01/2013	ROM COAL B	6.1	1.9	100			L13-5889
25/01/2013	PRODUCT COAL STOCKPILE B	5.3	3.2	100			L13-5890
25/01/2013	ROM COAL INPIT B	7.8	2.7	76			L13-5891
25/01/2013	WASTE INPIT A	3.2	5.2	<43			L13-5892
25/01/2013	WASTE INPIT B	7.2	3.8	76			L13-5893
25/01/2013	OVERBURDEN CURRENT DUMP NORTH	6.2	5.5	<43			L13-5894
25/01/2013	OVERBURDEN CURRENT DUMPING SOUTH	4.6	2.1	100			L13-5895
25/01/2013	TOP SOIL NORTH PIT 203	6.5	6.4	<43			L13-5896
25/01/2013	TOP SOIL PIT 203	8.3	4.3	<43			L13-5897
25/01/2013	HAUL ROAD @ OVERBURDEN DUMP	0.7	4.7	76			L13-5898
25/01/2013	HAUL ROAD @ CRIB HUT	1.1	4.4	<43			L13-5899
25/01/2013	HAUL ROAD @ OFFICE	0.9	2.7	100			L13-5900

* Non accredited tests
*** MacQuarie Geotech takes no responsibility for correctness of sampling if sampled by client

Authorised signatory ____________________
R. Cox
Date 31/01/2013

NATA Accredited Laboratory Number: 14874

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Environmental - Dust Emissions

Client Coalpac Cullen Valley
Job No 13-001
Report number 1598
Sample point Cullen Valley

Date sampled 25/01/2013
Date sample received 25/01/2013
Sampled in accordance with AS4264.1 NA
Sampled by: *** Macgeo

Sample date	Client Sample Identification	Moisture in Analysis* % US EPA AP42 C2	Silt Content* % US EPA AP42 C2	Velocity* cm/s EPA AP 42 13.2.5			Macgeo sample no.
25/01/2013	CV ROMCOAL STOCKPILE WESTERN	6.8	3.0	100			L13-5901
25/01/2013	CV ROMCOAL STOCKPILE NORTHERN	6.6	3.8	100			L13-5902
25/01/2013	WASTE INPIT WEST SIDE	4.8	4.4	76			L13-5903
25/01/2013	WASTE INPIT EAST SIDE	6.9	5.2	100			L13-5904
25/01/2013	OVERBURDEN DUMP PIT 105	3.9	3.6	100			L13-5905
25/01/2013	OVERBURDEN DUMP PIT 106	4.0	3.8	100			L13-5906
25/01/2013	TOPSOIL NOISE BUND	5.8	3	100			L13-5907
25/01/2013	TOPSOIL NEW REHAB EASTERN SIDE	5.3	9.6	<43			L13-5908
25/01/2013	HAUL ROAD 0.7km FROM W/SHOP	0.8	1.9	76			L13-5909
25/01/2013	HAUL ROAD 1.5km FROM W/SHOP	1.0	3.3	>100			L13-5910
25/01/2013	HAUL ROAD 2.3km FROM W/SHOP	0.8	3.1	76			L13-5911

* Non accredited tests
*** MacQuarie Geotech takes no responsibility for correctness of sampling if sampled by client

Authorised signatory ____________________
R. Cox
Date 31/01/2013

NATA Accredited Laboratory Number: 14874

MACQUARIE GEOTECH

Issue 1 revision D 16/06/09

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Appendix C Predictions at All Residences – Modifications Only

Table C1: Predictions for Modifications Only (shading indicates an exceedance of the relevant criterion)

Receptor ID	24-hour Average PM2.5	24-hour Average PM10	Annual Average PM2.5	Annual Average PM10	Annual Average TSP	Dust Deposition
			Acquisition/Assessment Criterion			
	-	50 µg/m³	-	-	-	2 g/m²/month
81	0	3	0.0	0	0	0.01
86[a]	1	4	0.0	0	0	0.01
87	0	3	0.0	0	0	0.01
103	1	7	0.0	0	1	0.01
104	1	8	0.0	0	1	0.01
106	1	10	0.1	0	1	0.02
107	1	9	0.1	0	1	0.02
108	1	9	0.1	0	1	0.02
109	1	7	0.1	0	1	0.02
111A	0	3	0.0	0	0	0.01
111B	0	3	0.0	0	0	0.01
112	1	5	0.0	0	0	0.02
113	1	6	0.1	0	1	0.02
114	1	7	0.1	0	1	0.03
119	0	4	0.0	0	0	0.01
123	1	6	0.1	1	1	0.05
139	1	6	0.1	1	1	0.05
142	1	7	0.1	1	1	0.16
143	1	6	0.1	1	1	0.12
144	1	4	0.1	1	1	0.09
169[b]	2	15	0.2	1	2	0.22
171[b]	1	10	0.1	1	1	0.14
179[c]	0	2	0.0	0	1	0.02
195[cd]	1	7	0.1	1	1	0.06
196[ac]	1	7	0.1	1	1	0.06
197[bc]	1	6	0.1	1	1	0.06
198[cd]	1	6	0.1	1	1	0.06
199[cd]	1	7	0.1	1	1	0.06
205	0	2	0.1	0	1	0.03
209	0	3	0.1	0	1	0.03
210	0	3	0.1	0	1	0.04
211	0	3	0.1	0	1	0.04
216	1	7	0.1	1	1	0.06
217a[a]	1	7	0.1	1	1	0.07
217b[b]	1	7	0.1	1	1	0.07
220	1	7	0.1	1	1	0.06
223	1	7	0.1	1	1	0.06
225	1	7	0.1	1	1	0.06
227	1	6	0.1	1	1	0.06
228	1	6	0.1	1	1	0.06
229	1	6	0.1	1	1	0.06
230	1	6	0.1	1	1	0.06
231	1	6	0.1	1	1	0.06
232	1	6	0.1	1	1	0.06
235	1	7	0.1	1	1	0.07
235	1	7	0.1	1	1	0.07
236	1	7	0.1	1	1	0.07
237	1	7	0.1	1	1	0.07
238	1	7	0.1	1	1	0.07
238	1	7	0.1	1	1	0.07
239	1	7	0.1	1	1	0.07
240	1	7	0.1	1	1	0.07
242	1	7	0.1	1	1	0.07
243	1	7	0.1	1	1	0.07
245	1	7	0.1	1	1	0.07
247	1	7	0.1	1	1	0.07
248	1	7	0.1	1	1	0.07
250	1	7	0.1	1	1	0.07

Receptor ID	24-hour Average		Annual Average			Dust Deposition
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	TSP	
	Acquisition/Assessment Criterion					
	-	50 µg/m³	-	-	-	2 g/m²/month
251	1	7	0.1	1	1	0.07
253	1	7	0.1	1	1	0.07
254	1	7	0.1	1	1	0.07
254	1	7	0.1	1	1	0.07
255	1	7	0.1	1	1	0.07
256	1	7	0.1	1	1	0.07
257	1	7	0.1	1	1	0.07
258	1	10	0.1	1	2	0.07
262[a]	1	6	0.1	1	1	0.06
263	1	6	0.1	1	1	0.06
264	1	7	0.1	1	1	0.06
267	1	7	0.1	1	1	0.06
268	1	7	0.1	1	1	0.06
270	1	7	0.1	1	1	0.06
270	1	7	0.1	1	1	0.06
271	1	7	0.1	1	1	0.06
272[a]	1	7	0.1	1	1	0.06
272[a]	1	7	0.1	1	1	0.06
272[a]	1	7	0.1	1	1	0.06
272[a]	1	7	0.1	1	1	0.07
273	1	5	0.1	1	1	0.05
273	1	5	0.1	1	1	0.05
275	1	6	0.1	1	1	0.05
276	1	6	0.1	1	1	0.06
276	1	6	0.1	1	1	0.06
277	1	6	0.1	1	1	0.06
278	1	6	0.1	1	1	0.06
279	1	6	0.1	1	1	0.06
280	1	6	0.1	1	1	0.06
281	1	6	0.1	1	1	0.06
283	1	7	0.1	1	1	0.06
284	1	7	0.1	1	1	0.06
285	1	7	0.1	1	1	0.06
288	1	7	0.1	1	1	0.06
289	1	7	0.1	1	1	0.06
291	1	8	0.1	1	1	0.07
296	1	8	0.1	1	1	0.07
297	1	8	0.1	1	1	0.07
298	1	7	0.1	1	1	0.07
301	1	8	0.1	1	1	0.07
302	1	8	0.1	1	1	0.07
304	1	8	0.1	1	1	0.07
305	1	8	0.1	1	1	0.07
306	1	8	0.1	1	1	0.07
308	1	8	0.1	1	1	0.07
309	1	8	0.1	1	1	0.07
311	1	9	0.1	1	2	0.07
312	1	10	0.1	1	2	0.08
313	1	10	0.1	1	2	0.08
314	1	10	0.1	1	2	0.08
315	1	8	0.1	1	1	0.07
315	1	8	0.1	1	1	0.07
316	1	8	0.1	1	1	0.07
317	1	8	0.1	1	1	0.07
318	1	8	0.1	1	1	0.07
321	1	8	0.1	1	1	0.07
325	1	11	0.1	1	2	0.08
326	2	13	0.1	1	2	0.08
327	2	13	0.1	1	2	0.08
328	1	5	0.1	1	1	0.05

Receptor ID	24-hour Average PM2.5	24-hour Average PM10	Annual Average PM2.5	Annual Average PM10	Annual Average TSP	Dust Deposition
Acquisition/Assessment Criterion	-	*50 $\mu g/m^3$*	-	-	-	*2 g/m^2/month*
329	1	4	0.1	1	1	0.05
330	1	4	0.1	1	1	0.05
331	1	4	0.1	1	1	0.05
332	1	4	0.1	1	1	0.05
333	1	4	0.1	1	1	0.05
335	1	4	0.1	1	1	0.04
342	1	4	0.1	1	1	0.04
343	1	4	0.1	1	1	0.04
344	1	4	0.1	1	1	0.04
345	1	4	0.1	1	1	0.04
347	1	4	0.1	1	1	0.05
349	1	7	0.1	1	1	0.05
350	1	5	0.1	1	1	0.05
350	1	5	0.1	1	1	0.06
350	1	5	0.1	1	1	0.06
350	1	6	0.1	1	1	0.06
350	1	6	0.1	1	1	0.06
352	1	6	0.1	1	1	0.06
352	1	7	0.1	1	1	0.06
353	1	6	0.1	1	1	0.06
354	1	6	0.1	1	1	0.06
355	1	6	0.1	1	1	0.06
356	1	6	0.1	1	1	0.06
357	1	6	0.1	1	1	0.06
358	1	6	0.1	1	1	0.06
360[a]	1	10	0.1	1	2	0.07
364	0	3	0.1	0	1	0.02
367	0	3	0.1	0	1	0.03
368	0	4	0.1	0	1	0.02
372	0	2	0.1	0	1	0.03
373	0	4	0.1	1	1	0.04
383	1	4	0.1	0	1	0.03
384	1	5	0.1	0	1	0.02
385	1	5	0.1	0	1	0.02
386	1	4	0.1	1	1	0.03
388	0	3	0.1	1	1	0.03
391	1	4	0.1	1	1	0.04
392	1	9	0.2	1	2	0.08
393[b]	2	18	0.3	2	5	0.18
394[b]	5	39	0.5	4	8	0.38
396[b]	8	**69**	1.4	12	25	1.08
401	1	5	0.1	0	1	0.02
403	1	5	0.1	1	1	0.02
404	1	5	0.1	0	1	0.02
405	1	5	0.1	0	1	0.02
406	1	4	0.1	0	1	0.02
407	1	4	0.1	0	1	0.02
408	1	4	0.1	0	1	0.02
410	1	7	0.1	1	1	0.04
419	1	8	0.1	1	1	0.03
419	1	8	0.1	1	1	0.04
421	1	8	0.1	1	2	0.04
426	3	24	0.3	2	3	0.10

[a] Crown-owned
[b] Coalpac-owned
[c] Located within Modifications boundary
[d] Under agreement

Appendix D Predictions At All Residences – Cumulative

Table D1: Cumulative Predictions (shading indicates an exceedance of the relevant criterion)

Receptor ID	Annual Average PM2.5	PM10	TSP	Dust Deposition
	Assessment Criterion/Advisory Reporting Standard			
	25 µg/m³	30 µg/m³	90 µg/m³	4 g/m²/month
81	5	11	26	1.0
86[a]	5	11	26	1.0
87	5	11	26	1.0
103	5	11	27	1.0
104	5	11	27	1.0
106	5	11	27	1.0
107	5	11	27	1.0
108	5	11	27	1.0
109	5	11	27	1.0
111A	5	11	26	1.0
111B	5	11	26	1.0
112	5	11	26	1.0
113	5	11	27	1.0
114	5	11	27	1.0
119	5	11	26	1.0
123	5	11	27	1.0
139	5	11	27	1.1
142	5	11	27	1.2
143	5	11	27	1.1
144	5	11	27	1.1
169[b]	5	12	28	1.2
171[b]	5	11	27	1.1
179[c]	5	11	27	1.0
195[cd]	5	11	27	1.1
196[ac]	5	11	27	1.1
197[bc]	5	11	27	1.1
198[cd]	5	11	27	1.1
199[cd]	5	11	27	1.1
205	5	11	27	1.0
209	5	11	27	1.0
210	5	11	27	1.0
211	5	11	27	1.0
216	5	11	27	1.1
217a[a]	5	11	27	1.1
217b[b]	5	11	27	1.1
220	5	11	27	1.1
223	5	11	27	1.1
225	5	11	27	1.1
227	5	11	27	1.1
228	5	11	27	1.1
229	5	11	27	1.1
230	5	11	27	1.1
231	5	11	27	1.1
232	5	11	27	1.1
235	5	11	27	1.1
235	5	11	27	1.1
236	5	11	27	1.1
237	5	11	27	1.1
238	5	11	27	1.1
238	5	11	27	1.1
239	5	11	27	1.1
240	5	11	27	1.1
242	5	11	27	1.1
243	5	11	27	1.1
245	5	11	27	1.1
247	5	11	27	1.1
248	5	11	27	1.1
250	5	11	27	1.1

Receptor ID	Annual Average			
	$PM_{2.5}$	PM_{10}	TSP	Dust Deposition
	Assessment Criterion/Advisory Reporting Standard			
	25 µg/m³	*30 µg/m³*	*90 µg/m³*	*4 g/m²/month*
251	5	11	27	1.1
253	5	11	27	1.1
254	5	11	27	1.1
254	5	11	27	1.1
255	5	11	27	1.1
256	5	11	27	1.1
257	5	11	27	1.1
258	5	11	28	1.1
262[a]	5	11	27	1.1
263	5	11	27	1.1
264	5	11	27	1.1
267	5	11	27	1.1
268	5	11	27	1.1
270	5	11	27	1.1
270	5	11	27	1.1
271	5	11	27	1.1
272[a]	5	11	27	1.1
272[a]	5	11	27	1.1
272[a]	5	11	27	1.1
272[a]	5	11	27	1.1
273	5	11	27	1.1
273	5	11	27	1.1
275	5	11	27	1.1
276	5	11	27	1.1
276	5	11	27	1.1
277	5	11	27	1.1
278	5	11	27	1.1
279	5	11	27	1.1
280	5	11	27	1.1
281	5	11	27	1.1
283	5	11	27	1.1
284	5	11	27	1.1
285	5	11	27	1.1
288	5	11	27	1.1
289	5	11	27	1.1
291	5	11	27	1.1
296	5	11	27	1.1
297	5	11	27	1.1
298	5	11	27	1.1
301	5	11	27	1.1
302	5	11	27	1.1
304	5	11	27	1.1
305	5	11	27	1.1
306	5	11	27	1.1
308	5	11	27	1.1
309	5	11	27	1.1
311	5	11	28	1.1
312	5	11	28	1.1
313	5	11	28	1.1
314	5	11	28	1.1
315	5	11	27	1.1
315	5	11	27	1.1
316	5	11	27	1.1
317	5	11	27	1.1
318	5	11	27	1.1
321	5	11	27	1.1
325	5	11	28	1.1
326	5	12	28	1.1
327	5	12	28	1.1
328	5	11	27	1.0

Receptor ID	Annual Average PM2.5	PM10	TSP	Dust Deposition
	Assessment Criterion/Advisory Reporting Standard			
	25 µg/m³	30 µg/m³	90 µg/m³	4 g/m²/month
329	5	11	27	1.0
330	5	11	27	1.0
331	5	11	27	1.0
332	5	11	27	1.0
333	5	11	27	1.0
335	5	11	27	1.0
342	5	11	27	1.0
343	5	11	27	1.0
344	5	11	27	1.0
345	5	11	27	1.0
347	5	11	27	1.0
349	5	11	27	1.0
350	5	11	27	1.1
350	5	11	27	1.1
350	5	11	27	1.1
350	5	11	27	1.1
350	5	11	27	1.1
352	5	11	27	1.1
352	5	11	27	1.1
353	5	11	27	1.1
354	5	11	27	1.1
355	5	11	27	1.1
356	5	11	27	1.1
357	5	11	27	1.1
358	5	11	27	1.1
360[a]	5	11	28	1.1
364	5	11	27	1.0
367	5	11	27	1.0
368	5	11	27	1.0
372	5	11	27	1.0
373	5	11	27	1.0
383	5	11	27	1.0
384	5	11	27	1.0
385	5	11	27	1.0
386	5	11	27	1.0
388	5	11	27	1.0
391	5	11	27	1.0
392	5	12	28	1.1
393[b]	5	13	31	1.2
394[b]	5	15	34	1.4
396[b]	6	22	51	2.1
401	5	11	27	1.0
403	5	11	27	1.0
404	5	11	27	1.0
405	5	11	27	1.0
406	5	11	27	1.0
407	5	11	27	1.0
408	5	11	27	1.0
410	5	11	27	1.0
419	5	11	27	1.0
419	5	11	27	1.0
421	5	11	28	1.0
426	5	12	29	1.1

[a] Crown-owned
[b] Coalpac-owned
[c] Located within Modifications boundary
[d] Under agreement

Appendix E Land Ownership Details

Table E1: Land ownership details

BLOCK ID	LOT	DP	OWNER ID	OWNER
1	120	704711	179	JR TILLEY & DG McGRATH
2	122	704711	2	CROWN
3	82	621620	180	DESTANAG PTY LTD
4	2	748283	181	WDD & AM CLARK
5	84	755759	182	RJ ALLEN
6	2	1083114	182	RJ ALLEN
7	20	755759	183	BJ & LL SKEEN
8	77	755759	184	B & F KUHNER
9	26	755759	185	JK HUTCHISON
10	73	755759	185	JK HUTCHISON
11	13	755766	186	RS HUTCHISON
12	76	755795		NATIONAL PARKS & WILDLIFE SERVICE
13	107	755767		NATIONAL PARKS & WILDLIFE SERVICE
14	7301	1131637	2	CROWN
15	7302	1137845	2	CROWN
16	38	755759	179	JR TILLEY & DG McGRATH
17	64	661880	180	DESTANAG PTY LTD
18	7300	1131637	2	CROWN
19	11	755759	180	DESTANAG PTY LTD
20	12	755759	180	DESTANAG PTY LTD
21	59	755759	180	DESTANAG PTY LTD
22	13	755759	180	DESTANAG PTY LTD
23	56	755759	180	DESTANAG PTY LTD
24	14	755759	180	DESTANAG PTY LTD
25	7	1035759	187	O'FARRELL PASTORAL COMPANY PTY LTD
26	68	755759	188	GJ & TJ MORRIS
27	4	1035759	187	O'FARRELL PASTORAL COMPANY PTY LTD
28	5	1035759	189	PJ PERROTT
29	97	755759	190	RL KELLAM
30	98	755759	2	CROWN
31	7001	1026563	2	CROWN
32	6	1035759	187	O'FARRELL PASTORAL COMPANY PTY LTD
33	8	1035759	187	O'FARRELL PASTORAL COMPANY PTY LTD
34	100	1028251	191	RF & RA CARTER
35	18	7881	191	RF & RA CARTER
36	1	385225	5	RI & GM LARKIN
37	26	7881	5	RI & GM LARKIN
38	27	7881	192	PMG & CE PARR
39	72	755759	2	CROWN
40	54	755767	193	VA , CA , SL & JA HANTOS
41	76	755759	3	PR & KA HALL
42	A	391695	4	LARKIN PASTORAL CO PTY LTD
43	58	755759	180	DESTANAG PTY LTD
44	55	755759	180	DESTANAG PTY LTD
45	57	755759	180	DESTANAG PTY LTD
46	47	755759	2	CROWN
47	46	755759	2	CROWN
48	45	755759	2	CROWN
49	54	755759	4	LARKIN PASTORAL CO PTY LTD
50	1	951805	4	LARKIN PASTORAL CO PTY LTD
51	48	755759	2	CROWN
52	49	1094781	4	LARKIN PASTORAL CO PTY LTD
53	7	1035759	187	O'FARRELL PASTORAL COMPANY PTY LTD
54	8	1035759	187	O'FARRELL PASTORAL COMPANY PTY LTD
55	1	834137	194	CJ & MH O'FARRELL PTY LTD
56	101	1028251	195	AP & MA CONSTANTINIDES & DR GAZZARD
57	1	382576	2	CROWN (THE COUNCIL OF THE SHIRE OF BLAXLAND)
58	A	380377	196	KA & MJ KIRK
59	B	380377	196	KA & MJ KIRK
60	1	204931	197	TJ & BN GILSHENAN
61	2	204931	198	KM PRICE
62	1	735808	2	CROWN (RTA)
63	1	633720	200	RN HARRIS
64	7	755759	3	PR & KA HALL
65	10	755759	3	PR & KA HALL
66	8	755759	3	PR & KA HALL
67	9	755759	3	PR & KA HALL
68	53	755759	4	LARKIN PASTORAL CO PTY LTD
69	74	755759	4	LARKIN PASTORAL CO PTY LTD
70	11	1125934	4	LARKIN PASTORAL CO PTY LTD
71	12	1125934	4	LARKIN PASTORAL CO PTY LTD
72	1	770408	195	AP & MA CONSTANTINIDES & DR GAZZARD
73	3	755759	187	O'FARRELL PASTORAL COMPANY PTY LTD
74	94	755759	43	JC MURRAY & KL MCFARLANE

