Air Quality

7

7. Air Quality

This section of the Environmental Assessment will consider the potential air quality impacts resulting from the Proposal.

7.1 Introduction

This air quality assessment reviews the current regulatory requirements and ambient air quality guidelines. The assessment then examines the current air quality in the locality and predicts the changes the changes likely to occur as a result of the rehabilitation. The effects of the continuing operation of Munmorah on local, regional and inter regional air quality are then discussed.

A large number of technical studies investigating air quality have been undertaken in the Central Coast area over a number of years, which include the effects of the Munmorah Power Station operating at base load capacity.

As the atmospheric emissions from the rehabilitated power station will be essentially unchanged, the consideration of air quality issues associated with the rehabilitation project has considered the findings of these studies to describe the existing air quality and the implications of the rehabilitation project for local and regional air quality.

An assessment has also been undertaken in accordance with the Approved methods for the modelling and assessment of air pollutants in NSW document (DEC, 2005) (the Approved Methods) in order to quantify the nature and extent of potential worst case ground level concentrations of emissions from Munmorah Power Station. The dispersion modelling assesses the air quality impact on the local scale of emissions of oxides of nitrogen, sulfur dioxide, fine particulates and other pollutants (including trace elements, volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs)).

The full report of the assessment carried out by Aurecon is provided as Appendix E and summarised in this chapter. The following pollutants are investigated:

- sulfur dioxide (SO_2)
- nitrogen dioxide (NO_2)
- fine particulates (PM_{10})
- other pollutants including fluoride compounds, cadmium (Cd), mercury (Hg) and dioxins and furans (PCDD/F)

As the historical data does not include the additional air quality impacts resulting from the commissioning of the Colongra Gas Turbine facility, and more recent approvals for increase generation at Eraring Power Station, the additional impact of these projects was also considered in the assessment.

The location of the Munmorah Power Station in relation to the other major industrial and diffuse air emission sources and the location of the ambient monitoring sites are provided in Figure 7.1.

7.2 Director-General's Requirements

The Part 3A Development Approval requires a level of environmental assessment stipulated by the Director-General of the NSW Department of Planning. The requirements relating to the technical air quality assessment are provided in Appendix A.

The DGRs include requirements to:

- undertake a comprehensive air quality impact assessment prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005) (Approved Methods)
- address air quality impacts at a local, regional and interregional level
- consider the potential impacts of emissions on photochemical smog formation in the Sydney basin.
- demonstrate that the project would meet the relevant impact assessment criteria
- demonstrate that the project has been designed to include the application of Best Available Control Technology (BACT) in relation to air emissions
- include an assessment of the feasibility, effectiveness and reliability of proposed measures details of how the performance and efficiency of the project would be monitored and managed against established performance standards.

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Projection: MGA

Munmorah Power Station **Rehabilitation Environmental Assessment**

FIGURE 7.1: Major local industrial air emission sources proposed (approved) and existing and compliance air monitoring stations

7.3 Regulations and Guidelines

A number of regulations and guidelines are applicable to the management, measurement and reporting of stationary (industrial) and ambient air emissions in NSW. These are discussed in more detail in Chapter 4 and Appendix E and are summarised below.

7.3.1 Protection of the Environment Operations (Clean Air) Regulation 2002

The regulation provides a list of scheduled premises and provides a description of the relevant groups to which the scheduled premises belongs.

Munmorah Power Station is currently classified as a Group 2 facility under the *Protection of the Environment Operations (POEO) (Clean Air) Regulation*. The DECCW Regulation requires older plant operating in NSW to comply with Group 5 emission standards by 2012 as stipulated in the *POEO (Clean Air) Regulation*.

The Environmental Protection Licence (EPL) issued under *POEO Act* sets emission and operational limits and monitoring requirements for the power station. Table 7.1 provides the concentration limits for emissions from the Munmorah stacks. The full EPL is available from the DECCW website (http://www.environment.nsw.gov.au/prpoeoapp/LicenceDetails.aspx)

The proposed rehabilitation of Munmorah Power Station will require a variation of the Environment Protection Licence to change the designated Fee Based Activity Scale to ">4000 Gwh generated". Under Clause 22 of the Regulation, a change in plant intensity such as the one proposed triggers a requirement to meet Group 6 emission limits.

Munmorah Power Station is currently compliant with all Group 6 emission standards, with the exception of NO_x (Table 7.1). The rehabilitation program aims to address this issue.

7.3.2 Ambient air quality guidelines

The guidelines used to assess ambient air quality are established by both the NSW DECCW and within the Ambient Air Quality and Air Toxics National Environment Protection Measures (NEPM). The air quality standards/goals for the various pollutants outlined by these organisations are listed in Table 7.2 and Table 7.3. These standards were developed based on the aim to limit public health and nuisance end point impacts on communities living in urban areas and/or in the region of influence of industrial or fugitive air emission sources.

These measures have been developed to assess air quality on a holistic basis to balance the expectation of the community to be protected from health and nuisance related air quality impact end points. This is actioned by all levels of government (Commonwealth, State and Local) through the recommendation of clean air policy initiatives, to limit fugitive air emissions as well as ensuring adherence to an economically and environmentally reasonable standard of care