BLOCK ID	LOT	DP	OWNER ID	OWNER
75	37	755759	43	JC MURRAY & KL MCFARLANE
76	40	755759	43	JC MURRAY & KL MCFARLANE
77	41	755759	43	JC MURRAY & KL MCFARLANE
78	112	751640		NATIONAL PARKS & WILDLIFE SERVICE
79	33	1125887	46	RI , AM & GM LARKIN
80	31	572044	44	AG DICKSON
81	32	1125887	45	THE MINISTER FOR EDUCATION & TRAINING
82	66	755759	2	CROWN
83	62	755759	2	CROWN
84	61	755759	2	CROWN
85	1	744575	48	A & L TETTE
86	60	755759	2	CROWN
87	3	737188	49	BK ABRAHAMS
88	15	755767	3	PR & KA HALL
89	100	755769	3	PR & KA HALL
90	7302	1131637	2	CROWN
91	99	755769	3	PR & KA HALL
92	77	755769	3	PR & KA HALL
93	25	755769	3	PR & KA HALL
94	24	755769	3	PR & KA HALL
95	36	755759	4	LARKIN PASTORAL CO PTY LTD
96	26	755769	4	LARKIN PASTORAL CO PTY LTD
97	1	1148995	5	RI & GM LARKIN
98	87	755759	5	RI & GM LARKIN
99	88	755759	5	RI & GM LARKIN
100	99	755759	5	RI & GM LARKIN
101	4	114337	5	RI & GM LARKIN
102	5	114337	5	RI & GM LARKIN
103	10	245921	57	JR & DM CRAM
104	11	245921	47	KA THOMAS
105	9	245921	56	A & M ABOU-TOUMA
106	8	245921	56	A & M ABOU-TOUMA
107	7	245921	55	G & M GEBRAEL
108	6	245921	54	PJ & CI DI MAURO
109	5	245921	53	J , P , GG & CG PICCIONE
110	4	245921	52	J HANNOUCHE
111	23	1065421	58	A & R SALMAN
112	3	245921	52	J HANNOUCHE
113	2	245921	51	MB & AM RINGIN
114	1	245921	50	PJ & EJ ISAACSON
115	24	755759	59	GA & BS JESSEP
116	44	755759	59	GA & BS JESSEP
117	34	755759	60	P & WE TILLEY
118	1	114337	59	GA & BS JESSEP
119	10	812300	61	LN GOLDSPINK
120	11	812300	59	GA & BS JESSEP
121	86	755759	59	GA & BS JESSEP
122	1	734531	62	JL MACPHEE
123	22	1103948	64	TW & JA NOLAN
124	21	1103948	63	DW MACPHEE
125	93	755759		NATIONAL PARKS & WILDLIFE SERVICE
126	39	755759		STATE FORESTS OF NSW
127	53	755767	3	PR & KA HALL
128	1	130047	3	PR & KA HALL
129	2	130047	3	PR & KA HALL
130	77	755767	199	D BARBER
131	76	755767	199	D BARBER
132	43	755767	199	D BARBER
133	119	755769	3	PR & KA HALL
134	2	502588	3	PR & KA HALL
135	119	755769	3	PR & KA HALL
136	2	502588	3	PR & KA HALL
137	105	755769	4	LARKIN PASTORAL CO PTY LTD
138	85	755769	5	RI &GM LARKIN
139	27	755769	5	RI & GM LARKIN
140	81	755769	5	RI & GM LARKIN
141	41	755769	5	RI &GM LARKIN
142	3	734531	65	PG DESCH & KC FARRUGIA
143	4	734531	66	DB SPEIRS
144	95	755759	67	DA & DM MULDOON
145	29	755759	42	WALLERWANG COLLIERIES
146	33	664527	42	WALLERWANG COLLIERIES
147	1	796723	42	WALLERWANG COLLIERIES
148	78	755759	42	WALLERWANG COLLIERIES
149	A	421385	42	WALLERWANG COLLIERIES

BLOCK ID	LOT	DP	OWNER ID	OWNER
150	2	235194	42	WALLERWANG COLLIERIES
151	30	755759	42	WALLERWANG COLLIERIES
152	43	755759	42	WALLERWANG COLLIERIES
153	28	755759	42	WALLERWANG COLLIERIES
154	B	421385	42	WALLERWANG COLLIERIES
155	31	755759	42	WALLERWANG COLLIERIES
156	89	755759	42	WALLERWANG COLLIERIES
157	101	723771	42	WALLERWANG COLLIERIES
158	C	421385	42	WALLERWANG COLLIERIES
159	3	235194	42	WALLERWANG COLLIERIES
160	102	723771	42	WALLERWANG COLLIERIES
161	83	755759	42	WALLERWANG COLLIERIES
162	50	755759	42	WALLERWANG COLLIERIES
163	51	755759	42	WALLERWANG COLLIERIES
164	1	620791	42	WALLERWANG COLLIERIES
165	91	755759	42	WALLERWANG COLLIERIES
166	2	620791	42	WALLERWANG COLLIERIES
167	35	755759	42	WALLERWANG COLLIERIES
168	92	755759		STATE FORESTS OF NSW
169	17	755769	27	PORTLAND ROAD PASTORAL CO PTY LTD
170	59	755769	29	BE NAKHLE
171	164	755759	27	PORTLAND ROAD PASTORAL CO PTY LTD
172	96	755759		STATE FORESTS OF NSW
173	35	755769	6	RK DICKENS (PERPETUAL LEASE)
174	1	502588	6	RK DICKENS
175	126	755769	6	RK DICKENS
176	261	755769	7	GE ORELLANA
177	7301	1131640	2	CROWN
178	330	755769	6	RK DICKENS
179	1	220269	6	RK DICKENS
180	20	870537	6	RK DICKENS
181	125	755769	6	RK DICKENS
182	62	755769	6	RK DICKENS
183	49	755769	6	RK DICKENS
184	3	220269	6	RK DICKENS
185	42	755769	6	RK DICKENS
186	1	870538	6	RK DICKENS
187	7316	1142025	2	CROWN (THE STATE OF NSW)
188	36	755769	27	PORTLAND ROAD PASTORAL CO PTY LTD
189	331	46518	27	PORTLAND ROAD PASTORAL CO PTY LTD
190	332	46518	27	PORTLAND ROAD PASTORAL CO PTY LTD
191	1	1025909	27	PORTLAND ROAD PASTORAL CO PTY LTD
192	63	755769	2	CROWN (THE STATE OF NSW)
193	7005	1026565	2	CROWN (THE STATE OF NSW)
194	333	41170	34	J KNOX
195	345	720602	33	KJ BLACKLEY
196	7315	1142024	2	CROWN (THE STATE OF NSW)
197	74	755769	31	BE & CE LEISEMANN & IL &KID FOLLINGTON
198	57	744769	30	DA TILLEY
199	1	376417	30	DA TILLEY
200	3	1148418	35	R TILLEY
201	1	160808	32	KD & RL KELLAM
202	11	1093481	36	GJ KEIGHTLEY
203	2	857736	8	JR GRACEY
204	12	1093481	8	JR GRACEY
205	2	870538	9	D DINO & J SERAGLIO
206	2	870538	9	D DINO & J SERAGLIO
207	7344	1154791	2	CROWN
208	326	755769	2	CROWN
209	1	249955	68	DJ RYAN
210	2	249955	69	FC & K TILLEY
211	3	249955	70	BJ & JM FITZGERALD
212	4	249955	27	PORTLAND ROAD PASTORAL CO PTY LTD
213	5	249955	28	LITHGOW COAL CO PTY LTD
214	1	48808	28	LITHGOW COAL CO PTY LTD
215	1	528538	27	PORTLAND ROAD PASTORAL CO PTY LTD
216	348	722331	137	BM EMMOTT
217	7312	1142022	2	CROWN
218	101	1106315	98	G & BA TILLEY
219	102	1106315	99	JR TILLEY
220	3	528538	97	KL BUNYON
221	1	218896	45	THE MINISTER FOR EDUCATION & TRAINING
222	1	973647	108	CP BAINY
223	1	315600	107	RJ WHITTAKER & SR BURROWS
224	2	315600	99	JR TILLEY

BLOCK ID	LOT	DP	OWNER ID	OWNER
225	4	980222	99	JR TILLEY
226	1	944003	99	JR TILLEY
227	1	305258	106	RG WRIGHT & KL NORRIS
228	1	944657	105	AA WOODS , EJ NICHOLLS & LH FIELD
229	1	302241	105	AA WOODS , EJ NICHOLLS & LH FIELD
230	1	302242	104	CM & BA GILBERT
231	2	302240	103	J FULLER
232	1	302239	102	RM PYNE
233	1	958777	101	TE CADDIS & RM PYNE
234	1	1094180	100	S NAPOLI
235	1	626789	143	RK & SM LANE
236	2	626789	144	TJ & KO TILLEY
237	8	2284	142	MC CRANE
238	7	2284	141	DP ROCHESTER
239	6	2284	140	SG TWEEDIE
240	5	2284	139	DW & GJ McCANN
241	4	2284	77	WF FITZGERALD
242	3	2284	77	WF FITZGERALD
243	2	2284		UNREF
244	1	2284		UNREF
245	328	755769	138	M BOTFIELD
246	25	2284	139	DW & GJ McCANN
247	20	2284	157	KO & SL ROCHESTER
248	19	2284	156	PB DRAPER
249	18	2284	155	GER YOUNG
250	17	2284	155	GER YOUNG
251	16	2284	155	GER YOUNG
252	15	2284	155	GER YOUNG
253	14	2284	154	M PASZTOR
254	13	2284	153	RW SELMES
255	12	2284	152	GE LANE
256	11	2284	152	GE LANE
257	21	2284	145	DJ TILLEY
258	21	249955	146	S & H FILLA
259	20	755769	2	CROWN
260	7014	1067906	2	CROWN
261	323	755769	2	CROWN
262	142	755769	2	CROWN (THE COUNCIL OF THE CITY OF GREATER LITHGOW)
263	A	382206	109	M STONE
264	B	382206	110	RD & DJ BLACKLEY
265	144	755769	2	CROWN (THE COUNCIL OF THE SHIRE OF BLAXLAND)
266	145	755769	2	CROWN (THE COUNCIL OF THE SHIRE OF BLAXLAND)
267	150	755769	114	AW GLEESON & SA MULDOON
268	148	755769	112	EA & DM LANE
269	146	755769	111	RD BLACKLEY
270	147	755769	111	RD BLACKLEY
271	149	755769	113	CD & JD McCANN
272	82	755769	2	CROWN
273	84	755769	115	GJ & TA HUTCHISON
274	307	755769	116	JL & MB HOWDEN
275	308	755769	116	JL & MB HOWDEN
276	309	755769	33	KJ BLACKLEY (PERPETUAL LEASE)
277	310	755769	117	RJ TILLEY
278	311	755769	118	FS GILSON
279	312	755769	119	N & JA ANDERSON
280	313	755769	120	SR WILLIAMS
281	314	755769	121	SJ BROOKS
282	343	42953	122	MW MERCER
283	317	755769	122	MW MERCER
284	318	755769	123	VN & E DEVEIGNE
285	319	755769	124	E BANKS
286	320	755769	125	MB BANKS
287	321	755769	126	KD FRIPP
288	322	755769	125	MB BANKS
289	118	755769	127	NG HARRADINE
290	1	934774	177	SW HOBBY
291	1	925015	158	A & R INZITARI
292	3	925015	159	SP MAYBURY
293	1/A	13644	159	SP MAYBURY
294	2/A	13644	158	A & R INZITARI
295	3/A	13644	160	DR & JA BATTERSBY
296	4/A	13644	161	PF KENDALL
297	7	13644	162	BJ SCOTT
298	6	13644	163	PF & DM TONER
299	5/A	13644	161	PF KENDALL

BLOCK ID	LOT	DP	OWNER ID	OWNER
300	8/A	13644	146	S & H FILLA
301	9/A	13644	164	CM O'NEILL
302	10/A	13644	165	CJ CONROY
303	11/A	13644	166	AI MILLER & BS WILSON
304	12/A	13644	166	AI MILLER & BS WILSON
305	13/A	13644	166	AI MILLER & BS WILSON
306	14/A	13644	166	AI MILLER & BS WILSON
307	15/A	13644	166	AI MILLER & BS WILSON
308	16/A	13644	167	T BATES
309	17	13644	178	ME STEWART
310	18/A	13644	147	SJ BANDIERA
311	19/A	13644	148	WG BROWN
312	20/A	13644	149	LM McDONALD
313	21/A	13644	150	N VIAPHAY
314	22/A	13644	151	KR WATERS
315	1	1004175	168	KL GODDEN
316	1/B	13644	169	CE & SM DAVIS
317	2/B	13644	169	CE & SM DAVIS
318	100	1050450	170	AW HALL
319	5/B	13644	170	AW HALL
320	6/B	13644	170	AW HALL
321	20	1013496	171	N THORNE
322	21	1013496	172	J & DLA MARKOWSKI
323	22	1013496	172	J & DLA MARKOWSKI
324	23	1013496	173	P REDDAN
325	24	1013496	174	SP & SA DUGGAN
326	1	1047161	175	THE MINISTER FOR ENERGY & UTILITIES
327	2	1047161	176	J PLAYFORD
328	1	10141	86	RP HARRIS
329	2	10141	87	R BAILEY
330	3	10141	88	DJ ANNESLEY
331	4	10141	89	GJ & VC WALSH
332	5	10141	90	BN ROCHESTER
333	6	10141	91	RP DOYLE
334	7	10141	92	P WARNER & YA HARRIS
335	8	10141	92	P WARNER & YA HARRIS
336	9	10141	92	P WARNER & YA HARRIS
337	10	10141	92	P WARNER & YA HARRIS
338	11	10141	93	GJ WILLIAMS
339	12	10141	93	GJ WILLIAMS
340	13	10141	93	GJ WILLIAMS
341	14	10141	93	GJ WILLIAMS
342	15	10141	93	GJ WILLIAMS
343	16	10141	94	AG & RL WILLIAMS
344	17	10141	95	RT & VE DOBSON
345	18	10141	96	DK & K NORTHEY
346	19	10141	89	GJ & VC WALSH
347	20	10141	88	DJ ANNESLEY
348	1	1008594	71	RE GILMORE & MG & PJ BULKELEY
349	2	1008594	72	RM CRANE
350	7	1017620	128	TANWIND PTY LTD
351	1	171665	2	CROWN
352	8	1017620	129	RS SPEIRS
353	1	24575	130	JM ELLIS
354	2	24575	131	E FABITS
355	3	24575	132	MS IVEY
356	4	24575	133	DC & KT CLAYDON & JD GARRETT
357	5	24575	134	ST & CP WILSON
358	6	24575	135	RJ DUNCAN
359	112	755769	2	CROWN
360	7314	1142023	2	CROWN
361	344	46506	136	RR COLE
362	3	1008594	71	RE GILMORE & MG & PJ BULKELEY
363	112	877190	1	COALPAC PTY LTD
364	1	556504	8	JR GRACEY
365	2	556504	8	JR GRACEY
366	65	755769	2	CROWN
367	1	872187	8	JR GRACEY
368	2	827480	10	RA FULLER
369	2	872187	10	RA FULLER
370	1	1038480	16	JA , SE BYROM & DC HUTTON
371	18	249955	15	MA & JL TAYLOR
372	15	249955	76	RE GILMORE
373	16	249955	77	WF FITZGERALD
374	14	249955	73	MG BULKELEY

BLOCK ID	LOT	DP	OWNER ID	OWNER
375	13	249955	73	MG BULKELEY
376	4	1008594	73	MG BULKELEY
377	16	755769		STATE FORESTS OF NSW
378	113	877190	1	COALPAC PTY LTD
379	104	755767	39	VL CHADWICK
380	5	816995	37	LJ WALLWORK
381	4	816995	38	SG & DR BOLZAN
382	6	816995	12	DA & KL MITCHELL
383	1	620560	11	BS BRETHERTON & B CHANDWICK
384	21	633083	13	A TABONE
385	22	633083	14	CEEDIVE PTY LTD
386	3	727017	17	TJ GRIFFITHS
387	19	249955	18	JR EMBLETON KJ KELLY
388	17	249955	78	VA McFADDEN
389	7302	1142032	2	CROWN
390	12	249955	73	MG BULKELEY
391	11	249955	73	MG BULKELEY
392	10	249955	75	IG PALMER
393	8	249955	74	B & G MUENZER
394	1	860892	84	G MUENZER
395	11	614429	83	HYROCK NSW PTY LTD
396	1	180294	1	COALPAC PTY LTD
397	11	755767	40	J MENCHIN
398	50	755767	40	J MENCHIN
399	3	816995	19	PJ & TM McFADDEN
400	2	816995	20	D HART
401	1	816995	21	KG & DA NEAVES
402	7	816995	22	KJ & DK SHAW
403	1	717021	23	BR & E BROWN
404	2	717021	23	BR & E BROWN
405	3	717021	23	BR & E BROWN
406	4	717021	24	PW GRIFFITHS
407	5	717021	25	TJ & SM GRIFFITHS
408	6	717021	26	RH GRIFFITHS
409	1	728859	78	VA McFADDEN
410	7	717021	79	PJ & SL McFADDEN
411	179	755769	82	SJ & DS TAYLOR
412	177	755769	80	V & F FAVA , C ROSITANO , F TEDESCO & E TODORELLO
413	13	755769	80	V & F FAVA , C ROSITANO , F TEDESCO & E TODORELLO
414	71	755769	80	V & F FAVA , C ROSITANO , F TEDESCO & E TODORELLO
415	72	755769	82	SJ & DS TAYLOR
416	68	755769	82	SJ & DS TAYLOR
417	178	755769	81	AP & KA BROWN
418	14	755769	81	AP & KA BROWN
419	15	755769	81	AP & KA BROWN
420	281	755769	82	SJ & DS TAYLOR
421	280	755769	82	SJ & DS TAYLOR
422	38	755769	82	SJ & DS TAYLOR
423	76	755769	82	SJ & DS TAYLOR
424	73	755769	82	SJ & DS TAYLOR
425	69	755769	82	SJ & DS TAYLOR
426	186	755769	85	JWJ & SM TAYLOR
427	121	41586	40	J MENCHIN
428	100	755767	41	KJ TAYLOR
429	6	1127747	201	DELTA ELECTRICITY
430	18	751636	201	DELTA ELECTRICITY
431	52	827626	201	DELTA ELECTRICITY
432	51	827626	201	DELTA ELECTRICITY
433	50	827626	201	DELTA ELECTRICITY
434	49	827626	201	DELTA ELECTRICITY
435	18	755769	202	GW & JL & TJ & JA CLARK
435	1	248472		STATE FORESTS OF NSW
436	22	755769	202	GW & JL & TJ & JA CLARK
437	185	755769	202	GW & JL & TJ & JA CLARK
438	64	755769	202	GW & JL & TJ & JA CLARK
439	264	755769	85	JWJ & SM TAYLOR
440	263	755769	85	JWJ & SM TAYLOR
441	1	1016508	203	GW & JL CLARK
442	1	813288	201	DELTA ELECTRICITY
443	5	1127747	204	LITHGOW DISTRICT CAR CLUB INC.
444	366	740604	201	DELTA ELECTRICITY
445	362	740604	201	DELTA ELECTRICITY
446	59	751636	201	DELTA ELECTRICITY
447	5	1092737	201	DELTA ELECTRICITY
448	191	629212	201	DELTA ELECTRICITY

BLOCK ID	LOT	DP	OWNER ID	OWNER
449	1	803655	201	DELTA ELECTRICITY
450	1	702619	201	DELTA ELECTRICITY
451	5	804929	201	DELTA ELECTRICITY
452	7	804292	201	DELTA ELECTRICITY
453	48	827626	201	DELTA ELECTRICITY
454	1	999329	201	DELTA ELECTRICITY
455	2	999329	201	DELTA ELECTRICITY
456	5	999329	201	DELTA ELECTRICITY
457	4	999329	201	DELTA ELECTRICITY
458	3	999329	201	DELTA ELECTRICITY
459	46	827626	201	DELTA ELECTRICITY
460	47	827626	201	DELTA ELECTRICITY
461	45	827626	205	CENTENNIAL FASSIFERN PTY LIMITED
462	44	827626	205	CENTENNIAL FASSIFERN PTY LIMITED
463	16	751636	205	CENTENNIAL FASSIFERN PTY LIMITED
464	343	751636	205	CENTENNIAL FASSIFERN PTY LIMITED
465	12	751636	205	CENTENNIAL FASSIFERN PTY LIMITED
466	342	751636	205	CENTENNIAL FASSIFERN PTY LIMITED
467	43	827626	205	CENTENNIAL FASSIFERN PTY LIMITED
468	20	877752	205	CENTENNIAL FASSIFERN PTY LIMITED
469	1	325532	201	DELTA ELECTRICITY
470	9	804929	206	CENTENNIAL SPRINGVALE PTY LIMITED & SPRINGVALE SK KORES PTY LIMITED
471	8	804929	201	DELTA ELECTRICITY
472	42	827626	201	DELTA ELECTRICITY
473	41	827626	201	DELTA ELECTRICITY
474	1	400022	201	DELTA ELECTRICITY
475	40	827626	201	DELTA ELECTRICITY
476	38	827626	207	EHANCE PLACE PTY LIMITED
477	363	740604	2	CROWN (THE COUNCIL OF THE CITY OF GREATER LITHGOW)
478	364	740604	2	CROWN
479	22	832446	208	TRANSGRID

Appendix F Borehole Sample Data For Fugitive GHG Calculations

Table F-1: Seam Gas Testing Results

Seam	Sample no.	Depth to Top of Sample (rounded)(m)	Sample thickness (m)	Measured gas content Qm (m3/t) on an as received (raw) basis	Average gas content gas content (m3/t)
Upper Irondale C - E	CP0001 (Geogas)	3	0.43	0.06	0.26
	CP0002 (Geogas)	4	0.83	0.11	
	CP0003 (Geogas)	5	0.79	0.52	
Irondale main	CP0004 (Geogas)	10	1.09	0.59	0.50
	CP0005 (Geogas)	11	0.82	0.50	
	CP0006 (Geogas)	12	0.42	0.70	
	Gas7 (CSGP)	11	0.54	0.3	
	Gas8 (CSGP)	12	0.42	0.34	
	Gas1 (CSGP)	53	0.78	0.14	0.19
	Gas2 (CSGP)	54	0.49	0.21	
	Gas3 (CSGP)	55	0.54	0.25	
Lithgow	CP0007 (Geogas)	27	0.69	0.58	0.52
	CP0008 (Geogas)	28	0.76	0.72	
	CP0009 (Geogas)	29	0.77	0.71	
	CP0010 (Geogas)	29	0.31	0.59	
	Gas9 (CSGP)	28	0.55	0.3	
	Gas10 (CSGP)	29	0.79	0.42	
	Gas11 (CSGP)	30	0.48	0.18	
	Gas4 (CSGP)	76	0.61	0.34	0.33
	Gas5 (CSGP)	77	0.79	0.31	
	Gas6 (CSGP)	78	0.74	0.33	

Source: **GEOS Mining (2011)**

APPENDIX B

Acoustics Impact Assessment

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COALPAC PTY LTD

ACOUSTICS IMPACT ASSESSMENT

MODIFICATIONS TO CULLEN VALLEY MINE AND INVINCIBLE COLLIERY PROJECT APPROVALS

ENVIRONMENTAL IMPACT STATEMENT

REPORT J0130-75-R2
11 FEBRUARY 2014

Prepared for:
Hansen Bailey Pty Ltd
P.O. Box 473
SINGLETON NSW 2330

Prepared by:
Mark Bridges BE Mech (Hons) MAAS
Principal Consultant

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1 INTRODUCTION

Coalpac Pty Ltd (Coalpac) owns and operates the existing Invincible Colliery and Cullen Valley Mine. Invincible Colliery has been owned and operated by Coalpac since 1988 and Cullen Valley Mine was acquired by Coalpac in 2007. Each mine operates as a separate entity with separate project approvals under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Coalpac is seeking to modify both project approvals under Section 75W of the former Part 3A of the EP&A Act. These modifications are sought to facilitate the extension to the respective approved mining areas via open cut and highwall coal mining methods at each site as well as the orderly rehabilitation of the final landform in the area.

Bridges Acoustics was commissioned by Hansen Bailey on behalf of Coalpac Pty Ltd (Coalpac) to undertake a noise and vibration impact assessment for both Modifications. The purpose of this assessment is to form part of an Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support the Modification applications.

1.1 Invincible Colliery Modification

The Invincible Colliery Modification (INV MOD4) will seek approval for the following activities that are not approved under its current Project Approval (PA 07_0127):

- Extension to PA 07_0127 for four years from December 2016 to December 2020;
- Extension of 87.7 ha to areas approved for open cut mining;
- Extension of 85.7 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Installation of a water pipeline which will result in the ability to transfer water between Invincible Colliery and Cullen Valley Mine. The pipeline alignment will largely remain on or adjacent to existing access tracks within the Ben Bullen State Forest; and
- Backfilling of the residual final voids resulting from existing mining operations and the rehabilitation of areas affected by subsidence from historic underground mining operations in the area to create a free-draining final landform.

All other operational aspects including coal production and processing, coal transport, operational hours and employment would remain consistent with operations approved under PA 07_0127.

1.2 Cullen Valley Mine Modification

The Cullen Valley Mine Modification (CV MOD2) will seek approval for the following activities that are not approved under its current Development Approval (DA 200-5-2003):

- Extension of 61.9 ha to areas approved for open cut mining;
- Extension of 78.6 ha to areas approved for highwall mining. These highwall mining operations will not result in additional surface disturbance;
- Ability to benefit from the transfer of water to and from Invincible Colliery via a proposed pipeline; and
- Backfilling and rehabilitation of the residual final void resulting from existing mining operations to create a free-draining final landform.

All other operational aspects including coal production and processing, coal transport, operational hours and employment would remain consistent with operations approved under DA 200-5-2003.

1.3 Environmental Noise Policies

This report includes an assessment of noise and blasting impacts associated with the Modifications in accordance with current NSW Environment Protection Authority (EPA) guidelines and policies as described below.

- The *NSW Industrial Noise Policy* (INP) (EPA, 2000) is intended to guide noise investigations from existing or proposed industrial developments including coal mines. The INP recommends procedures to determine:
  - background noise levels at receiver properties;
  - existing noise levels from an industrial site;
  - recommended, not mandatory, noise criteria for existing and proposed operations;
  - predicted noise levels from proposed developments; and
  - negotiation options if recommended noise criteria are not or may not be met.
- The *NSW Road Noise Policy* (RNP) (DECCW, 2011) provides recommended noise criteria and assessment procedures for road traffic noise, including Project-related traffic, from public roads but excludes noise produced by vehicle movements on private property such as a mine site. The RNP also contains recommended sleep disturbance criteria;
- The *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (Blasting Guideline) (Australian and New Zealand Environment Conservation Council (ANZECC), 1990) recommends residential ground vibration and overpressure limits and time restrictions for blasting;
- *DIN 4150 Part 3 – Structural Vibration: effects of vibration on structures* (ISO, 1999) recommends vibration limits to avoid or minimise vibration impacts on structures including residences; and
- *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 – Reg 12AB* Clause 3 (cumulative noise levels), Clause 5 (airblast overpressure) and Clause 6 (ground vibration).

1.4 Receivers

Areas affected by the Modifications are predominately located on land within the Ben Bullen State Forest and on land owned by Coalpac and affiliated entities. Rural residential receivers adjoin the Modification areas to the north-east, north, west and south, while the remainder of the Ben Bullen State Forest extends to the east. The township of Cullen Bullen is located to the west of Invincible Colliery and south of Cullen Valley Mine, Glencore's Baal Bone Colliery is located to the north east and Mt Piper Power Station (MPPS) is located to the south.

A land ownership plan showing land owned by Coalpac and its affiliates, other mining companies and private individuals or companies is included in each noise contour figure in Appendix A.

1.5 Glossary

The following acoustical terms are used in this report:

Sound Pressure — Small air pressure variations above and below normal atmospheric pressure that are perceived by human ears as sound;

Frequency	The rate of sound pressure fluctuations per second, expressed as cycles per second or hertz (Hz). Human ears in good condition can typically detect sound in the frequency range 20 Hz to 20,000 Hz (20 kHz), depending on sound level;
Decibels, dB	A noise level unit based on a logarithmic scale of Pascals of sound pressure above and below atmospheric pressure. Expressing a sound pressure level in decibels implies root-mean-squared (RMS) sound pressure unless explicitly stated otherwise. Human ears in good condition can typically detect sound pressures from the threshold of perception at 0 dB (20 uPa) to the threshold of pain at 140 dB (200 Pa). An increase of 10 dB is perceived as an approximate doubling of sound level by an average human ear;
dBL	Linear decibels, the same as dB but used to explicitly define a decibel scale in the absence of any frequency weighting;
dBC	C weighted decibels, where the C weighting means very low and very high frequencies are artificially reduced to leave mid-range frequencies unchanged. Most sound monitoring instruments include an A-weighting option, enabling direct measurement of noise levels in dBC;
dBA	A-weighted decibels, where the A weighting means frequencies below 500Hz and above 10kHz are artificially reduced to approximate the frequency response of an average human ear. Most sound monitoring instruments include an A-weighting option, enabling direct measurement of noise levels in dBA;
LA90	The A-weighted noise level exceeded 90% of the time (which can be thought of as the quietest 10% of the time) over a defined measurement period, usually 15 minutes or one hour, and widely accepted as the background noise level;
LAeq	The A-weighted equivalent continuous, or logarithmic average, noise level over a defined time period either measured or predicted at a specific location; and
Sound Power	Sound energy emitted by a source, measured in watts (W) or expressed on a decibel scale with 0 dB representing 1 picowatt (1 pW) of sound power. While both sound pressure and sound power can be expressed on a decibel scale, they are not interchangeable or directly comparable. Sound power levels are most commonly expressed as unweighted decibels (dBL) but can be expressed as A-weighted decibels (dBA).

2 EXISTING ENVIRONMENT

2.1 Cullen Valley Mine EIS

The *Cullen Valley Mine Extension Environmental Impact Statement* (International Environmental Consultants, 2003) included *Noise and Vibration Impact Assessment, Open Cut Extension, Cullen Valley Mine* (Atkins Acoustics, April 2003) (the Cullen Valley Mine Atkins Report) which included results from background noise measurements taken at four representative receiver locations in the area in May 2002, as shown in Table 1.

Table 1: Measured Background Noise Levels, Cullen Valley Mine Atkins Report, May 2002.

Property Reference[1], Location	Measured Background Level, LA90,15min		
	Day	Evening	Night
139 'Red Springs'	32	29	29
179 'Hillcroft'	29	28	28
205 'Forest Lodge	27	28	29
103-110 Northern Allotments	24	25	25

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2.2 Invincible Colliery EIS

The *Proposed Extension to the Invincible Colliery Environmental Impact Statement* (R. W. Corkery & Co. Pty Limited, 2008) included *Noise Impact Assessment of the Proposed Extension to the Invincible Colliery Open Cut Mine and Production Increase* (Environmental Resources Management Australia Pty Ltd, January 2008) (the ERM Report) included results from background noise measurements at two representative receiver locations taken in the area in December 2005, as shown in Table 2. Both properties are now owned by an entity associated with Coalpac.

Table 2: Measured Background Noise Levels, ERM Report, December 2005.

Property Reference[1], Location	Measured Background Level, LA90,15min		
	Day	Evening	Night
394 'Hillview'	36	30[2]	30[2]
393 'Billabong'	36	30[2]	30[2]

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2 Background levels below 30 L90,15min were reported as 30 LA90,15min by ERM.

2.3 Baal Bone Colliery EIS

The *Environmental Assessment – Baal Bone Colliery* (AECOM, 2010) included *Noise Impact Assessment Baal Bone Colliery* (Atkins Acoustics, November 2009) (the Baal Bone Colliery Atkins Report) which included results from background noise measurements taken at two representative receiver locations in the area in November 2008, with the Baal Bone Colliery Coal Handling and Preparation Plant (CHPP) not operating, as shown in Table 3. As these two properties are relatively close to each other, the lower background noise levels measured at property 143 have been adopted for this assessment.

Table 3: Measured Background Noise Levels, Baal Bone Colliery Atkins Report, November 2008.

Property Reference[1], Location	Measured Background Level, LA90,15min		
	Day	Evening	Night
144 Muldoon	29	32	32
143 Speirs	32	33	33

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2.4 Property 212 Noise Monitoring

Coalpac commissioned Global Acoustics to complete two noise surveys on Property 212 owned by Coalpac. The property is located south of Cullen Valley Mine and west of Cullen Bullen township. This location was chosen by Coalpac to assist in determining background and ambient noise levels at nearby privately owned properties. Results from long term unattended noise surveys completed in June and November 2008 are shown in Table 4.

Table 4: Measured Background Noise Levels at Property 212, Global Acoustics, 2008.

Property Reference[1], Location, Time Period	Measured Background Level, LA90,15min		
	Day	Evening	Night
212 Coalpac June 2008	34[2]	27	27
212 Coalpac November 2008	36[2]	32	26

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2 Day background levels may have been affected by Cullen Valley Mine daytime only activity and should be ignored.

2.5 Cullen Valley Mine Quarterly Noise Monitoring

Coalpac commissioned Global Acoustics to complete a series of quarterly noise surveys at various receiver locations near Cullen Valley Mine. Results shown in Table 5 are based on short term noise measurements, generally over periods of 15 minutes, with Cullen Valley Mine operating normally. Background levels in *italics* were noted to be at least partly due to mining or related operations, while levels in normal font did not appear to be influenced by mining noise based on comments attached to each measurement result in the Global Acoustics reports.

Table 5: Measured Daytime Background Noise Levels, Global Acoustics, 2008 - 09.

Property Reference[1], Location	Measured Background Level, LA90,15min 12 June, 18 June, 5 August, 12 November 2008, 25 February, 28 May, 11 September 2009, 14 March, 29 May, 11 September, 7 December 2012 26 March 2013	Typical Background Sources
139 'Red Springs'	32, 31, *32*, *32*, 32, 35, 32 *38*, *37*, *33*, *31* 30	Distant traffic, birds, other natural sources, *Cullen Valley mining equipment*
179 'Hillcroft'	*39*, *38*, *32*, *33*, 35, *38*, *35* 50, *36*, *33*, *29* *34*	Insects, *Cullen Valley mining equipment*
205 'Forest Lodge'	27, 22, 20, 28, 33, 18, 33 40, *26*, *25*, *22* 28	Insects, frogs, birds, *Cullen Valley mining equipment*
169 Doble[2]	35, 31, 36, 35, 37, 36, 37 41, 31, 32, 36 33	Highway traffic
199 Tilley	40, 32, 36, 29, 42, 45, 42 43, 35, 40, 37 34	Highway traffic

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2 Property 169 is now owned by Coalpac.

2.6 Invincible Colliery Quarterly Noise Monitoring

Coalpac commissioned Global Acoustics to complete a series of quarterly noise surveys at various receiver locations near Invincible Colliery. Results shown in Table 6 are based on short term noise measurements, generally over periods of 15 minutes with Invincible Colliery operating normally.

Background levels in Table 6 in *italics* were noted to be at least partly due to mining or related operations, while levels in normal font did not appear to be influenced by mining noise based on comments attached to each measurement result in the Global Acoustics reports.

Global Acoustics also completed two long term unattended noise surveys at five locations near Invincible Colliery, generally with the mine operating normally, with results presented in Table 7. Background noise levels obtained during Invincible Colliery operation should be considered an upper limit to levels that would be measured in the absence of noise from the mine.

Table 6: Measured Background Noise Levels, Global Acoustics, 2008 – 09, 2012 - 13.

Property Reference[1], Location	Measured Background Level, LA90,15min[2]		Typical Background Sources
	5 August 08, 25 February, 28 May, 10 September 09 14 March, 29 May, 11 September, 7 December 2012 26 March, 21 June 2013		
	Day	Evening	
394 'Hillview'[3]	37, 38, *49*, *39*	32, 33, *45*, *29*	Traffic, frogs, insects, *Invincible CPP*
393 'Billabong'[3]	36, 36, *47*, 42	31, 34, *35*, *33*	Traffic, frogs, birds, *Invincible CPP*
South Cullen Bullen	- , - , 36, 33 50, 44, 38, 38 40, 38	- , - , 28, 26 44, - , 48, - 33, -	Traffic, frogs, Insects
West Cullen Bullen	- , - , 35, 32 34, 36, 35, 35 32, 38	- , - , 31, 31 34, - , 36, - 33, -	Traffic, frogs, Train
Central Cullen Bullen[4]	34, 38, 32, 42 37, 35, 44, 39 46, 44	*34*, 34, 25, 29 42, - , 44, - 28, -	Traffic, *Cullen Valley mining*, insects, frogs, birds

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2 A dash "-" denotes the location was omitted from that survey in that time period.

3 Properties 393 and 394 are now owned by affiliates of Coalpac.

4 Monitoring location on Invincible Avenue or Mudgee Road, Cullen Bullen.

Table 7: Measured Long Term Background Noise Levels, Global Acoustics, 2009.

Property Reference[1], Location	Measured Background Level, LA90,15min		
	28 May – 8 June, 11 - 16 September 2009		
	Day	Evening	Night
Property 394 'Hillview'[2]	39, 38	34, 34	30, 28
Property 393 'Billabong'[2]	36, 38	32, 33	26, 30
Property 362 Cullen Bullen South	33, 34	26, 31	24, 28
Farley Street Cullen Bullen West	31, 34	27, 30	26, 28
Mudgee Road Cullen Bullen Central	32, 38	26, 31	26, 28

1 Property Reference number as listed in this report and shown on the noise contour figures in Appendix A.

2 Properties 393 and 394 are now owned by affiliates of Coalpac.

2.7 Most Recent Long Term Background Noise Monitoring

Coalpac commissioned Global Acoustics to complete additional background noise surveys in November 2011. Global Acoustics monitored background and ambient noise levels at four representative receiver locations:

- Location M1 – Adjacent to the Castlereagh Highway approximately 400m north of Cullen Bullen, representing Cullen Bullen receivers close to the Highway;
- Location M2 – Approximately 100m east of the Castlereagh Highway and 2.5 km north of Cullen Bullen, on Property 171 owned by Coalpac;
- Location M3 – Approximately 550m west of the Castlereagh Highway and 30m north of Red Springs Road, on Property 104; and
- Location M4 – Adjacent to Back Cullen Road approximately 740m south of Portland Cullen Bullen Road, north east of Residence 373.

Acoustic Research Laboratories EL-215 Type 2 noise monitors were installed at each location for the period 1 November to 15 November 2011 and programmed to measure and store 15 minute A-weighted percentile statistics. Results from the noise monitors were processed according to INP guidelines, including an analysis of weather conditions during the noise survey based on weather data supplied by Coalpac from the Invincible Colliery weather station.

The weather data indicated winds above 5m/s had the potential to affect measured noise levels during the day on 2 November, 10 November and 14 November 2011. Data for these days have been highlighted in small italic font and excluded from the Rating Background Levels (RBLs) and average ambient noise levels presented in Tables 8 to 11.

Table 8: Measured Noise Levels, Location M1 Cullen Bullen, dBA.

Day, Date	Background Level, LA90,15min			Ambient Level LAeq,15min		
	Day	Evening	Night	Day	Evening	Night
Tue 1 – Wed 2/11	*39.4*	30.5	27.5	*62.1*	60.0	59.4
Wed 2 – Thu 3/11	*37.8*	28.8	28.0	*62.6*	59.0	59.4
Thu 3 – Fri 4/11	35.2	29.8	27.5	63.1	59.8	58.9
Fri 4 – Sat 5/11	34.0	36.8	27.5	64.2	63.5	58.1
Sat 5 – Sun 6/11	35.7	33.0	27.0	64.0	58.6	55.9
Sun 6 – Mon 7/11	35.8	34.0	28.3	63.5	60.4	58.0
Mon 7 – Tue 8/11	35.5	34.5	28.8	62.5	58.9	58.6
Tue 8 – Wed 9/11	36.5	34.0	28.5	62.2	60.6	59.3
Wed 9 – Thu 10/11	36.0	36.5	29.7	62.7	59.2	58.3
Thu 10 – Fri 11/11	*37.5*	35.0	31.0	*64.4*	60.9	59.6
Fri 11 – Sat 12/11	36.5	34.0	27.8	64.0	63.0	57.7
Sat 12 – Sun 13/11	35.0	32.8	27.0	63.0	58.3	53.8
Sun 13 – Mon 14/11	33.5	30.3	28.0	62.7	60.0	58.6
Mon 14 – Tue 15/11	*35.9*	29.7	27.5	*62.5*	59.4	58.8
Tue 15 – Wed 16/11	34.5	-	-	62.6	-	-
Weekly Median / Average	35.5	33.5	27.9	63.2	60.4	58.4

Table 9: Measured Noise Levels, Location M2 Property 171, dBA.

Day, Date	Background Level, LA90,15min			Ambient Level LAeq,15min		
	Day	Evening	Night	Day	Evening	Night
Tue 1 – Wed 2/11	-	33.4	28.5	-	54.5	56.3
Wed 2 – Thu 3/11	*34.2*	30.0	27.3	*65.7*	45.5	53.6
Thu 3 – Fri 4/11	35.2	30.0	28.0	57.4	44.0	43.3
Fri 4 – Sat 5/11	37.5	35.0	26.5	63.1	58.0	44.2
Sat 5 – Sun 6/11	34.2	31.0	27.0	61.8	46.1	44.3
Sun 6 – Mon 7/11	36.5	31.3	27.0	58.7	53.9	47.4
Mon 7 – Tue 8/11	33.7	31.8	29.0	61.1	48.9	45.8
Tue 8 – Wed 9/11	37.6	28.8	27.0	72.6	62.2	42.3
Wed 9 – Thu 10/11	32.4	33.0	30.5	65.9	48.4	61.8
Thu 10 – Fri 11/11	*33.0*	29.3	30.5	*64.5*	46.9	46.4
Fri 11 – Sat 12/11	40.0	35.0	27.3	62.0	64.7	52.1
Sat 12 – Sun 13/11	34.2	28.8	26.5	60.8	45.5	44.4
Sun 13 – Mon 14/11	37.0	30.0	27.0	62.0	49.9	46.3
Mon 14 – Tue 15/11	*40.0*	31.0	27.5	*71.9*	55.8	48.6
Tue 15 – Wed 16/11	37.5	-	-	60.0	-	-
Weekly Median / Average	36.5	31.0	27.3	64.8	56.7	52.9

Table 10: Measured Noise Levels, Location M3 Red Springs Road, dBA.

Day, Date	Background Level, LA90,15min			Ambient Level LAeq,15min		
	Day	Evening	Night	Day	Evening	Night
Tue 1 – Wed 2/11	33.0	29.0	27.8	41.5	42.8	39.3
Wed 2 – Thu 3/11	*34.6*	29.3	27.3	*45.2*	40.2	38.1
Thu 3 – Fri 4/11	31.2	28.8	27.5	39.5	40.1	35.7
Fri 4 – Sat 5/11	31.0	35.3	27.5	40.8	43.8	38.5
Sat 5 – Sun 6/11	30.0	29.5	27.5	38.1	43.1	41.1
Sun 6 – Mon 7/11	30.5	29.5	27.3	44.3	38.3	35.6
Mon 7 – Tue 8/11	30.0	29.0	27.5	39.4	41.1	40.4
Tue 8 – Wed 9/11	32.1	30.8	28.0	51.5	47.2	40.0
Wed 9 – Thu 10/11	32.0	30.3	28.2	44.5	41.8	39.8
Thu 10 – Fri 11/11	*33.3*	31.0	28.0	*48.6*	42.4	40.8
Fri 11 – Sat 12/11	31.5	34.8	27.0	40.0	43.8	37.0
Sat 12 – Sun 13/11	29.5	29.5	27.5	40.1	41.4	39.8
Sun 13 – Mon 14/11	30.8	32.5	27.5	40.9	41.5	38.8
Mon 14 – Tue 15/11	*30.9*	30.9	27.5	*44.9*	46.3	39.9
Tue 15 – Wed 16/11	29.5	-	-	38.1	-	-
Weekly Median / Average	30.9	29.9	27.5	43.8	43.1	39.2

Table 11: Measured Noise Levels, Location M4 Back Cullen Road, dBA.

Day, Date	Background Level, LA90,15min			Ambient Level LAeq,15min		
	Day	Evening	Night	Day	Evening	Night
Tue 1 – Wed 2/11	-	30.5	29.8	-	39.0	39.0
Wed 2 – Thu 3/11	*33.7*	29.8	29.0	*57.9*	50.8	36.8
Thu 3 – Fri 4/11	32.5	30.5	29.5	56.8	47.1	40.0
Fri 4 – Sat 5/11	33.2	33.0	29.5	62.9	60.9	42.7
Sat 5 – Sun 6/11	32.0	30.3	29.5	59.6	37.7	38.2
Sun 6 – Mon 7/11	32.7	31.5	28.5	59.2	46.1	46.0
Mon 7 – Tue 8/11	33.5	31.5	29.5	53.8	45.6	37.0
Tue 8 – Wed 9/11	37.0	29.3	28.5	67.0	64.8	33.9
Wed 9 – Thu 10/11	32.0	32.0	29.2	67.5	51.7	53.1
Thu 10 – Fri 11/11	*37.6*	30.8	29.5	*66.3*	51.6	43.8
Fri 11 – Sat 12/11	35.5	32.8	28.5	62.2	69.2	57.3
Sat 12 – Sun 13/11	31.7	30.3	29.0	57.6	44.4	42.6
Sun 13 – Mon 14/11	31.5	32.3	28.5	68.3	58.7	41.8
Mon 14 – Tue 15/11	*34.4*	31.5	28.8	*68.0*	66.6	41.4
Tue 15 – Wed 16/11	32.5	-	-	54.6	-	-
Weekly Median / Average	32.5	31.1	29.1	63.4	61.2	48.1

Global Acoustics also completed a series of operator attended noise surveys at each long term monitoring location covering the day, evening and night periods, primarily to identify and quantify dominant sources of background and ambient noise at each location. A Rion NA-28 sound level meter was used to measure 1/3 octave percentile noise levels over 15 minute periods at each location while survey staff noted dominant and audible noise sources. Results from the surveys were presented by Global Acoustics in report 11330_R01 dated 24 November 2011 and are summarised in Table 12.

Table 12: Short Term Noise Survey Results, November 2011, dBA.

Location	Period Date Time	Measured Noise Levels			Noted Noise Sources
		LAmax	LAeq	LA90	
M1 Cullen Bullen	Day 1 2/11 10:34	87.1	70.3	48.5	Highway traffic dominant, birds and breeze audible, mining not audible
	Day 2 15/11 15:15	86.0	67.2	35.6	Highway traffic dominant, birds sheep and breeze audible, mining not audible
	Evening 1 1/11 19:46	85.0	62.0	33.0	Highway traffic dominant, frogs in background, mining not audible
	Evening 2 15/11 18:54	87.4	65.7	36.1	Highway traffic dominant, frogs in background, mining not audible
	Night 1 1/11 22:50	84.6	60.4	25.7	Highway traffic dominant, insects and frogs in background, mining not audible
	Night 2 15/11 23:24	85.8	59.7	29.2	Highway traffic dominant, insects in background, mining not audible

Location	Period Date Time	Measured Noise Levels			Noted Noise Sources
		LAmax	LAeq	LA90	
M2 Property 171	Day 1 2/11 11:05	65.1	50.7	41.3	Highway traffic dominant, breeze and insects in background, Baal Bone Colliery audible < 30 LAeq
	Day 2 15/11 15:49	61.1	47.7	34.5	Highway traffic dominant, birds in background, mining not audible
	Evening 1 1/11 20:26	69.8	45.2	33.4	Highway traffic dominant, frogs and insects in background, Baal Bone Colliery audible < 30 LAeq
	Evening 2 15/11 18:28	59.5	45.1	33.7	Highway traffic dominant, birds in background, Baal Bone Colliery CHPP and dozer 44 LAmax, 33 LAeq
	Night 1 1/11 22:26	61.7	42.5	34.4	Highway traffic, insects and birds dominant, Baal Bone Colliery CHPP 33 LAeq
	Night 2 15/11 22:30	63.9	47.2	28.1	Highway traffic dominant, insects in background, Baal Bone Colliery CHPP 30 LAeq
M3 Red Springs Road	Day 1 2/11 11:35	67.1	46.2	37.4	Local traffic and breeze dominant, dogs and birds in background, Highway barely audible, Baal Bone Colliery audible not measurable
	Day 2 15/11 16:21	54.5	35.1	27.6	Highway traffic dominant, birds and breeze in background, mining not audible
	Evening 1 1/11 20:54	53.8	39.4	32.7	Insects dominant, Highway traffic intermittently audible, mining not audible
	Evening 2 15/11 18:00	54.6	38.6	32.2	Highway traffic dominant, birds in background, mining not audible
	Night 1 1/11 22:00	51.2	39.8	31.0	Frogs and insects dominant, Highway traffic audible, mining not audible
	Night 2 15/11 22:02	56.3	39.4	30.3	Dogs, Highway traffic and insects dominant and in background, mining not audible
M4 Back Cullen Road	Day 1 2/11 10:11	69.3	44.7	36.3	Birds and breeze dominant, mining not audible
	Day 2 15/11 14:45	60.3	42.3	34.1	Birds, breeze and traffic dominant, mining not audible
	Evening 1 1/11 18:02	57.1	39.5	32.7	Breeze, birds and insects dominant, mining not audible
	Evening 2 15/11 19:18	76.2	50.9	33.5	Birds dominant, breeze and traffic audible, mining not audible
	Night 1 1/11 23:15	53.5	31.1	27.6	Frogs, insects, distant traffic dominant, MPPS audible <25 dBA, mining not audible
	Night 2 15/11 22:59	42.8	30.5	23.9	Distant traffic dominant, insects in background, mining not audible

2.8 Adopted Background Noise Levels

A relatively large number of noise surveys have been completed in the area in recent years. Background noise levels tend to vary at most monitoring locations due to seasonal and other factors, although levels at or below 30 LA90 are common during the evening and night. Background noise levels during the day do not tend to reduce below 30 LA90 at all locations and have been subject to further investigation:

Cullen Bullen — Measured background noise levels within Cullen Bullen, with one exception, are consistently at or above 32 LA90 during the day and were 35 LA90 in the most recent survey;

Near Highway — Measured background noise levels near the Castlereagh Highway north and south of Cullen Bullen, with one exception, are consistently at or above 32 LA90 during the day and were 36 LA90 at Property 171 in the most recent survey; and

Remote from Highway — Measured background noise levels at locations remote from the Castlereagh Highway regularly reduce to 30 LA90 or lower, although long term measured levels remained above 30 LA90 at all locations during the recent noise survey.

The recent noise survey indicated a measured background level of 31 LA90 during the day at Location M3 Red Springs Road approximately 550m from the Highway. All locations closer than this distance from the Highway tend to receive a background level of 32 LA90 or above while locations further from the Highway tend to receive a background level at or below 30 LA90 at times. A distance of 500m from the Highway has therefore been adopted to indicate the boundary of the higher background noise category.

Table 13 shows adopted background levels for two receiver groups.

Table 13: Adopted Rating Background Levels (RBLs).

Receiver Area	Rating Background Level, LA90,15min		
	Day	Evening	Night
Group A - within 500m of the Castlereagh Highway, including Cullen Bullen township	32	30	30
Group B - more than 500m from the Highway	30	30	30

While a number of noise survey results have indicated higher background levels than adopted in Table 13, the adopted levels are considered appropriately conservative and justifiable.

2.9 Existing Industrial Noise Levels

Noise levels produced by the existing MPPS and the proposed future MPPS extension are discussed in the *Mt Piper Power Station Extension Environmental Assessment* (MPPS EA) (SKM, September 2009). The MPPS EA assessed existing and proposed noise levels to four locations generally in the range 2100 to 2500 m from the MPPS as shown in Figure 1-1 in the MPPS EA. Tables 5-1 and 6-1 in the MPPS EA show a predicted noise level of 34 to 36 LAeq,15min at the closest assessment locations for both the coal fired and gas fired expansion options, including a 5 dBA low frequency correction factor.

The MPPS EA does not include noise contours for prevailing weather conditions and did not assess receiver locations north of the MPPS. The property with the greatest potential to receive audible noise from both the Project and the expanded MPPS would be Property 426 which is approximately

2800 m north of the MPPS. Property 426 would therefore receive approximately 32 to 34 LAeq,15min from the expanded MPPS under prevailing weather conditions during the night, based on extrapolation of results in the MPPS EA. Other properties included in this assessment are further from the MPPS and are expected to receive lower noise levels from this source.

Recent noise monitoring data indicates a received MPPS noise contribution of less than 25 LAeq at Location M4 Back Cullen Road which is consistent with an existing MPPS noise level below 31 LAeq at Property 426.

The Ivanhoe North Project is understood to have permanently ceased operations, therefore no significant industrial noise is expected to be produced from this site. Baal Bone Colliery is in long term care and maintenance and it is unclear if or when operations will recommence. As such it is discounted as a significant industrial noise source.

3 CRITERIA

3.1 Mining Noise - INP

The INP contains two sets of noise criteria for residential receivers. Intrusive criteria are set 5 dBA above the adopted Rating Background Level (RBL) in each time period and are designed to limit the relative audibility of mining or industrial operations. These criteria can be adjusted by one or more ‘modifying factors’ such as tonality or impulsiveness described in Section 4 of the INP, or alternatively the source noise levels can be adjusted to consider any modifying factors applicable to those sources. Any relevant adjustments have been applied to source noise levels in this assessment.

Amenity limits recommended in the INP depend on existing industrial noise levels and the nature of the receiver area. The amenity limits are designed to control the total or cumulative level of industrial noise at a sensitive receiver such as a residence. Amenity criteria are set to the amenity limits in cases where limited industrial noise is currently received, or to lower levels to ensure the cumulative impact of existing and proposed noise sources does not exceed the amenity limit for each time period.

As noise survey results indicate existing industrial noise levels are below 30 LAeq,15min at all locations, no corrections for existing industrial noise are required and the amenity limits have been adopted. For the purposes of determining appropriate noise amenity criteria, all assessed receivers have conservatively been assigned the ‘rural’ amenity category. Table 14 shows Project Specific Noise Levels (PSNLs) derived from the measured background noise levels and existing industrial noise levels for the two receiver groups shown in Table 8:

- Group A – Receivers within 500m of the Castlereagh Highway; and
- Group B – Receivers more than 500m from the Highway.

Table 14: INP Project Specific Noise Levels.

Time Period	Day 7am – 6pm[1]		Evening 6pm – 10pm	
Receiver Group	A	B	A	B
Adopted background noise level LA90,15min (Section 2.3)	32	30	30	
Intrusive Criteria LAeq,15min (Background + 5 dBA)	37	35	35	
Amenity limit LAeq,period (INP, rural category)	50	50	45	
Existing industrial noise level LAeq,period	<36	<36	<36	
Amenity Criteria LAeq,period (Table 2.2 of INP)[2]	50[2]	50[2]	45[2]	
Adopted Intrusive Noise Criteria LAeq,15min	37	35	35	

1 Night ends, and Day begins, at 8am on Sundays and public holidays.

2 The amenity criteria are used to assess potential cumulative noise impacts.

PSNLs in Table 14 apply within 30m of a residence or at the receiver property boundary where the boundary is closer than 30m from the residence. Car and truck traffic on public roads and train movements on public rail lines are subject to alternative noise criteria as described below.

3.2 Where Criteria May be Exceeded

Noise criteria listed in Table 14 should be considered the levels above which some acoustic impact may be noticed by receivers. Louder noise levels at a receiver do not necessarily imply the noise is unacceptable at that receiver. The INP describes strategies to deal with potential exceedances of the criteria such as:

- best practice noise mitigation measures applied to individual plant items and mine operating procedures designed to mitigate remaining noise impacts;
- adoption of alternative noise criteria based on achievable noise levels in conjunction with noise mitigation measures and considering other factors such as social worth attached to the development and historical noise levels from existing related developments;
- negotiation of offset arrangements with regulators and/or the affected community; and
- acquisition of properties where the predicted or measured noise impacts are unacceptable and other options cannot reasonably be negotiated.

3.3 Cumulative Noise Levels

The INP and Clause 12AB(3) of the SEPP Mining recommend two sets of criteria, including the intrusive criteria which would apply to the Project operating alone and the amenity criteria which are intended to control the total noise level at a receiver location from all industrial or mining developments. As noise levels from both Cullen Valley Mine and Invincible Colliery are highest during the day and no night mining operations are proposed, cumulative noise levels are only assessed during the day.

Cumulative noise levels are therefore assessed to the daytime amenity criterion shown in Table 14 which is 50 LAeq,11hr.

3.4 Existing Noise Criteria – Invincible Colliery

The Invincible Project Approval 07_0127 contains a number of environmental performance conditions, including conditions 2 and 3 in Schedule 3 which are reproduced below.

Impact Assessment Criteria

2. *The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria set out in Table 2 at any residence on privately owned land, or on more than 25 percent of any privately owned land.*

Table 2: Impact assessment criteria dBA

Residence / Location	*Day* *LAeq,15 minute*	*Evening* *LAeq,15 minute*	*Night* *LAeq,15 minute*
All privately owned land	*40*	*35*	*35*

However, if the Proponent has a written negotiated noise agreement with any landowner and a copy of this agreement has been forwarded to the Department and DECC, then the Proponent may exceed the noise limits in Table 2 on that land in accordance with the negotiated noise agreement.

Notes:

- *To determine compliance with the LAeq,15minute noise limits, noise from the project is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 m of the dwelling (rural situations) where the dwelling is more than 30 metres from the boundary. Where it can be demonstrated that direct measurement of noise from the project is impractical, the Department and DECC may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*
- *These limits apply under meteorological conditions of:*
  - *wind speeds of 3 m/s at 10 metres above ground level; or*
  - *up to 3ºC/100 m temperature inversion strength for all receivers, plus a 2m/s source to receiver component drainage flow wind at 10 metres above the ground level for those receivers where applicable.*

Land Acquisition Criteria

3. *If the noise generated by the project exceeds the criteria in Table 3 at any residence on privately owned land, or on more than 25% of any privately owned land, the Proponent shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in the conditions 6-8 of schedule 4.*

Table 3: Acquisition criteria dBA

Residence / Location	*Day LAeq,15 minute*	*Evening LAeq,15 minute*
All privately owned land	*45*	*40*

3.5 Existing Noise Criteria – Cullen Valley Mine

The Cullen Valley Development Approval 200-5-2003 contains a number of environmental performance conditions, including conditions 2 to 5 in Schedule 4 which are reproduced below.

NOISE

Noise Limits

2. *The Applicant shall ensure that the noise generated by the development does not exceed the noise limits in Table 1 at any privately owned land:*

Day	*Evening*	*Night*	*Night*	*Land Descriptor*
LAeq,15minute			*LA1,1minute*	
43	*38*	*35*	*45*	· *Ryan* · *Tesoriero* · *Fitzgerald* · *Tilley* · *Red Springs (during mining to the west of the railway line)* · *Hillcroft (during mining to the west of the railway line)* · *Dobson* · *Williams* · *Northey*
40	*40*	*38*	*45*	*Forest Lodge*
37	*35*	*35*	*45*	*Red Springs (during mining to the east of the railway)*
35	*35*	*35*	*45*	*Hillcroft (during mining east of the railway) and all other land (including vacant land)*

Table 1: Noise limits dB(A)

However, if the Applicant has a written noise agreement with any landowner, and a copy of this agreement has been forwarded to the Department and DEC, then the Applicant may exceed the noise limits in Table 1 for the landowner's land in accordance with the terms of the noise agreement.

Additional Noise Mitigation - Forest Lodge

3. Upon receiving a written request from the landowner, the Applicant shall investigate (and subsequently implement) all reasonable and feasible measures to mitigate the noise impacts of the development on the residence identified as Forest Lodge in the map in Appendix 3, in consultation with the landowner, and to the satisfaction of the Director- General.

Continuous Improvement

4. The Applicant shall:

(a) investigate ways to reduce the noise generated by the development;

(b) implement best practice noise mitigation measures at the development; and

(c) report on these investigations and the implementation of any new noise mitigation measures at the development in the AEMR.

Land Acquisition Criteria

5. If the noise generated by the development exceeds the criteria in Table 2, the Applicant shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in Conditions 3-5 of Schedule 5.

Day	*Evening*	*Night*	*Land Descriptor*
LAeq,15minute			
43	*40*	*40*	· *Ryan* · *Tesoriero* · *Fitzgerald* · *Tilley* · *Red Springs (during mining to the west of the railway line)* · *Hillcroft (during mining to the west of the railway line)* · *Dobson* · *Williams* · *Northey*
42	*40*	*40*	*Red Springs (during mining to the east of the railway)*
40	*40*	*40*	*Hillcroft (during mining east of the railway) and all other land (including vacant land)*

Table 2: Land Acquisition Criteria dB(A)

Notes:

- *For more information on the individually named properties in Table 2 see Appendix 3.*
- *Noise from the development is to be measured at the most affected point or within the residential boundary or at the most affected point within 30m of the dwelling (rural situations) where the dwelling is more than 30m from the boundary to determine compliance with the LAeq(15 minute) noise limits in Table 1 and 2.*
- *For the purpose of noise measures required for this condition, the LAeq (15 minute) noise level must be measured or computed at the nearest or most affected residence over a period of 15 minutes using "FAST" response on the sound level meter. For the purpose of the noise criteria for this condition, 5dB(A) must be added to the measured level if the noise is substantially tonal or impulsive in character.*
- *Where it can be demonstrated that direct measurement of noise from the development is impractical, the DEC may accept alternative means of determining compliance. See Chapter 11 of the NSW Industrial Noise Policy.*
- *The modification factors presented in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.*
- *Noise from the development is to be measured at 1m from the dwelling façade to determine compliance with the LA1(1minute) noise limits in Tables 1 and 2.*
- *The noise emission limits identified in Condition 2 and 5 apply under meteorological conditions of:*
- *Wind speed up to 3m/s at 10 metres above ground level; or*
- *Temperature inversion conditions of up to 3oC/100m and wind speed up to 2m/s at 10 metres above the ground in accordance with the definitions provided in the Industrial Noise Policy; and*
- *Temperature inversion conditions do not apply in conditions 2 and 5 where the noise limits are assessed at 43 LAeq(15 minute).*
- *Construction noise is considered to be operational noise for the purposes of this consent.*

3.6 Adopted Operational Noise Criteria

The proposed Modifications are sought to permit continuation of previously operating mines, with no significant changes to operational practises and relatively minor extensions of permitted mining areas immediately adjacent to previously mined areas. The current development consent and project approval conditions for existing operations at Invincible Colliery and Cullen Valley Mine are therefore the most applicable noise criteria for this assessment.

3.7 Construction Noise

Construction noise levels from most industrial developments are normally assessed to the Interim Construction Noise Guideline (ICNG) (DECC, 2009). Section 1.2 of the ICNG states it does not apply to industrial sources, including construction associated with quarrying and mining, and suggests this activity be assessed under the INP. Section 1.3 of the INP, however, specifically excludes construction noise from the INP.

As the ICNG is the most recent policy document, noise criteria applied to proposed construction work are sourced from the INP and are therefore identical to mine operational criteria, although any potential exceedances of the noise criteria for relatively short term construction activities are not expected to be as important as longer term operational noise impacts.

3.8 Sleep Disturbance

Sleep disturbance can be caused by a short, sharp sound that is noticeably louder than the typical or usual noise level within a bedroom. Historically, sleep disturbance criteria were sourced from the Environmental Noise Control Manual (EPA, 1985) and the INP Application Notes suggest the historical noise criterion of 15 dBA above the night background noise level should continue to be used in the absence of research to suggest an alternative. The INP Application Notes also point to the NSW Road Noise Policy for guidance on sleep disturbance criteria.

The RNP acknowledges the effects of noise on sleep disturbance have not yet been conclusively determined. Nevertheless, Section 5.4 of the RNP states:

From the research on sleep disturbance to date it can be concluded that:

- *maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep;*
- *one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

The suggested range of 50-55 dBA inside a bedroom is approximately equivalent to an external noise level of 60-65 dBA, assuming bedroom windows remain partly open. External sleep disturbance criteria of 47 LA1,1min within 500m of the Highway and 45 LA1,1min more than 500m from the Highway based on the historical criterion, and 60 LAmax based on the RNP recommendations, for the hours 10pm to 7am (or to 8am on Sundays and public holidays) are therefore adopted for this assessment. Noise levels below 45 LA1,1min are considered very unlikely to cause sleep disturbance, while noise levels less than 60 LAmax are unlikely to cause awakening reactions according to the RNP.

3.9 Traffic Noise

Relevant road traffic noise criteria are listed in Table 3 in the RNP. Noise criteria for Situation 3 "Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments", which applies to road traffic on the Castlereagh Highway, are

60 LAeq,15hr during the day and 55 LAeq,9hr during the night for residential receivers. Recommended noise criteria apply to all traffic, including vehicles associated with the Project.

The LAeq,15hr and LAeq,9hr parameters refers to the average traffic noise level over an entire 15 hour day or 9 hour night.

3.10 Low Frequency Noise

Section 4 of the INP recommends low frequency noise levels be considered in the normal operational noise criteria by the addition of a 5 dBA 'modifying factor' to received noise levels if the received dBC level exceeds the dBA level by more than 15 dB. An assessment of dBC and dBA levels, to determine the need for a low frequency correction to received noise levels, is included in this report.

3.11 Blast Overpressure and Vibration

Current noise and vibration criteria for occupied buildings such as residences, schools and hotels as recommended in the Blasting Guideline are:

- Overpressure 115 dBL; and
- Ground vibration 5mm/s Peak Particle Velocity (PPV).

The Blasting Guideline recognises blast effects cannot always be controlled accurately and allows higher limits of 120 dBL and 10mm/s PPV for up to 5% of the total number of blasts on a site in a 12 month period. Recommended blasting criteria apply during the hours 9am to 5pm Monday to Saturday, excluding public holidays, and are designed to minimise disturbance to occupants.

The majority of occupied buildings can withstand much greater vibration levels, typically well over 20 mm/s, before the onset of superficial or cosmetic damage. Vibration levels well over 25 mm/s would typically be required to cause structural damage to these buildings. Appendix J4 of *Australian Standard 2187.2-2006 Explosives – Storage and use, Part 2: Use of explosives* suggests a vibration criterion of 15 mm/s at 4 Hz, rising to 50 mm/s at 40 Hz and above, would protect occupied buildings with light weight construction materials such as timber frames and plasterboard lining. The Standard recommends a vibration criterion of 50 mm/s for industrial and heavy commercial buildings. The recommended vibration criterion of 5 mm/s and upper limit of 10 mm/s for occupied buildings is therefore adequate to protect these buildings from even superficial or cosmetic damage.

Similarly, occupied buildings routinely withstand wind pressures, including gusts, so are not particularly sensitive to overpressure. Appendix J5 of the Standard states "From Australian and overseas research, damage (even of a cosmetic nature) has not been found to occur at airblast levels below 133 dBL. Windows are the building element currently regarded as most sensitive to airblast, and damage to windows is considered improbable below 140 dBL". The recommended criterion of 115 dBL, and upper limit of 120 dBL, is therefore adequate to protect occupied buildings from damage by overpressure.

3.11.1 Heritage Items

Indigenous and European heritage items are known to exist in the area. Table 15 shows heritage items noted to be potentially sensitive to blasting impacts and suggested ground vibration criteria for each. The suggested ground vibration criteria should be reviewed by a geotechnical expert based on a detailed assessment of each site. The expert should confirm the suggested criteria are appropriate or specify alternative criteria considering the resistance of each site to potential ground vibration related damage and other site specific factors. Suggested criteria for the four known rock shelters in Table 15 should not be adopted in any Blast Management Plan or other document, and blasts should not occur within 500m of each rock shelter, without prior confirmation from a geotechnical expert regarding appropriate criteria.

Table 15: Potentially Sensitive Heritage Sites and Indicative Vibration Criteria.

(I)ndigenous or (E)uropean Heritage Item	Comments	Suggested Vibration Criteria
(I) Rock shelters	Four shelters near the Modification areas	20 mm/s [1]
(E) Carleon Coach House	Occupied residence	5 mm/s [2]
(E) Miner's cottages	Occupied residences	5 mm/s [2]
(E) Cullen Bullen Public School	Occupied buildings	5 mm/s [2]
(E) Cullen Bullen Royal Hotel	Occupied building	5 mm/s [2]

1 Suggested vibration criteria should be reviewed by a geotechnical expert based on a detailed assessment of each structure.

2 Criteria set to minimise disturbance to occupants would also protect these items from structural damage.

4 ASSESSMENT

4.1 Noise Assessment Method

Noise levels from operations proposed under both Modifications have been assessed using a comprehensive model of the site based on RTA Technology's Environmental Noise Model (ENM) software. ENM is a general purpose noise modelling package that combines terrain and noise source information with other input parameters such as weather conditions to predict noise levels at specific receiver locations or as contours over a receiver area. It is recognised in NSW as the most appropriate choice for situations involving complex topography and a large number of individual noise sources and where a detailed assessment of the effects of atmospheric conditions on noise propagation is required.

The standard ENM package includes data input modules to allow terrain and noise source information to be entered and amended, plus an initial setup page containing terrain and source lists and modelled weather conditions for each scenario. All terrain and source files were prepared for this assessment using a combination of AutoCad and Excel based data then automatically converted to ENM format terrain and source files using specially prepared software. All outputs were obtained using software equivalent to ENM's standard sectioning and contouring algorithms and are presented on a base plan. Tabulated noise levels at residences, and noise levels over 25% of contiguous property areas, have been produced by specially prepared software based on ENM's intermediate calculation files used to produce the noise contours. Noise contour figures are presented in Appendix A.

Additional calculations have been completed to selected residences using ENM's single-point mode to determine any need for a low frequency penalty as recommended in the INP.

4.2 Weather Conditions

Atmospheric conditions including temperature, relative humidity, wind speed, wind direction and vertical temperature gradient can all affect noise propagation and received noise levels at some distance from a source. The INP recommends noise enhancing winds or temperature inversions that occur for at least 30% of the time in any season or time period should be considered when predicting noise levels.

4.2.1 Gradient Winds

A number of weather datasets were supplied by Coalpac from the Cullen Valley Mine and Invincible Colliery weather stations, in addition to datasets previously compiled by PAE Holmes in 2010 and 2011 using the California Meteorological (CALMET) Model. Weather station data analysis was completed using the DECCW's Noise Enhancement Wind Analysis (NEWA) program in each of 16 compass directions, as shown in Tables 16 and 17. Values in bold font highlight potentially noise enhancing winds that occur for 30% of the time or more in any season or time period.

Table 16 shows potentially noise enhancing winds can occur from the north-east or from the west during the day and evening, based on data from the Cullen Valley Mine weather station.

Table 16: Noise Enhancing Winds 2009/10, Cullen Valley Mine Weather Station.

Wind Direction	Occurrence of Noise Enhancing Winds, % of Season and Time Period											
	Summer			Autumn			Winter			Spring		
	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night
N	**31**	10	6	25	5	5	17	11	6	24	11	7
NNE	**37**	19	10	28	7	6	12	8	3	24	13	6
NE	**42**	**34**	17	**35**	14	9	12	6	2	26	17	7
ENE	**39**	**42**	20	**35**	18	12	12	10	4	23	21	7
E	**38**	**44**	22	**34**	21	14	10	10	4	20	21	8
ESE	**32**	**47**	24	30	25	16	9	10	4	18	21	8
SE	24	**39**	22	26	24	16	8	11	4	15	18	9
SSE	16	24	16	19	18	12	5	9	4	11	12	7
S	14	15	12	16	13	9	6	6	3	13	8	7
SSW	17	13	9	18	12	7	14	11	7	20	8	8
SW	19	10	6	20	9	6	21	18	11	25	9	8
WSW	22	8	5	22	9	6	28	23	14	29	11	10
W	24	8	4	22	8	6	**33**	26	17	30	13	10
WNW	26	8	4	24	8	6	**35**	26	17	30	13	10
NW	27	7	4	22	7	6	28	23	13	27	12	9
NNW	26	8	5	21	5	5	22	16	9	25	11	9

Table 17 shows the same potentially noise enhancing wind from the north-east appears in the Invincible Colliery weather station data during all time periods, although these data do not include the dominant westerly breeze that appeared in the Cullen Valley Mine data.

The noise model therefore includes 3 m/s winds from the north-east during all time periods and 3 m/s winds from the west during the day and evening, representing the worst case from both sets of data.

Table 17: Noise Enhancing Winds 2009/10, Invincible Colliery Weather Station.

Wind Direction	Occurrence of Noise Enhancing Winds, % of Season and Time Period											
	Summer			Autumn			Winter			Spring		
	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night
N	24	**31**	**35**	26	29	22	10	**33**	25	15	**39**	29
NNE	29	**51**	**54**	**34**	**53**	**37**	14	**40**	**32**	20	**56**	**39**
NE	30	**55**	**57**	**37**	**59**	**41**	16	**42**	**33**	21	**59**	**42**
ENE	29	**54**	**57**	**36**	**58**	**41**	15	**43**	**32**	21	**60**	**43**
E	23	**50**	**53**	29	**54**	**40**	13	**39**	29	17	**56**	**39**
ESE	10	26	24	14	**31**	20	8	11	8	10	23	17
SE	5	5	6	7	7	5	4	4	2	6	6	7

Wind Direction	Occurrence of Noise Enhancing Winds, % of Season and Time Period											
	Summer			Autumn			Winter			Spring		
	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night	Day	Even.	Night
SSE	6	2	4	5	3	2	5	5	4	7	3	5
S	9	6	7	8	10	6	13	17	13	13	7	9
SSW	16	7	9	16	13	8	24	22	18	20	9	11
SW	18	8	9	20	14	9	27	22	19	22	10	12
WSW	18	9	8	20	14	9	27	22	18	21	10	12
W	16	8	7	18	12	8	25	20	16	19	9	10
WNW	13	4	4	15	5	5	17	7	7	13	4	5
NW	7	3	2	8	3	2	6	1	2	5	2	3
NNW	11	7	6	12	5	2	5	5	4	8	6	6

4.2.2 Temperature Inversions

Weather data from the Cullen Valley Mine and Invincible Colliery weather stations include 15 minute air temperature data measured at 2 m and 10 m above the ground. Analysis of these data can indicate the presence of a temperature inversion, however the measured temperature difference over an 8m interval close to the ground cannot reasonably be extrapolated to the 100 m height interval that is required for long distance noise propagation calculations.

Analysis of the Cullen Valley Mine and Invincible Colliery data, considering measurements for the winter months from 6 pm to 7 am, indicates significant temperature inversions are likely to occur for approximately 47% of the time at Cullen Valley Mine and approximately 63% of the time at Invincible Colliery. In this case, a ‘significant’ temperature inversion is indicated by a 0.24°C difference between the 2 m and 10 m temperatures which is considered approximately equivalent to an F-class inversion.

Similarly, a G-class inversion is assumed to be indicated by a 0.5 °C temperature difference between 2 m and 10 m above the ground and occurs for approximately 27% of the time at Cullen Valley Mine and 39% of the time at Invincible Colliery. While these results are only approximate, they indicate significant temperature inversions occur for at least 30% of the time in this area and therefore require assessment.

4.2.3 Drainage Flows

Cold air drainage flows tend to run downhill and would therefore flow in different directions over various areas of the site depending on local terrain. A detailed inspection of topography in the area indicates the Project is located on land that is above receiver properties in all directions, indicating cold air would flow in various directions during a temperature inversion. All cases, however, there is very little catchment area for significant cold air flows to form.

Given the wide variation in drainage flow directions and small expected flows arising from minimal catchment areas, additional noise enhancement due to drainage flows associated with temperature inversions is not expected to cause significant noise enhancement and has not been included.

4.2.4 Adopted Weather Conditions

Table 18 shows adopted atmospheric parameters for this assessment. The adopted weather conditions represent prevailing conditions for all receivers.

Table 18: Modelled Weather Conditions.

Atmospheric Parameter	Day and Evening			Night	
	Neutral	NE Wind	W Wind	Inversion	NE Wind
Temperature, °C	20	20	20	10	10
Relative Humidity, %	70	70	70	90	90
Wind Speed, m/s	0	3	3	0	3
Wind Direction	-	North-east	West	-	North-east
Temp Gradient, °C/100 m	-1	-1	-1	3	0

Noise contour figures for prevailing weather conditions have been prepared by taking the outer envelope, or maximum noise level, of each set of weather conditions for the relevant time period. For example, the day noise contours shown in Appendix A for prevailing weather conditions represent the maximum of the three sets of day weather conditions listed in Table 18.

4.2.5 Strong Temperature Inversions

In the absence of data clearly indicating the typical strength of temperature inversions that occur in this area, it is considered possible that inversions stronger than 3 °C/100 m may occur in the area from time to time.

Temperature inversions tend to cause increased received noise levels because they refract sound 'rays' down towards the ground. Winds also cause increased noise levels, for receivers down wind, for the same reason. Research indicates the effects of inversions and winds are approximately cumulative and the noise model software adopts this approach by combining inversions and winds into an equivalent inversion strength or an equivalent radius of curvature for sound rays. For the 'rural' terrain category in ENM software as used for this assessment, the equivalent inversion strength used for determining received noise levels is calculated by:

Equivalent Inversion °/100m = Inversion °/100m + 2.5 x Wind speed m/s. *Equation 1.*

Table 18 indicates the night scenarios include a 3 °/100m inversion or a 3 m/s wind from the north-east. According to Equation 1, a 3m/s wind is equivalent to a 7.5 °/100 m inversion for receivers downwind of the source. The night scenarios therefore include an equivalent inversion of 7.5 °/100 m for most receiver locations. This equivalent inversion is significantly stronger, and causes greater noise enhancement, than the INP default 3 °/100 m inversion strength.

The approach adopted in this assessment therefore satisfies the recommendations in the INP while simultaneously assessing the effects of strong noise enhancement for potentially affected receivers.

4.3 Noise Control and Management Measures

The Modifications are sought to permit continuation of mining immediately adjacent to previously mined areas. The Modifications, if granted, would permit mining for a relatively short period of approximately four years.

The INP acknowledges the difficulty of applying best practise noise control measures to established industrial premises. In addition, the nature of mining and other extractive industries often precludes relocation of noise sources to more shielded locations, as mining activity must occur where the resource to be mined is located.

Coalpac has advised that the relatively short duration of mining sought for each Modification cannot financially support acquisition of a best practise noise controlled equipment fleet. This assessment therefore adopts a conservative approach and considers typical noise levels produced by standard mining equipment, consistent with the standard mining fleets previously employed which remain available for use at both Invincible Colliery and Cullen Valley Mine.

4.4 Operational Noise Sources

4.4.1 Mining, Coal Processing and Transportation

Mining operations would require a number of items of fixed and mobile equipment to uncover, extract, process and transport coal. Sound power levels for mining and coal processing equipment have been derived from on-site noise measurements where possible or from manufacturer's data or from noise measurements around similar equipment on other mine sites. In particular, sound power levels for existing coal processing equipment at both Cullen Valley Mine and Invincible Colliery are based on noise measurements taken on site by Global Acoustics in December 2010.

Figures showing modelled noise source locations are attached in Appendix A following the noise contour figures. The figures show the modelled location of each source, where the actual location is the lower left corner of each text entity. Source heights above local ground level have been determined based on the estimated height of the acoustic centre for each source type, while sound power levels for modelled sources are shown in Table 19.

Table 19: Modelled Noise Sources and Sound Power Levels.

Code, Source	Octave Band Centre Frequency, dBL [1]									dBL Total	dBA Total
	31.5	63	125	250	500	1k	2k	4k	8k		
Mining Sources											
E1, EX2500 excavator	123	123	121	116	112	115	114	106	102	128.1	119.4
E2, EX1200 excavator	121	121	119	114	110	113	112	104	100	126.1	117.4
e, Coal 100t excavator	115	116	118	116	113	103	104	101	93	123.0	113.8
F, Cat 992 front end loader[3]	120	120	118	113	108	112	110	103	99	125.0	116.0
C, Cat 777 coal truck	113	115	117	116	115	112	111	102	98	123.1	117.5
O, Cat 785 overburden truck	114	116	118	117	116	113	112	103	99	124.1	118.5
o, Cat 777 overburden truck	113	115	117	116	115	112	111	102	98	123.1	117.5
D, Drill	121	121	114	106	110	111	112	107	98	125.1	116.7
Z, Dozer	120	121	119	116	114	112	113	108	106	126.2	118.6
G, Grader	117	117	119	117	112	101	102	99	91	124.0	113.2
W, Water cart	115	116	118	116	113	103	104	101	93	123.0	113.8
s, Service truck	117	119	116	112	105	101	97	93	87	122.8	108.5
R, Coal haul truck[2]	112	112	110	108	102	103	102	95	91	117.3	108.1
HM, Highwall miner	103	103	108	111	113	109	106	100	92	117.5	114.2
CHPP and Transportation Sources											
CP, Cullen Valley crusher	115	115	117	110	110	110	108	102	94	121.7	114.6
IC, Invincible crusher	101	108	109	110	113	112	112	106	97	118.9	117.0
K, Klockner Crusher	101	101	104	99	100	101	97	91	86	109.4	104.4
IP, Invincible CPP	128	122	117	117	118	116	115	109	103	130.1	120.9
CB, Invincible crusher building	110	110	106	105	103	102	99	93	84	114.8	106.4
B Multi-Product Bin	111	110	111	110	110	111	110	102	91	118.8	115.0
P, Water transfer/booster pump	96	97	99	97	94	84	85	82	74	104.0	94.8

1. dBL means unweighted, as opposed to A-weighted, noise levels.
2. Road-type haul trucks used to transport product coal off-site.

Minor items of equipment that are unlikely to produce significant audible noise at any receiver, such as light vehicles, have been omitted from the assessment.

Many mobile sources have been modelled in multiple locations for a proportion of the time at each location, such as four locations for 25% of the time at each location. Such sources are indicated in the source location figures in Appendix A with a '/2', '/4' or '/6' after the source code, indicating the source has been modelled at that location for approximately 50%, 25% or 16% of the time.

4.5 Predicted Mining Noise Levels

Noise levels from Modification operations have been modelled for the representative operating scenarios and time periods shown in Table 20.

Table 20: Modelled Weather Conditions.

Contour Figure	Time Period, Weather Conditions	Modelled Operations			
		Mining	Coal Processing	Coal Transport	Water Pump
Cullen Valley Mine					
1	Day Neutral	Included	Included	Included	-
2	Day Prevailing	Included	Included	Included	-
3	Evening Neutral	Included	Included	-	-
4	Evening Prevailing	Included	Included	-	-
Invincible Colliery					
5	Day Neutral	Included	Included	Included	Included
6	Day Prevailing	Included	Included	Included	Included
7	Evening Neutral	-	-	Included	Included
8	Evening Prevailing	-	-	Included	Included
9	Night Prevailing	-	-	-	Included

Table 20 indicates, for example, that coal transportation from Cullen Valley Mine to MPPS or other destinations is only proposed during the day period, while similar coal transportation from Invincible Colliery to MPPS is proposed during the day and evening periods. Proposed operating time restrictions are consistent with current planning approvals and prior operations.

Table 21 summarises predicted worst case noise levels from the proposed Cullen Valley Mine Modification at residences and over 25% of property areas, with shading to indicate residences or properties that would be potentially affected by the Modification. Residences and properties that are owned by a mining company or the Crown, are subject to a private agreement with Coalpac or are predicted to receive noise levels below 35 dBA, have been excluded from the table.

Table 21: Summary of Predicted Cullen Valley Mine Noise Levels, LAeq,15min.

Owner Ref	Residence				25% of Property Area				Noise Criteria Day/ Evening
	Lot Ref	Day		Evening	Lot Reference	Day		Evening	
		Neutral	Prevailing			Neutral	Prevailing		
Noise Contour Figure		1	2	4	Noise Contour Figure	1	2	4	
9	205	24.7	36.5	36.0	205,206	23.1	36.9	36.4	37/35
16	-	-	-	-	370	22.1	35.3	34.6	35/35
59	-	-	-	-	115,116,118,120, 121	24.3	35.6	35.3	35/35
63	-	-	-	-	124	24.0	35.8	35.3	35/35
64	123	13.2	21.4	33.4	123	26.2	36.1	35.5	35/35
65	142	23.6	36.1	35.5	142	26.2	37.5	36.8	35/35
66	143	22.3	35.5	35.0	143	22.3	38.7	38.3	35/35
68	209	31.1	36.7	24.1	209	26.0	34.6	32.8	43/38
70	211	33.9	36.3	19.1	211	35.3	38.2	19.9	43/38
Total Affected Residences/ Properties		-	-	-	Significant	-	-	-	-
		-	-	-	Moderate	-	2	1	-
		-	3	2	Mild	-	4	5	-

Red shading – a significant noise impact of 5 dBA or more above the intrusive criteria;
Blue shading – a moderate noise impact of less than 5 dBA above the intrusive criteria; and
Green shading – a mild noise impact of 2 dBA or less above the intrusive criteria.

Table 21 shows noise levels from the proposed Cullen Valley Mine Modification are expected to meet relevant noise criteria at all except three residences (205, 142 and 143), with minor predicted criteria exceedances in the range 0.5 to 1.5 dBA at these three residences during the day and 0.5 to 1.0 dBA at two (205 and 142) residences during the evening. Cullen Valley Mine is not proposed to operate during the night.

Noise levels from the Cullen Valley Mine Modification are also expected to meet relevant noise criteria over all except 7 property areas, with five properties (205 and 206, 370, 115 to 121 except 117 and 119, 123 and 124) expected to receive mild criteria exceedances of up to 2 dBA and two properties (142 and 143) expected to receive moderate criteria exceedances in the range 2.5 to 3.7 dBA.

Any issues arising from predicted noise levels over property areas, such as possible future subdivision of properties and construction of additional residences, are not expected to be significant considering the Modification seeks approval to extract a limited coal resource at Cullen Valley Mine.

Worst case predicted noise levels at Residence 205 are expected to occur intermittently when a water cart visits the water fill point at the southern end of the Cullen Valley mining area under worst case prevailing weather conditions, in this case a moderate north-easterly wind. Considering the intermittent nature of this noise source and the very minor predicted criteria exceedance under worst case conditions, noise levels at Residence 205 would substantially comply with the criteria.

Predicted noise levels at Residences 142 and 143 are expected to occur under simultaneous worst case operating and weather conditions, in this case operation of all mining equipment near the northern extent of the mining area during a moderate westerly breeze. Considering worst case predicted noise levels exceed the criterion by 0.5 to 1.1 dBA, noise levels at Residences 142 and 143 would substantially comply with the criteria and any noise impacts at these residences are expected to be insignificant.

Table 22 summarises predicted worst case noise levels from the proposed Invincible Colliery Modification at residences and over 25% of property areas, with shading to indicate residences or properties that would be potentially affected by the Modification. Residences and properties that are owned by a mining company or the Crown, are subject to a private agreement with Coalpac or are predicted to receive noise levels below 35 dBA, have been excluded from the table.

Table 22: Summary of Predicted Invincible Colliery Noise Levels, LAeq,15min.

Owner Ref	Residence				25% of Property Area				Criteria Day/ Evening
	Lot Ref	Day		Evening	Lot Reference	Day		Evening	
		Neutral	Prevailing			Neutral	Prevailing		
Noise Contour Figure		5	6	8	-	5	6	8	
18	-	-	-	-	387	27.5	36.1	20.5	40/35
23	403	25.1	35.9	21.9	403-405	25.7	36.1	22.8	40/35
	404	24.5	35.9	21.1					
24	406	22.2	32.6	18.7	406	23.8	36.6	21.8	40/35
26	408	21.4	32.6	19.6	408	22.6	36.2	20.9	40/35
72	349	34.0	37.6	19.3	349	33.4	35.9	19.3	40/35
73	391	28.7	37.4	22.0	374-376,390,391	33.6	38.5	21.0	40/35
75	392	32.7	40.2	24.3	392	33.9	39.9	24.0	40/35
77	373	30.5	34.5	17.3	373	30.6	35.1	17.2	40/35
78	388	29.5	37.2	21.0	388,409	29.7	37.3	20.4	40/35
79	-	-	-	-	410	27.0	36.6	18.9	40/35
80	412	27.4	38.5	24.9	412-414	29.6	39.3	26.2	40/35
81	419E	24.6	34.7	17.1	417-419	26.7	37.1	23.1	40/35
	419W	24.6	36.6	19.2					
82	421	24.9	33.1	15.8	411,415,416, 420-425	31.6	40.5	25.7	40/35
85	426	29.3	37.6	22.5	426,439,440	25.3	34.6	16.6	40/35
203	-	-	-	-	441	20.3	35.6	15.5	40/35
Total Affected Residences/ Properties		-	-	-	Significant	-	-	-	-
		-	-	-	Moderate	-	-	-	-
		-	1	-	Mild	-	1	-	-

Red shading – a significant noise impact of 5 dBA or more above the intrusive criteria;
Blue shading – a moderate noise impact of less than 5 dBA above the intrusive criteria; and
Green shading – a mild noise impact of 2 dBA or less above the intrusive criteria.

Table 22 shows Residence 392 is predicted to receive 0.2 dBA over the day noise criterion and 25% of the property occupied by Residence 421 is predicted to receive 0.5 dBA over the day noise criterion. These predicted criteria exceedances are very minor in nature and, accordingly, the proposed Invincible Colliery Modification is considered to meet the noise criteria.

4.6 Predicted Low Frequency Noise Levels

According to the INP, low frequency noise levels can become significant if the predicted or measured noise level at a receiver contains dominant noise in the 20 Hz to 250 Hz frequency bands. The INP recommends a low frequency noise penalty of 5 dBA be added to received noise levels before comparison with the criteria if the received dBC level is more than 15 dB above the received dBA level.

The need for a low frequency penalty has been assessed at representative residences, using the single-point mode of the noise model software which allows the received noise spectrum to be predicted. Total dBC and dBA levels are shown in Table 23 for all residences near Cullen Valley Mine and Invincible Colliery that are predicted to receive a noise level over 35 dBA.

Table 23: Predicted Low Frequency Noise Levels, dBC and dBA.

Time Period, Weather Conditions, Receiver	Octave Band Centre Frequency, dBL								dBC	dBA	dBC-dBA
	31.5	63	125	250	500	1k	2k	4k			
Cullen Valley Mine Receivers											
Day, Prevailing, Residence 205	48	50	47	42	40	28	15	-9	52.8	39.3	13.5
Day, Prevailing, Residence 142	47	45	45	37	37	30	18	-10	49.9	37.2	12.7
Day, Prevailing, Residence 143	45	46	45	37	37	29	16	-13	49.5	36.8	12.8
Day, Prevailing, Residence 209	47	45	38	33	35	33	26	10	48.0	36.6	11.4
Day, Prevailing, Residence 211	48	45	39	34	33	32	29	15	48.6	36.3	12.2
Evening, Prevailing, Resid 205	46	50	47	41	39	26	13	-11	52.2	38.8	13.3
Evening, Prevailing, Resid 142	47	45	44	37	37	28	16	-12	49.2	36.6	12.6
Evening, Prevailing, Resid 143	45	45	44	37	36	27	14	-15	48.7	35.9	12.8
Evening, Prevailing, Resid 209	39	37	34	27	22	4	-10	-40	40.5	23.6	17.0
Evening, Prevailing, Resid 211	36	33	29	22	17	3	-12	-37	36.8	18.6	18.2
Invincible Colliery Receivers											
Day, Prevailing, Residence 349	51	45	43	43	36	29	16	-13	51.1	37.8	13.3
Day, Prevailing, Residence 388	51	48	44	42	39	27	13	-19	52.1	38.4	13.7
Day, Prevailing, Residence 391	51	48	45	41	37	25	9	-25	52.1	37.3	14.7
Day, Prevailing, Residence 392	56	50	45	43	40	31	20	-5	55.2	39.9	15.3
Day, Prevailing, Residence 403	50	46	47	40	35	22	4	-40	51.8	36.6	15.1
Day, Prevailing, Residence 404	49	47	47	40	35	21	2	-43	51.6	36.4	15.2
Day, Prevailing, Residence 412	52	49	48	42	39	29	14	-20	53.5	39.3	14.2
Day, Prevailing, Resid. 419W	51	47	47	40	38	26	11	-24	52.1	37.8	14.3
Day, Prevailing, Residence 426	54	46	42	36	34	27	15	-8	52.3	34.7	17.7

Table 23 indicates all of the closest Cullen Valley Mine residences are expected to receive acceptable low frequency noise levels. A dBC to dBA difference of greater than 15 dB is noted for Residences 209 and 211 under evening prevailing weather conditions, however received noise levels under these conditions are more than 5 dBA below the criterion. Addition of a 5 dBA low frequency penalty would increase reported received noise levels to 29 and 24 dBA which remain significantly below the 38 dBA evening criterion at these receivers.

Table 23 also indicates low frequency noise levels are acceptable or marginally acceptable at all Invincible Colliery receivers. A dBC to dBA difference of 15.1 to 15.3 dB is noted at Residences 392, 403 and 404, however these differences are only marginally over the 15 dB threshold. A strict interpretation of the INP, including a 5 dB low frequency penalty for these three receivers, is not appropriate as such a penalty would result in Residences 403 and 404 being considered affected by the Modification while closer receivers such as 388, 391 and 412 would be considered unaffected. Such an outcome is not considered reasonable.

Residence 426 is also expected to receive a dBC to dBA difference of more than 15 dB, however the addition of a 5 dBA penalty at this receiver would result in a predicted noise level of 39.7 dBA which would remain within the 40 dBA daytime criterion.

Low frequency noise levels are not assessed at Invincible Colliery receivers during the evening and night as noise levels during these time periods are in all cases more than 5 dBA below relevant noise criteria.

4.7 Assessment of Residual Noise Impacts

Chapter 8 of the INP recommends a range of equity and other issues be considered to place any predicted residual noise impacts into context and assist in weighing the noise impacts against other environmental, social and other impacts and benefits of the proposed Modifications.

4.7.1 Characteristics of the area and receivers likely to be affected

The extent and number of receivers affected

Both Modifications are proposed to permit continued operation of established coal mining developments, with no significant change to equipment or mining practises and natural extensions of mining areas for a relatively short period.

The closest receivers to Cullen Valley Mine and Invincible Colliery are rural landholdings that are primarily used for cattle grazing, with some of the closest rural properties owned by Coalpac or its affiliates. Receivers located generally east of Cullen Valley Mine and west of Invincible Colliery currently receive traffic noise from the Castlereagh Highway, with receivers west of both mines currently receiving intermittent train noise from the Wallerawang – Gwabegar Railway Line.

Four residences are predicted to receive noise levels over current daytime noise criteria, with predicted criteria exceedances in the range 0.2 to 1.5 dBA which are considered minor. Two of these four residences are also predicted to receive noise levels over the criteria during the evening, with minor predicted exceedances in the range 0.5 to 1.0 dBA. Predicted criteria exceedances would occur under simultaneous worst case operating and weather conditions, which would only occur occasionally. Noise levels would therefore comply with the criteria at all residences for the majority of the time.

The daily activities of the community

The majority of rural receivers in the vicinity of Cullen Valley Mine and Invincible Colliery either occupy small rural residential properties or own or operate farming enterprises which include intermittent and occasional use of tractors and other diesel powered machines to complete various tasks. A number of receivers also derive income from other sources apart from farming and therefore travel daily to places of employment in the local or regional area.

Property values

The property values of receivers adjacent to the Modification Boundaries are consistent with the rural nature of the area and the market values of such land.

Zoning of receiver properties and the appropriateness of the zoning

Surrounding receivers are predominantly located on land zoned 1(a) – Rural (General) under the *Lithgow City Local Environmental Plan 1994*. This zoning allows agricultural activities, with mining and other industrial activities permissible with development consent.

Potential change in ambient levels as a result of the Modifications

The acoustic environment in the region is complex with a mix of industrial, mining, transportation and other noise sources in the area. Coal mines and associated power generation facilities have been located in the region for decades, as have rural activities such as cattle raising and use of major transport links such as the Castlereagh Highway and the Wallerawang – Gwabegar Railway Line (WGRL).

All receivers that are potentially affected by the Modifications would have previously received some mining or coal transportation noise from either Cullen Valley Mine or Invincible Colliery, depending on the location of the receiver. Receivers located generally north east of Cullen Valley Mine would also have previously received some noise from Baal Bone Colliery and currently receive significant noise from the Castlereagh Highway. Receivers located generally west of Invincible Colliery currently receive significant noise from the Castlereagh Highway and the WGRL, while some receivers in this area would have received some noise from coal mining and rehabilitation work associated with the Ivanhoe North Coal Project.

The extent of impacts to birds and other animals

Birds and other animals quickly become accustomed to noise from various sources such as coal mining and road traffic, as evidenced by the variety of wildlife that can be observed adjacent to highways and other roads. Traffic noise levels adjacent to roads can reach levels greater than predicted noise levels from the Modifications.

Mining companies regularly use land adjacent to active mining areas for cattle grazing, with no noticeable adverse impact on the animals, while birds can often be observed in the vicinity of mining areas. Noise levels from the Modifications would be similar to previous noise levels from Cullen Valley Mine and Invincible Colliery. There is no known evidence that previous mining noise levels from Cullen Valley Mine or Invincible Colliery have caused adverse noise impacts on domestic or wild animals.

The likely variation between individuals in response to the noise

There can be a large variation in an individual's response to industrial noise based on dose-response and other research in Australia and overseas.

Recent mining activity associated with Cullen Valley Mine and Invincible Colliery did not attract noise related complaints from the group of residents located to the north. Occasional complaints relating to noise have been received from one complainant located to the west. As predicted noise levels are consistent with previous noise levels, no further noise related complaints are expected to be received by Coalpac as a result of the Modifications.

The amenity of areas used for outdoor recreation or conservation, heritage or wilderness areas

The Ben Bullen State Forest adjoins the eastern boundary of both Cullen Valley Mine and Invincible Colliery. Noise levels associated with the proposed Modifications would remain consistent with previous noise levels in publicly accessible areas of the Ben Bullen State Forest.

Noise levels within the township of Cullen Bullen, including over any parks or reserves within the township, would be below 35 dBA and would therefore be acceptable.

Other industry in the area (including agriculture)

Cattle grazing currently occurs on properties in the vicinity of the Modification Boundaries, however this is a low-intensity agricultural activity requiring only occasional mechanical assistance. Other coal mining developments in the region include Baal Bone, Enhance Place and Angus Place Collieries, while other major industries in the region include MPPS and Wallerawang Power Station. Coal mining and power generation are long standing major industries that significantly contribute to the regional economy.

Some audible noise can be generated by local industries such as the Hyrock Depot located north east of Invincible Colliery, while an approved but not yet constructed small quarry may be established in the future near Portland Road west of Cullen Bullen township.

4.7.2 Characteristics of the proposal and its noise or vibrations

The noise characteristics of the activity

Operations proposed under each Modification would generally produce a semi-continuous low hum with regular variations as specific machines such as haul trucks move from place to place. Noise levels would vary from being inaudible or barely perceptible to being clearly audible depending on the location and orientation of the receiver, background noise levels and weather conditions.

Proposed operating hours restrictions, particularly with no proposed night work, would significantly limit any potential for noise impacts at receivers. Existing coal haulage restrictions from Cullen Valley Mine, to the daytime period only, limit any noise impacts associated with coal transport to Cullen Bullen receivers. Mining at Invincible Colliery would only occur during the day.

With only minor noise impacts predicted at a few residences under reasonable worst case conditions, noise levels from the Modifications would generally comply with current noise criteria and any exceedances of the criteria would be occasional and intermittent, and very minor, in nature.

The extent to which any remaining noise impacts exceed the PSNLs

Four rural residences are predicted to receive noise levels over current noise criteria, with predicted criteria exceedances in the range 0.2 to 1.5 dBA under reasonable worst case operating and daytime weather conditions. Two of these residences are predicted to receive up to 1.0 dBA over the evening noise criterion under reasonable worst case operating and weather conditions, which is not considered significant.

The circumstances and times when the PSNLs are likely to be exceeded

Exceedances of the current noise criteria are predicted to occur under combined worst case operating and weather conditions, which are expected to occur occasionally and intermittently rather than regularly and consistently. Four rural residences are predicted to receive noise levels 0.2 to 1.5 dBA over the daytime noise criteria, while two of these residences are predicted to receive 0.5 to 1.0 dBA over the evening criteria.

The circumstances and times when noise levels are likely to be lower than the PSNLs

Predicted noise levels are expected to occur under reasonable worst case operating and weather conditions combined. Noise levels would generally be lower than the predicted levels and, considering the minor nature of predicted criteria exceedances, would meet current noise criteria for most of the time at all receivers.

The accuracy with which impacts can be predicted, and the likelihood that the impacts will occur in the manner predicted

The predicted noise levels were calculated using industry best practice noise modelling methods which are generally acknowledged to provide an accuracy of 2 dBA in most cases. Periods of higher noise levels may occur due to relatively brief periods of strongly noise enhancing weather conditions, however such periods are expected to occur occasionally and are difficult to reliably predict.

Coalpac has committed to regular noise monitoring at representative receiver locations to confirm the predicted noise levels would be met.

The degree to which the character of the noise is new to an area and differs from existing noise sources

Both proposed Modifications are sought to permit continuation of currently approved operations, with Invincible Colliery seeking an additional operating period of 4 years. Noise levels would be very similar to noise levels previously produced by both Cullen Valley Mine and Invincible Colliery, as no significant changes to mining methods or mining machines are proposed.

Receivers would therefore be used to noise associated with each proposed Modification.

The economic benefit and social worth of the proposal for the local area, the region or the nation

As described in Section 6.9 (Economics) of this EA, the proposed Modifications are estimated to have net social benefits to Australia of between $219M and $227M and hence are desirable and justified from an economic efficiency perspective.

The Modifications are estimated to make the following total annual contributions to the regional economy for the proposed period of continued operation:

- $149M in annual direct and indirect regional output or business turnover;
- $46M in annual direct and indirect regional value added;
- $19M in annual direct and indirect household income; and
- 245 direct and indirect jobs.

4.7.3 The feasibility of additional mitigation or management measures

Alternative sites or routes for the development

As each proposed Modification includes continuation of existing mining developments, there are no reasonable alternative sites for the developments.

The technical and economic feasibility of alternative noise controls or management procedures

The proposed Modifications do not propose additional noise mitigation measures above those that have been successfully employed previously. Further mitigation measures are technically possible, however any such measures are not economically feasible considering the market for this coal is domestic thermal coal for MPPS and the short duration of proposed operations.

In addition, the minor and occasional nature of predicted exceedances of the current noise criteria indicate significant noise control costs would be difficult to justify even if the Modifications provided additional financial resources.

4.7.4 Equity issues

The costs borne by a few for the benefit of others

The EA for the Modifications acknowledges all of the social, environmental and economic impacts of the Modifications, being negative, positive or neutral. The predicted minor and occasional noise impacts at a few residences are considered justified by the expected economic benefits to the local and regional community.

The long term cumulative increase in noise levels

There are no predicted exceedances of the INP cumulative noise criteria at any receiver. The Modifications seek approval for a relatively short term operating period, which would limit the potential for any long term increase in environmental noise levels.

The opportunity to compensate effectively those affected

Research has repeatedly indicated an average noise level increase of less than 2 dBA, in a varying noise source such as traffic, is barely perceptible to the average person.

Mining noise is similar to semi-continuous traffic noise in that it varies over short and medium time scales from a few seconds to a few minutes. A mining noise level change of up to 2 dBA and by extension an exceedance of up to 2 dBA above current noise criteria is therefore unlikely to be noticed by receivers. In the absence of noticeable noise impacts at any receiver, no noise related compensation is expected to be required.

4.7.5 Justification

Considering the very minor and occasional extent of predicted noise criteria exceedances, no noticeable or significant noise impacts are expected to occur at any receiver. The proposed Modifications are therefore considered justifiable considering the issues raised in Chapters 8 and 9 of the INP.

4.8 Recommended Noise Monitoring

Noise levels from each Modification area should be monitored to confirm the predicted noise levels are not exceeded. A continuation of the current noise monitoring strategy would generally be appropriate, however a review of the current noise management plans for Cullen Valley Mine and Invincible Colliery would be required to confirm the plans remain relevant to the Modifications.

Each review should specifically consider the relevance of current noise monitoring locations. The Invincible Colliery monitoring locations at properties 393 'Billabong' and 394 'Hillview' may no longer be required as both properties are owned by an affiliated entity of Coalpac. It may be appropriate to replace these locations with others such as properties 392 and perhaps 426.

The Cullen Valley Mine monitoring locations at properties 169 and 199 may no longer be required as recent noise monitoring consistently shows mining noise is not audible at these properties. In addition, property 169 is now owned by Coalpac. It may be appropriate to relocate these monitoring locations to properties such as 114 and 143 located generally north and north-east of Cullen Valley Mine.

4.9 Construction Noise

4.9.1 Construction Activities

Installation of a water transfer pipeline from the northern section of Invincible Colliery to property 197 (owned by Coalpac) would be the only significant construction work associated with the proposed Modifications. The earthmoving phase for construction activities typically produce the highest sound power level and is therefore considered in this assessment.

Proposed pipeline construction work would occur within 'daytime' hours as defined in the INP which are 7am to 6pm Monday to Saturday and 8am to 6pm Sunday and public holidays.

4.9.2 Construction Noise Sources

Table 24 shows typical construction noise sources required to complete the proposed works, assuming all machines operate simultaneously to present a worst case assessment.

Table 24: Proposed Pipeline Construction Sources and Sound Power Levels.

Typical Construction Machines	Sound Power Level, LAeq	
	Per Machine	Total
Backhoe/bobcat x1	108	115
Truck x1 (50% of the time)	105	
Excavator x1	114	

Table 24 shows a sound power level of 115 dBA is appropriate to assess noise levels from construction work associated with the water transfer pipeline.

4.9.3 Construction Noise Assessment

Existing vegetation and topography prevent a direct line of sight from much of the pipeline route to sensitive receivers. The majority of the pipeline route is shielded by natural ridgelines and vegetation in the Ben Bullen State Forest, and is remote from receivers.

A short section of pipeline would run approximately 400 m to 800 m from closest receivers located near the Castlereagh Highway. Assuming a direct line of sight to a receiver, a predicted sound power level of 115 dBA from pipeline construction work would produce a noise level of approximately 55 dBA at a receiver located 400 m from the work site, and a noise level of approximately 49 dBA at a receiver located 800 m from the work site, for a period of a few days as the construction work progresses past these receivers.

A predicted noise level in the range 49 to 55 dBA would be significantly above the current mining noise criteria, however the very limited duration of noise impacts at each receiver would limit the extent of noise impacts. Further, the nature of the work and flexibilities afforded while undertaking these works, such as avoiding noise enhancing weather conditions, restricting truck delivery times and reducing the items of machinery would assist in minimising potential adverse impacts to sensitive receivers in this area. Nevertheless, a construction noise management plan is recommended to ensure all feasible and reasonable noise mitigation and management measures are considered and implemented.

4.10 Sleep Disturbance

Proposed operating hours for both Cullen Valley Mine and Invincible Colliery Modifications exclude night operation, with the exception of the proposed water transfer pumps and pipeline that may be required to operate at night. Predicted noise levels from the transfer pumps, as shown in Figure A9 in Appendix A, would be significantly below 30 dBA at any receiver therefore no sleep disturbance impacts are expected to occur.

4.11 Road Traffic Noise

Noise from vehicles travelling on public roads such as the Castlereagh Highway, excluding noise from vehicles travelling within Cullen Valley Mine and Invincible Colliery, is assessed in this section.

Vehicles accessing Cullen Valley Mine would generally use the Castlereagh Highway and the Cullen Bullen Bypass, while the majority of vehicles accessing Invincible Colliery would travel from the south via the Castlereagh Highway.

4.11.1 Existing Traffic Flows

Traffic and Transport Impact Assessment (Hyder Consulting, 2011) (Hyder Report) includes an assessment of existing traffic flows on the Castlereagh Highway in the vicinity of Cullen Bullen. Section 2 of the Hyder Report concludes the Castlereagh Highway carried approximately 3,500 vehicles per day in 2010/2011, with an increase in background traffic flows of approximately 2% per annum.

A *Review of Traffic Issues* (DC Traffic Engineering, December 2013) concluded the traffic flows and annual increase in background traffic reported by Hyder remained valid.

Existing Castlereagh Highway traffic flows reported by Hyder included traffic associated with Cullen Valley Mine and Invincible Colliery operations, therefore no additional traffic associated with each proposed Modification should be added. An annual increase of 2% per annum for traffic not associated with the Modification implies a total of 3750 vehicles per day in 2014, excluding expected decreases in regional traffic flows arising from the recent suspension of Baal Bone Colliery and completion of the Ivanhoe North Project.

4.11.2 Construction Traffic Flows

Construction of the water transfer pipeline is expected to generate less than 10 vehicle trips (20 vehicle movements) per day for a period of approximately one month. Additional traffic noise associated with the construction phase is therefore considered insignificant and has not been assessed further.

4.11.3 Calculated Traffic Noise Levels

Traffic noise calculations are based on the Calculation of Road Traffic Noise (CoRTN) method developed by the United Kingdom Department of Transport (UKDoT), with adjustments to the base method to determine an average (LAeq) noise level. The traffic noise calculations include an assumption that 90% of the Annual Average Daily Traffic (AADT) occurs in a 15 hour day.

The operational situation for the Modifications would result in the continuation of haulage to domestic destinations by truck as currently approved for both Cullen Valley Mine and Invincible Colliery. Proposed traffic noise levels would therefore be consistent with the existing situation. Calculated traffic noise levels based on 3,800 vehicle movements per day are shown in Table 25.

Table 25: Calculated Castlereagh Highway Traffic Noise Levels, Day, LAeq,15hr.

Scenario	AADT				Calculated LAeq,15hr		
	Base Traffic	+Trucks	+Cars	Total	At 50m	At 100m	At 1000m
2010/2011 traffic	3006	404	90	3500	58.7	55.0	42.5
2014 traffic	3254	404	90	3748	58.9	55.3	42.7
2018 traffic	3522	404	90	4016	59.1	55.5	43.0

Table 25 shows the 60 LAeq,15hr traffic noise criterion would be met at any residence 50m from the Castlereagh Highway.

The closest residence to the Castlereagh Highway between Invincible Colliery and MPPS (excluding residences owned by Coalpac) is Residence 426, located approximately 1 km west of the Highway. Traffic noise levels associated with the Modification would remain significantly below the noise criteria at this residence, with no noticeable change from current noise levels, and would therefore be acceptable at all receivers.

4.12 Blast Overpressure and Vibration

Blasting would be required to prepare overburden for removal. A typical blast includes a number of separate charged holes which are detonated in a specific pattern to maximise the effectiveness of the blast. The Modifications will require less than the currently approved 20 blast events per month, or five blasts per week, at each of Cullen Valley Mine and Invincible Colliery to achieve the proposed production rates.

Blast effects including ground vibration and overpressure depend on the following factors:

- Ground conditions including rock types and layers;
- Groundwater conditions including extent and depth;
- Distance from the blast site to a receiver;
- How well the explosive charges are confined with stemming material;
- Maximum Instantaneous Charge (MIC) for the blast event;
- Topography between the blast site and receivers; and
- Atmospheric conditions including wind speed, wind direction and vertical temperature gradient.

Blast effects have been calculated using the equations in Appendix J of *Australian Standard 2187.2-2006 Explosives – Storage and use, Part 2: Use of explosives*. The MIC is determined by the weight of explosive material per hole multiplied by the maximum number of holes detonated simultaneously within the firing pattern and is typically in the range 50 to 600 kg for many previous blast events at Cullen Valley Mine and Invincible Colliery.

A database of previous blast events at Cullen Valley Mine and Invincible Colliery has been analysed. The blast data indicate the Australian Standard vibration and overpressure equations are appropriate for both Modification areas based on commonly adopted values of K = 1140 and B = 1.6 for the ground vibration coefficients.

The existing Blast Management Plans would be reviewed to ensure they remain relevant to the modified operations.

4.12.1 Predicted Blast Effects

Table 26 shows calculated ground vibration and overpressure levels for closest blast events to each receiver location, taking into account topographical or other shielding between the blast site and the receiver where relevant. Results have been calculated in the absence of mitigation measures and should be compared with the 5 mm/s and 115 dB criteria for occupied residences and a conservative ground vibration criterion of 20 mm/s for sensitive aboriginal rock shelters. Calculated overpressure levels assume a typical well confined bench blast.

Table 26 indicates no exceedances of appropriate blast criteria are expected at any receiver.

Table 26: Predicted Blast Effects, No Mitigation.

MIC, kg	75	150	300	600	75	150	300	600	Criteria
Receiver (closest distance)	Ground Vibration, mm/s				Overpressure, dBL				mm/s, dBL
Residence 139 (1390m)	0.4	0.6	1.1	1.9	102	105	108	111	5, 115
Residence 114 (1510m)	0.3	0.5	0.9	1.6	101	104	107	110	5, 115
Residence 142 (1550m)	0.3	0.5	0.9	1.5	100	103	106	109	5, 115
Residences 426 (1450m)	0.3	0.6	1.0	1.7	101	104	107	110	5, 115
Residence 392 (1800m)	0.2	0.4	0.7	1.2	99	101	104	107	5, 115
Cullen Bullen (>1100m)	0.5	0.9	1.5	2.6	100[1]	103[1]	106[1]	108[1]	5, 115
Rock shelters (> 400m)	2.5	4.3	7.5	13.1	N/A[2]	N/A[2]	N/A[2]	N/A[2]	20, N/A

1 Overpressure level reduced by 5 dBL due to significant topographical shielding.

2 Overpressure criteria are not required for the rock shelters as they are not sensitive to overpressure.

4.13 Cumulative Noise Levels

Cumulative noise impacts would potentially be caused by simultaneous operation of both Cullen Valley Mine and Invincible Colliery and other nearby major industrial developments including:

- The existing MPPS and the MPPS Extension Project to the south; and
- The Western Rail Coal Unloader to the south of MPPS.

Additional major industrial developments that are too far from the Project to have the potential for cumulative noise impacts, and have therefore not been considered further, include:

- Angus Place/Springvale Collieries;
- Pine Dale Coal Mine, including the Yarraboldy Extension; and
- Wallerawang Power Station.

Cumulative noise levels have been assessed under noise enhancing weather conditions, as predicted noise levels are higher under those conditions. For the purposes of this assessment, average noise levels over an entire day (LAeq,11hr) are estimated at 3 dBA lower than the predicted LAeq,15min level listed in Table 22 due to typical variation in open cut mine operations and weather conditions during an average day.

In contrast, MPPS tends to operate consistently with minimal variation in noise level during a typical day or evening period. Noise from MPPS would vary to some extent due to variable weather conditions during a day, however this variation has been conservatively ignored for the purposes of this assessment. Existing noise levels from MPPS are discussed in Section 2.9.

Noise levels from the proposed Western Rail Coal Unloader are described in the *Western Rail Coal Unloader Environmental Assessment* (SKM, 2007), specifically in the noise impact assessment in Appendix F. Table 6-3 in the noise impact assessment indicates a predicted noise level of up to 39 LAeq,15min during adverse weather conditions at the closest Receiver 5 from combined activities associated with the Unloader including train movements, the dump hopper and conveyors. Receiver 5 is approximately 560m from the nearest point on the rail loop and approximately 1300m from the dump hopper.

Results from the cumulative noise assessment for representative private receivers are presented in Table 27. Residences expected to receive less than 33 dBA from all three assessed developments have generally been excluded from the table. A dash '-' in Table 27 indicates predicted noise levels less than 28 LAeq. Cumulative noise levels during the evening and night have not been assessed as Invincible Colliery is not proposed to operate during these time periods.

Table 27: Cumulative Noise Assessment.

Owner Ref	Residence Ref	Noise Level Contribution, LAeq,11hr day				
		Cullen Valley Mine	Invincible Colliery	MPPS and MPPS Extension Project	Western Rail Coal Unloader Project	Cumulative Noise Level
23	403	27.0	32.9	28	-	34.9
	404	26.2	32.9	28	-	34.8
72	349	20.8	34.6	28	-	35.6
73	391	26.9	34.4	29	-	36.1
75	392	24.2	37.2	30	-	38.1
80	412	26.0	35.5	30	-	36.9
85	426	19.2	34.6	34	-	37.4

Table 27 shows cumulative noise levels would remain well below the 50 LAeq,11hr day noise criterion recommended for rural residences. No cumulative noise impacts are therefore expected to occur at any receiver.

5 CONCLUSION

This assessment shows environmental noise levels from the proposed Cullen Valley Mine and Invincible Colliery Modifications are expected to substantially meet current noise criteria, with only minor predicted noise impacts in the range 0.2 to 1.5 dBA at four residential receivers. A review of each current Noise Management Plan is recommended, with a focus on confirming previous noise monitoring locations or updating the monitoring locations, to ensure each plan remains relevant.

Construction noise associated with the water transfer pipeline from Invincible Colliery to Property 197 is expected to generally have minimal noise impacts. There is potential for adverse noise impacts to occur at sensitive receivers while installing the pipeline on part of Property 197 adjacent to the Castlereagh Highway. These works may be clearly audible during breaks in highway traffic and would potentially exceed relevant operational noise criteria for a period of a few days. The very short construction period and flexibility of the proposed works in terms of timing and construction equipment is expected to limit any noise impacts, therefore construction noise levels associated with the Modifications are considered acceptable. Nevertheless a Construction

Management Plan should be developed and implemented to ensure all feasible and reasonable noise mitigation measures are implemented during the pipeline construction phase.

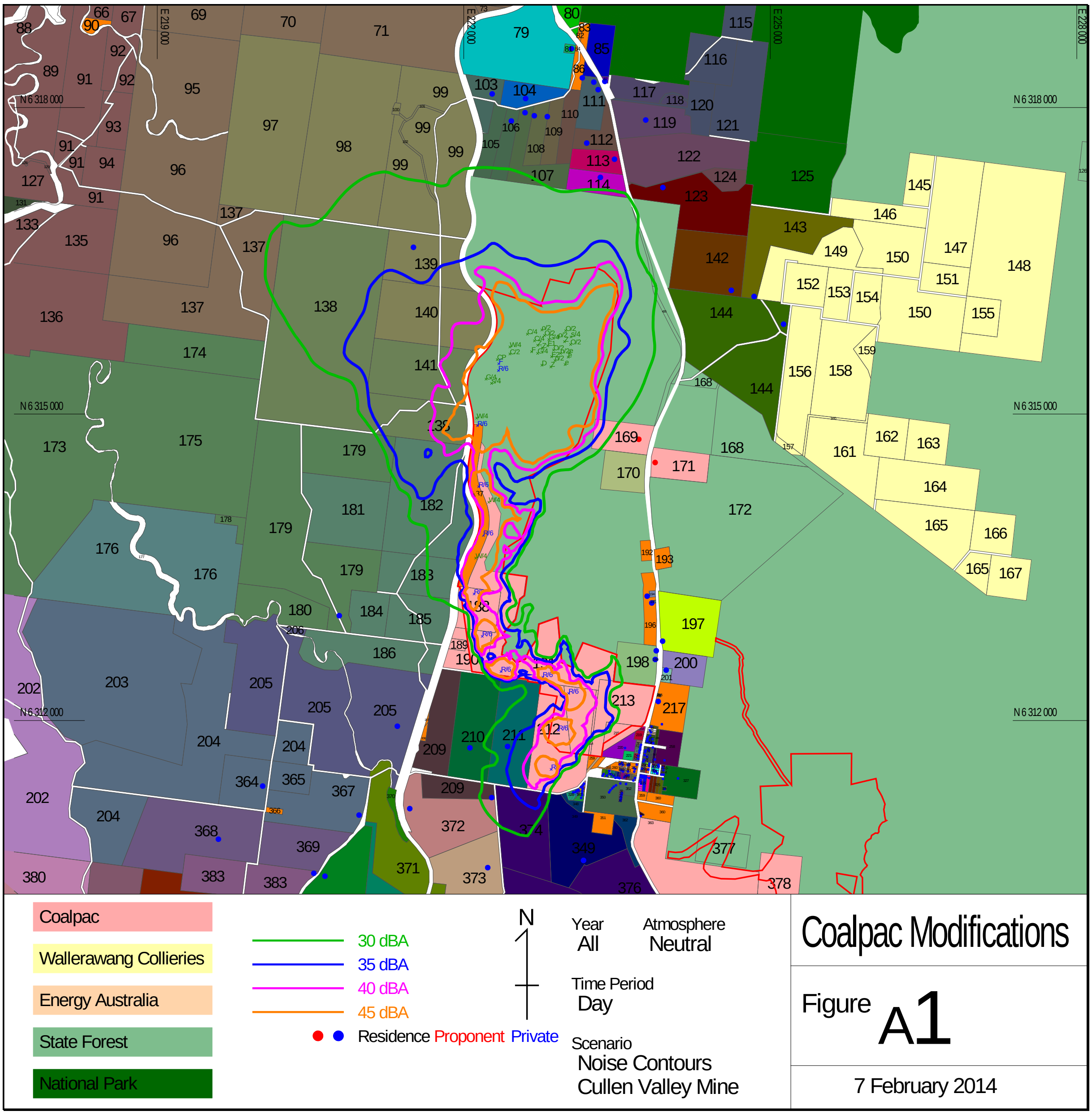
Sleep disturbance cannot reasonably occur from the Modifications as no significant night operation is proposed. The proposed water transfer pumps and pipeline may operate at night, however noise levels from these sources would not be audible at any receiver.

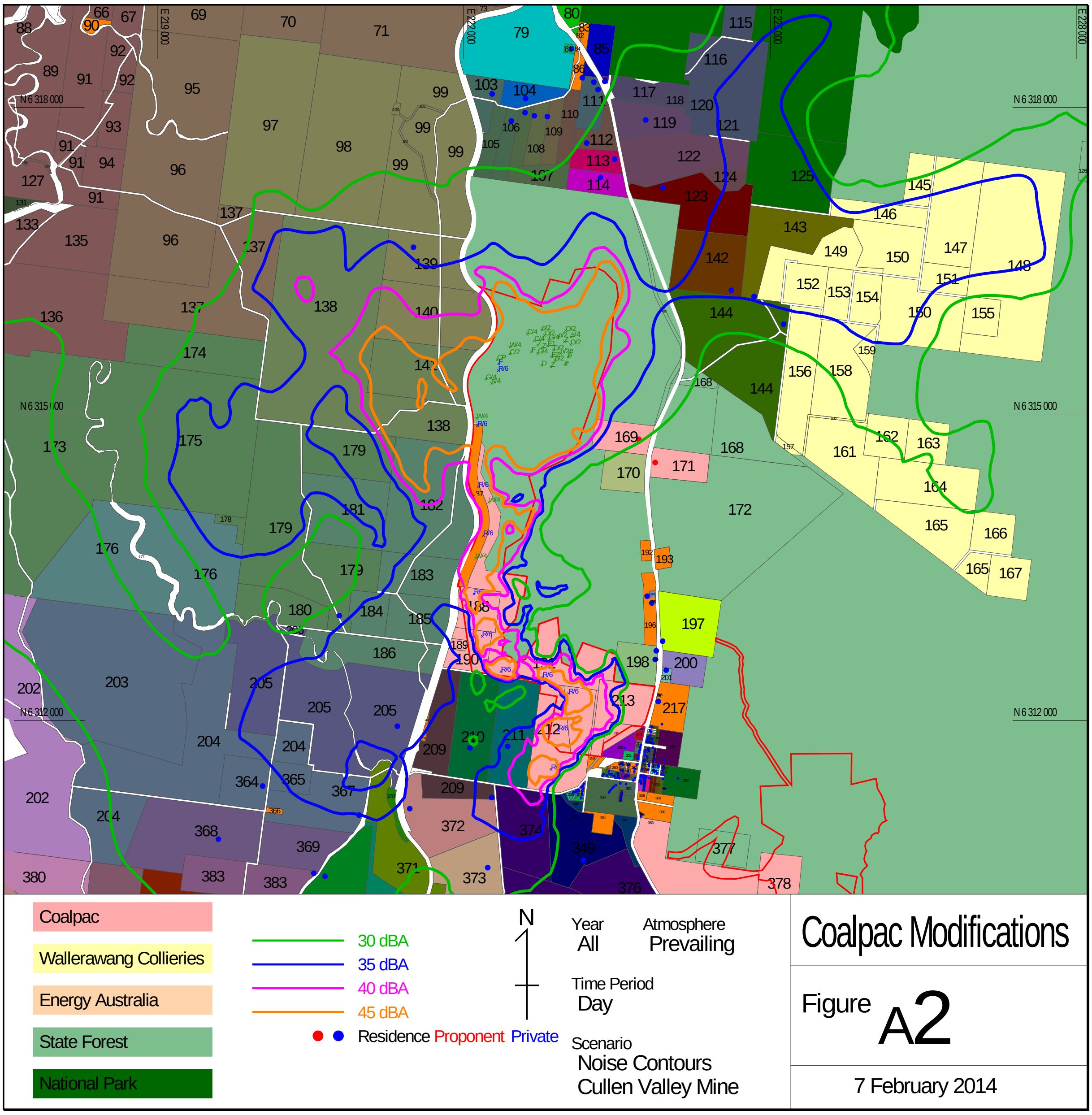
Noise from road traffic associated with transfer pipeline construction is expected to be insignificant, while traffic noise associated with the Modifications is expected to comply with relevant criteria at all sensitive receivers.

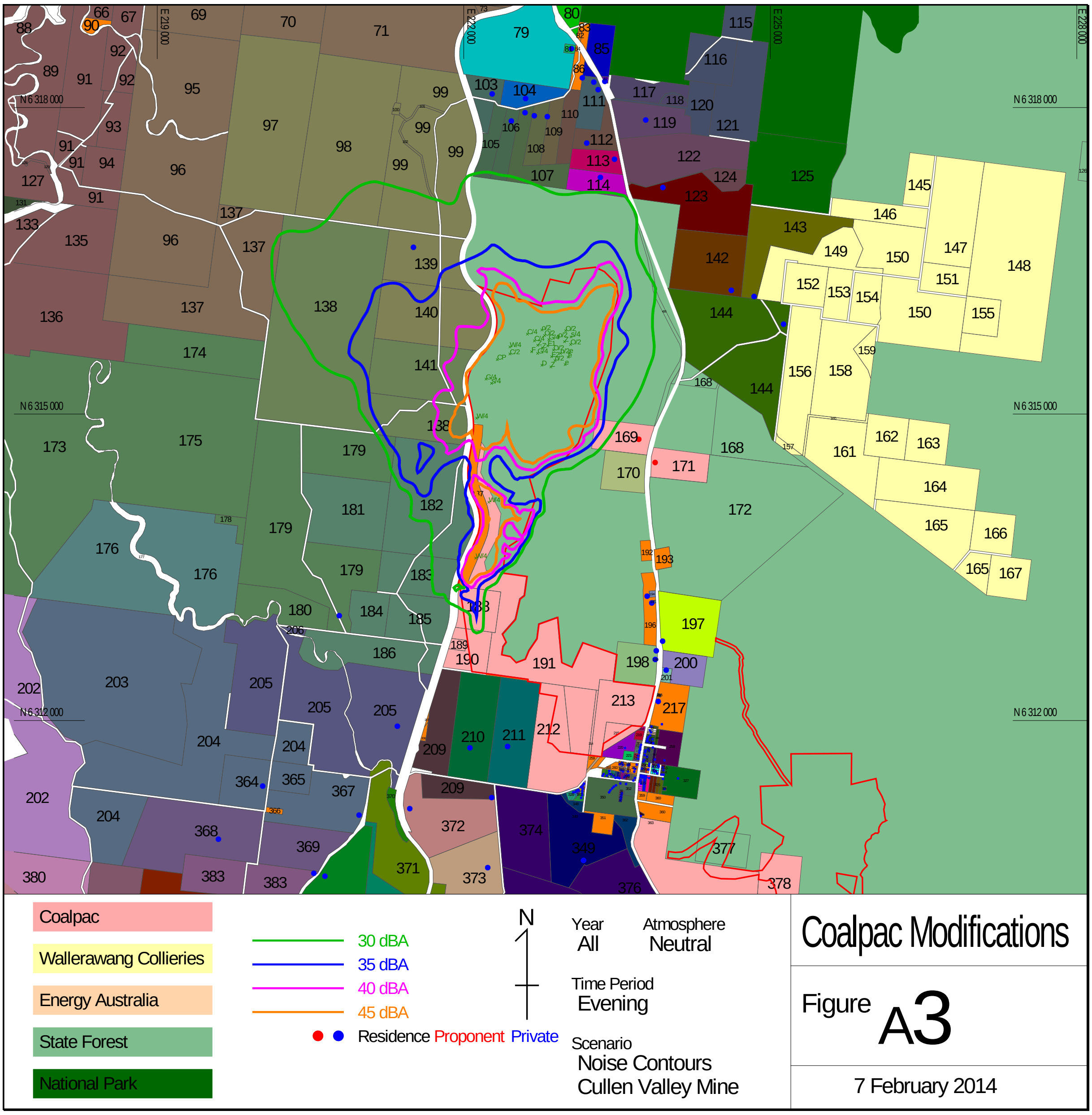
An assessment of low frequency noise levels indicates a few receivers may experience some low frequency noise, however such noise would remain substantially within relevant criteria. Significant low frequency noise impacts are therefore unlikely to occur at any privately owned receiver.

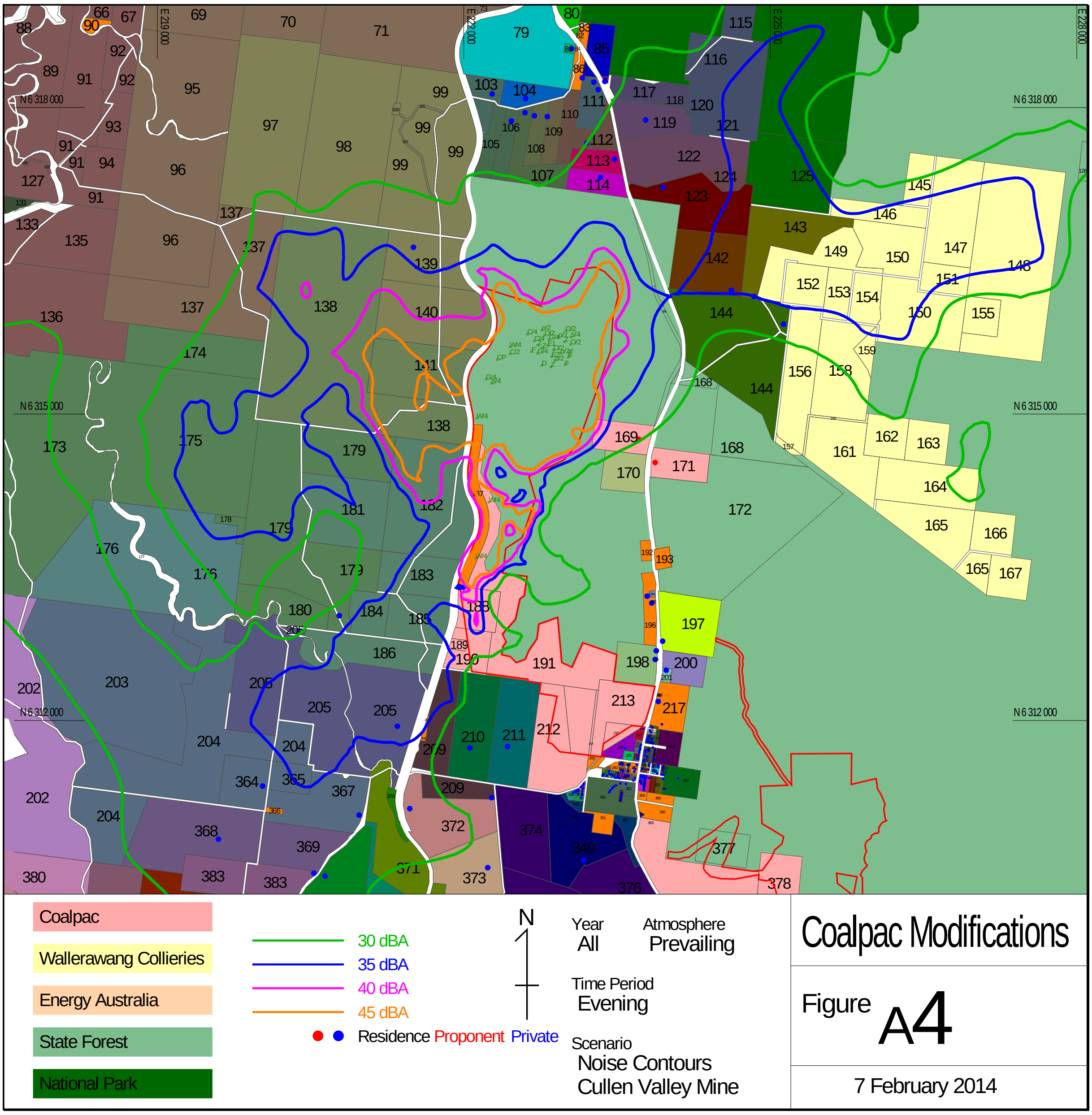
Blasting effects will be consistent with ground vibration and overpressure levels experienced during recent mining activities under existing approvals. No adverse impacts are expected at sensitive receivers, heritage buildings or known aboriginal heritage sites. A review of each Blast Management Plan is recommended to ensure the plans remain relevant.

APPENDIX A – FIGURES


Coalpac
Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year
All
Atmosphere
Neutral
Time Period
Day
Scenario
Noise Contours
Cullen Valley Mine
Coalpac Modifications
Figure A1
7 February 2014


Coalpac
Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year
All
Atmosphere
Prevailing
Time Period
Day
Scenario
Noise Contours
Cullen Valley Mine
Coalpac Modifications
Figure A2
7 February 2014


Coalpac
Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year
All
Atmosphere
Neutral
Time Period
Evening
Scenario
Noise Contours
Cullen Valley Mine
Coalpac Modifications
Figure A3
7 February 2014


Coalpac
Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year
All
Atmosphere
Prevailing
Time Period
Evening
Scenario
Noise Contours
Cullen Valley Mine
Coalpac Modifications
Figure A4
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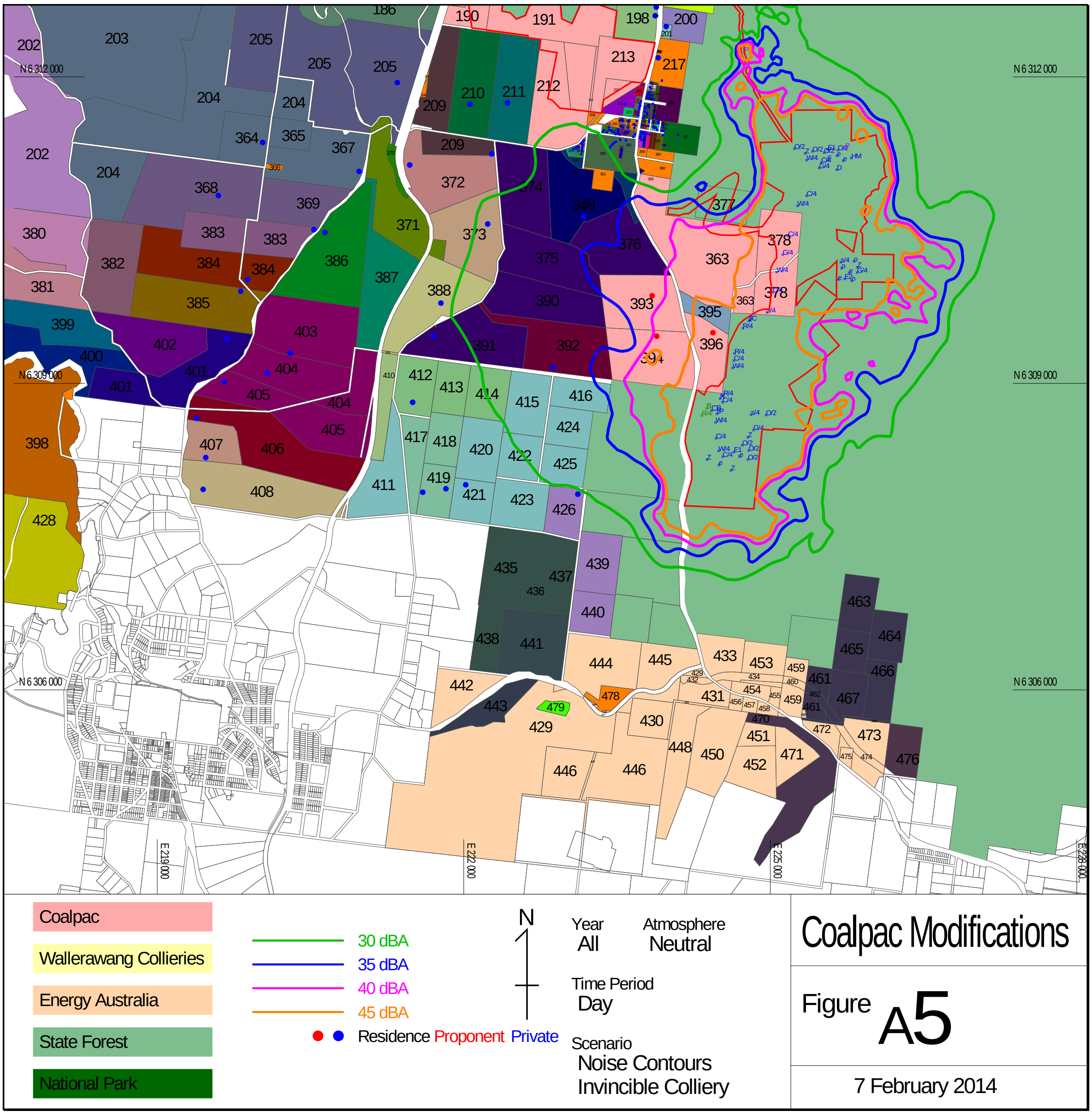
Coalpac
Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year All
Atmosphere Neutral
Time Period Day
Scenario Noise Contours Invincible Colliery
Coalpac Modifications
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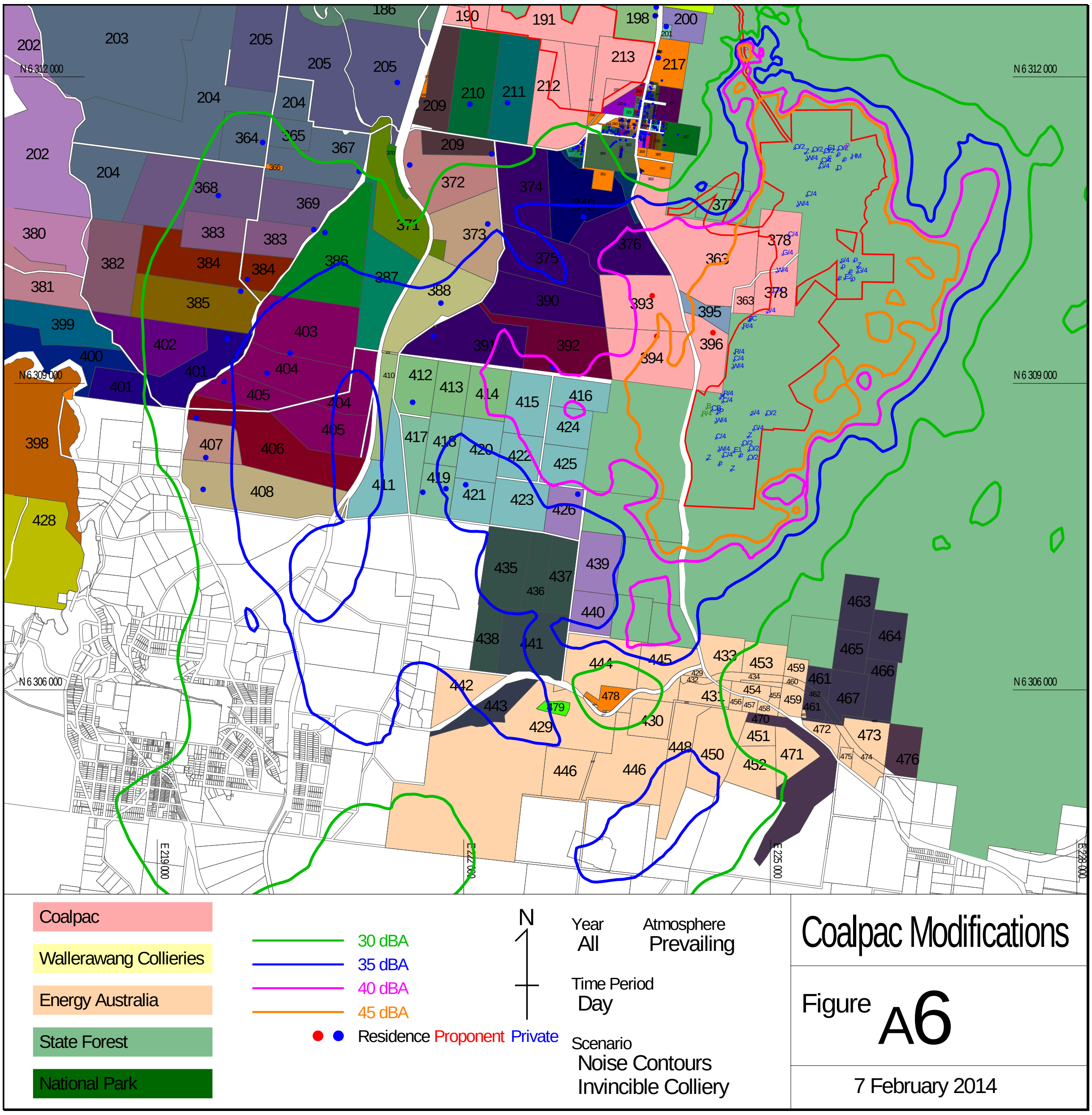
N 6 309 000
N 6 306 000
E 219 000
E 222 000
E 225 000
E 228 000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Coalpac
Wallerawang Collieries
Energy Australia
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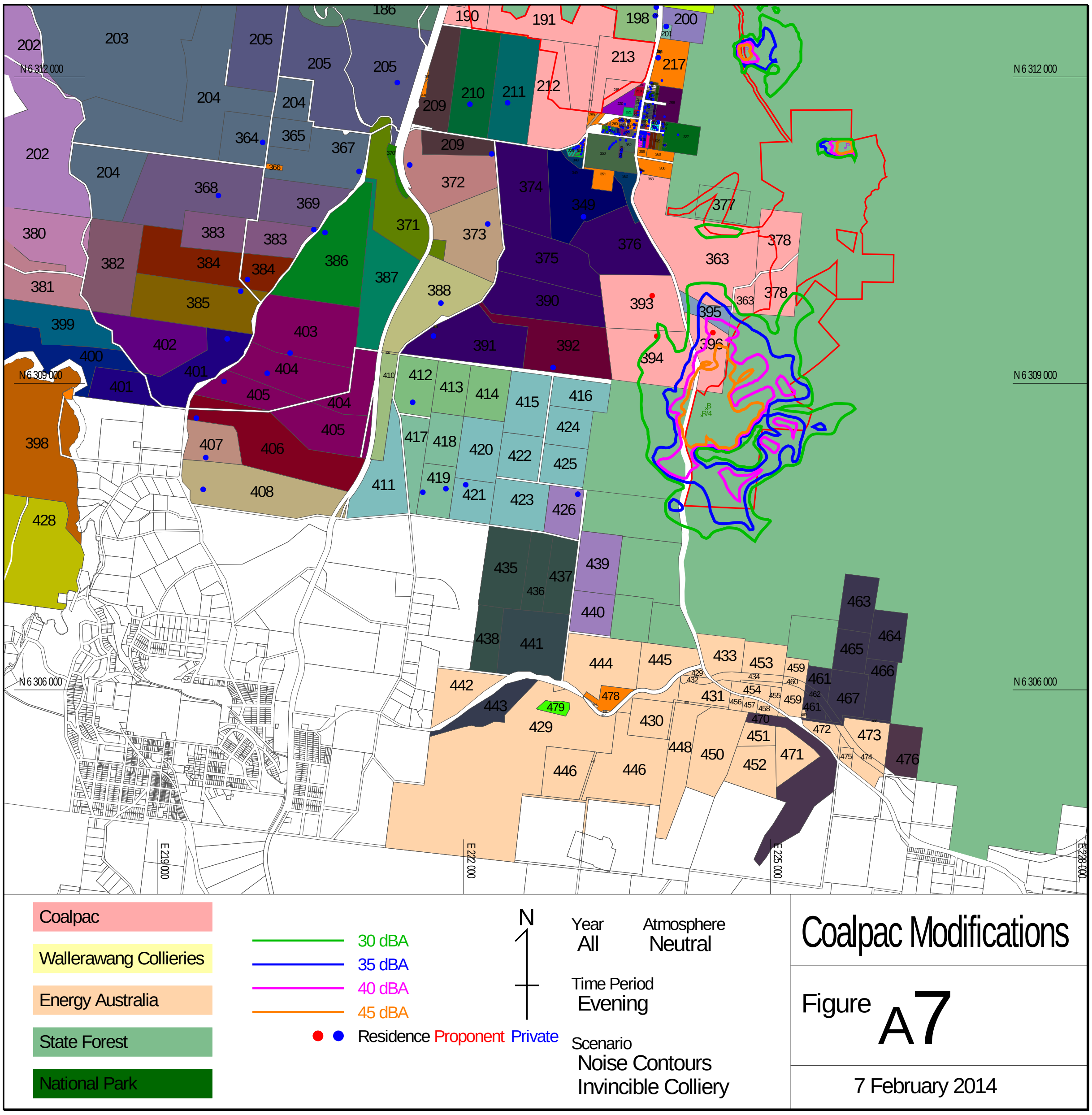
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year
All
Atmosphere
Prevailing
Time Period
Day
Scenario
Noise Contours
Invincible Colliery
Coalpac Modifications
Figure A6
7 February 2014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Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
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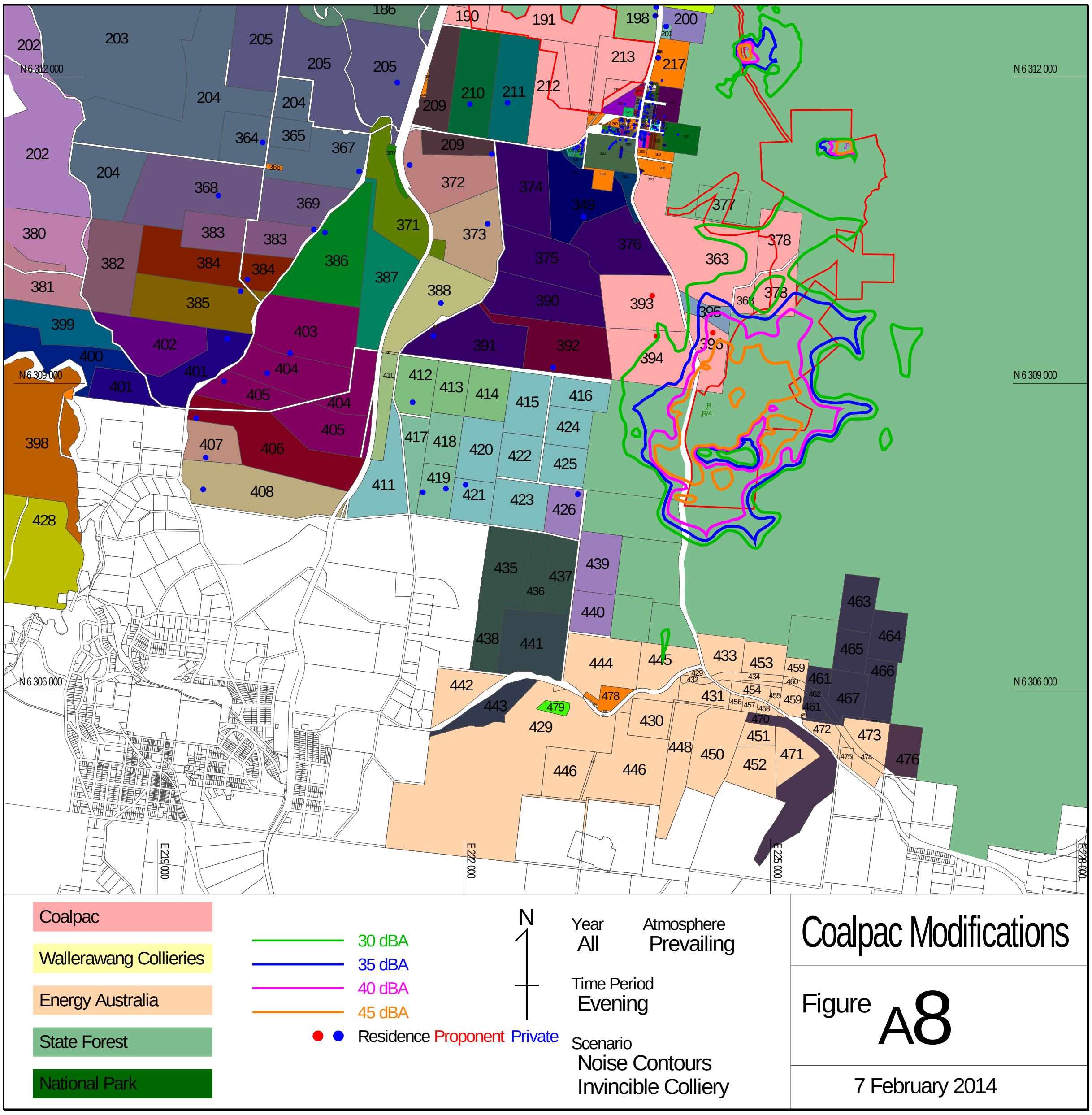
Year All
Atmosphere Neutral
Time Period Evening
Scenario Noise Contours Invincible Colliery
Coalpac Modifications
Figure A7
7 February 2014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E 219 000
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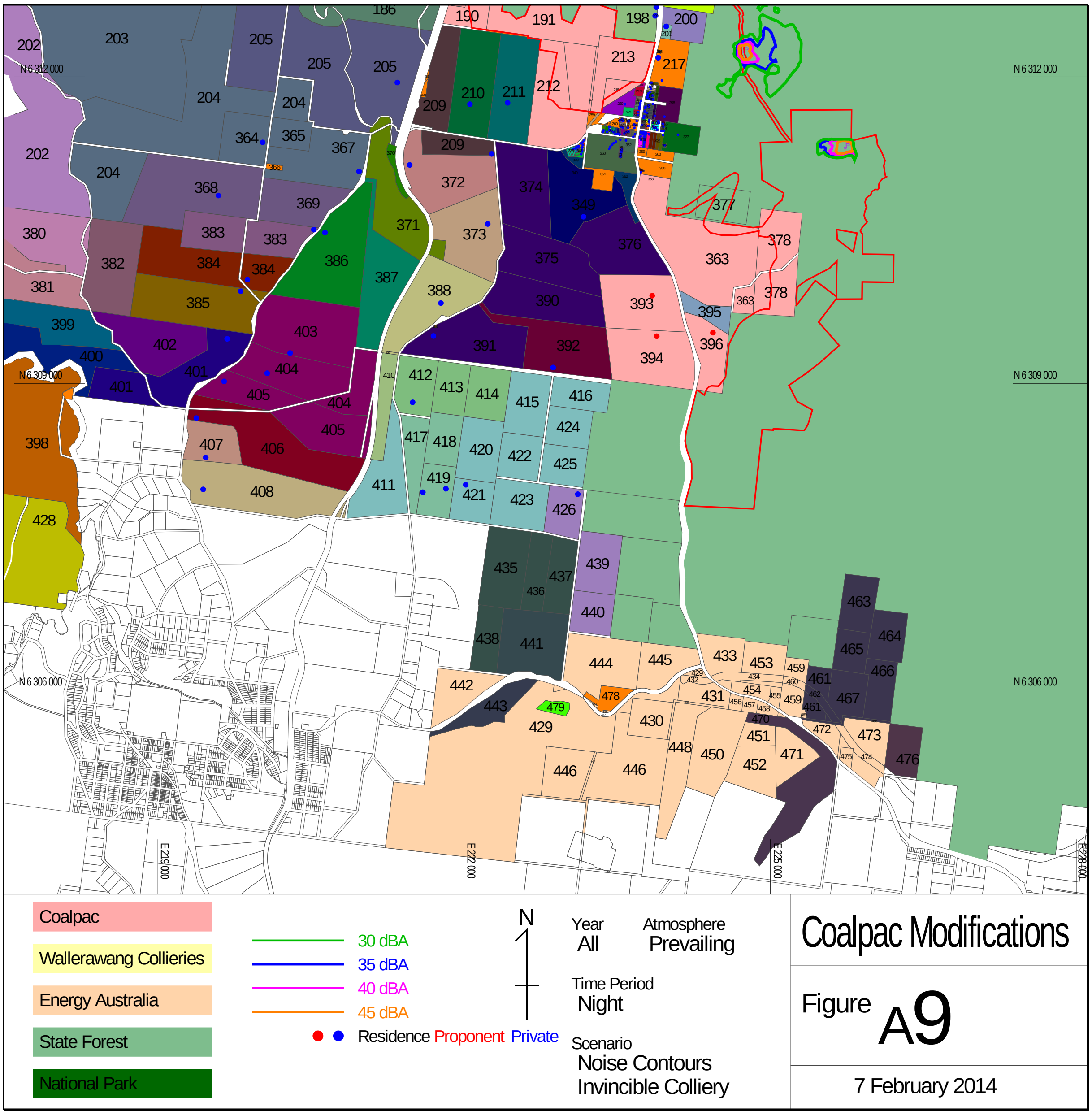
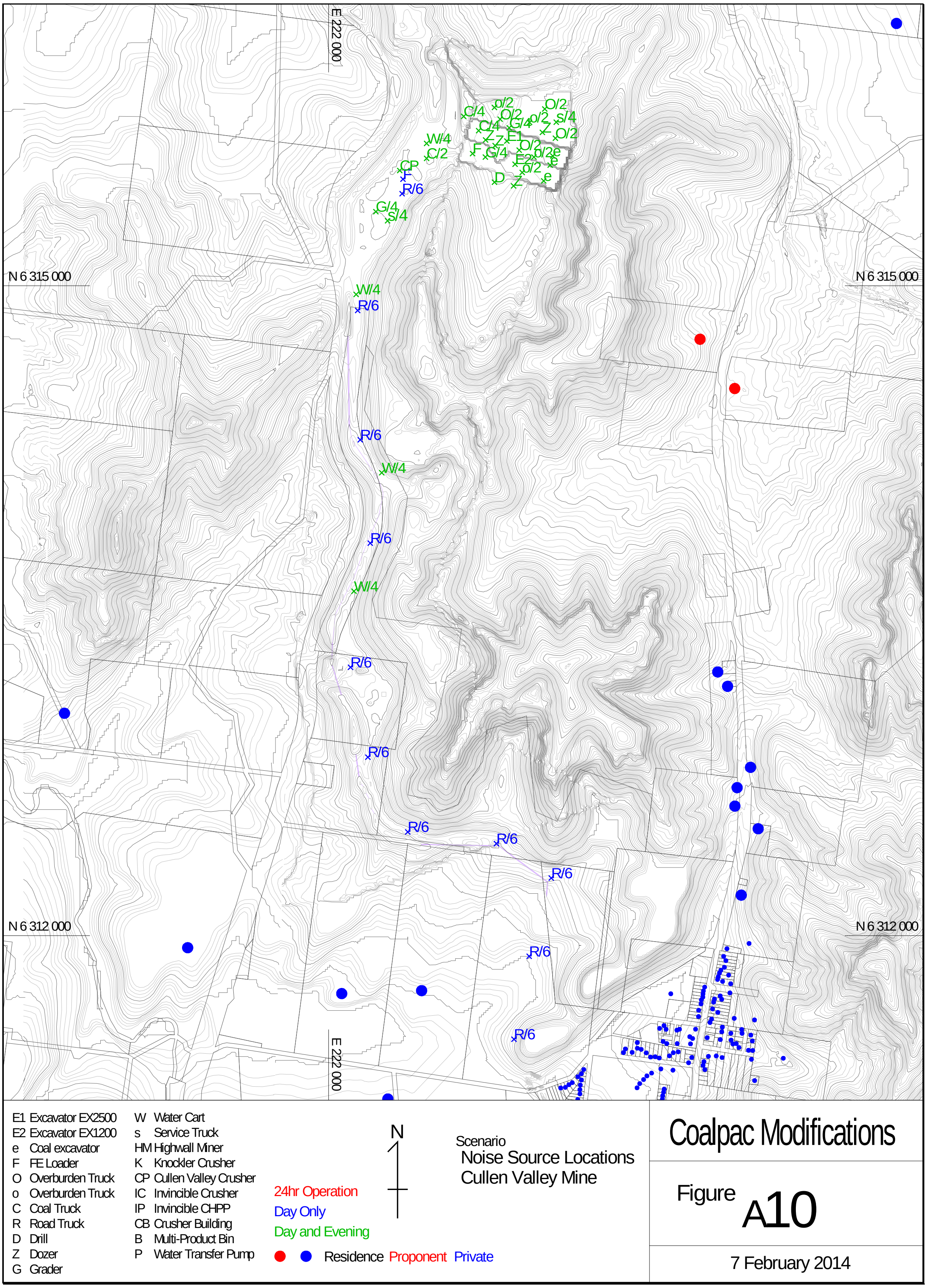
Coalpac
Wallerawang Collieries
Energy Australia
State Forest
National Park
30 dBA
35 dBA
40 dBA
45 dBA
Residence Proponent Private
N
Year
All
Atmosphere
Prevailing
Time Period
Evening
Scenario
Noise Contours
Invincible Colliery
Coalpac Modifications
Figure A8
7 February 2014



Coalpac Modifications

Figure A9

7 February 2014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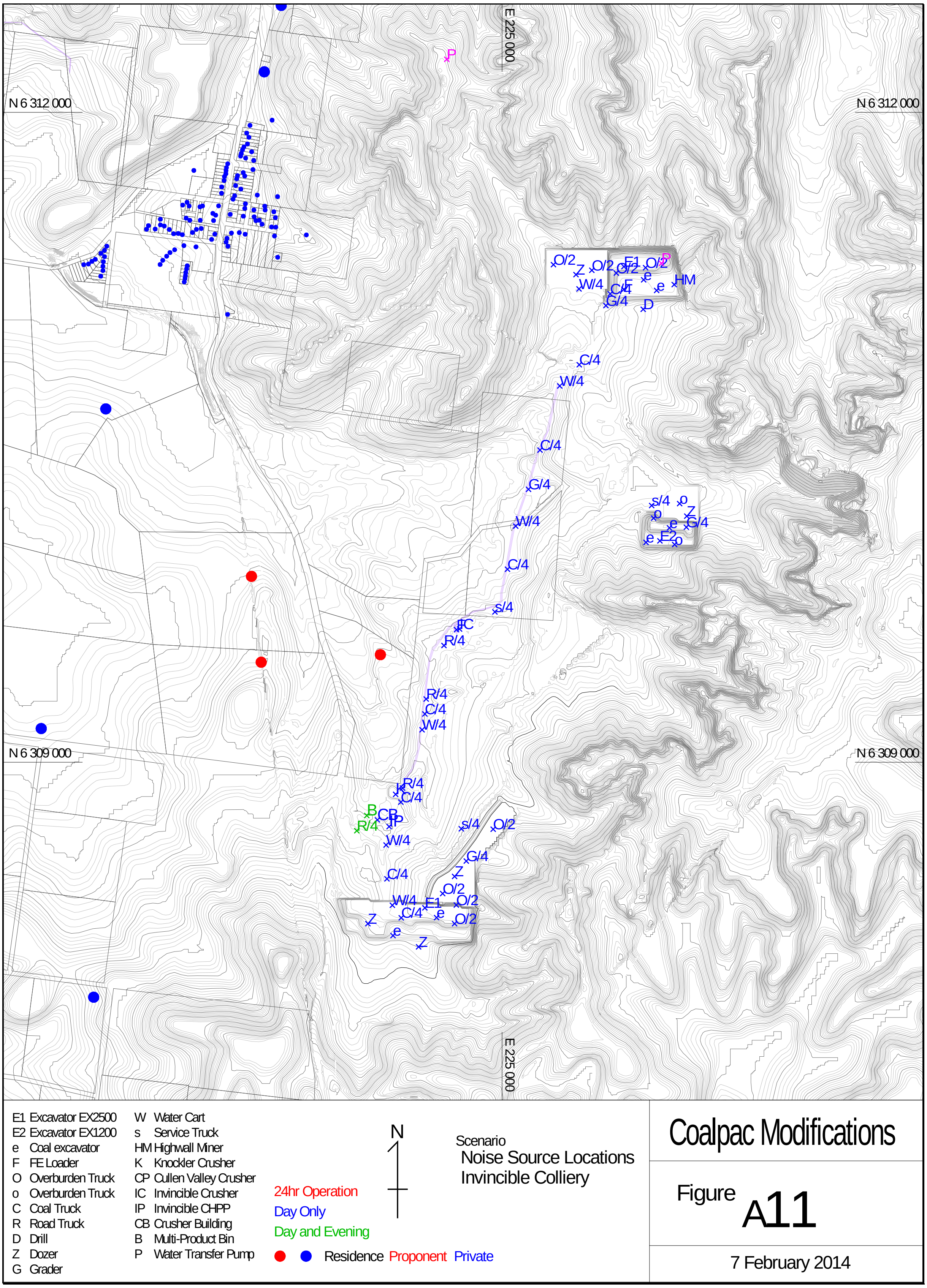
E1 Excavator EX2500
E2 Excavator EX1200
e Coal excavator
F FE Loader
O Overburden Truck
o Overburden Truck
C Coal Truck
R Road Truck
D Drill
Z Dozer
G Grader
W Water Cart
s Service Truck
HM Highwall Miner
K Knockler Crusher
CP Cullen Valley Crusher
IC Invincible Crusher
IP Invincible CHPP
CB Crusher Building
B Multi-Product Bin
P Water Transfer Pump
24hr Operation
Day Only
Day and Evening
Residence Proponent Private
N
Scenario
Noise Source Locations
Cullen Valley Mine
Coalpac Modifications
Figure A10
7 February 2014


N 6 312 000
N 6 309 000
E 225 000
E1 Excavator EX2500
E2 Excavator EX1200
e Coal excavator
F FE Loader
O Overburden Truck
o Overburden Truck
C Coal Truck
R Road Truck
D Drill
Z Dozer
G Grader
W Water Cart
s Service Truck
HM Highwall Miner
K Knockler Crusher
CP Cullen Valley Crusher
IC Invincible Crusher
IP Invincible CHPP
CB Crusher Building
B Multi-Product Bin
P Water Transfer Pump
24hr Operation
Day Only
Day and Evening
Residence Proponent Private
N
Scenario
Noise Source Locations
Invincible Colliery
Coalpac Modifications
Figure A11
7 February 2014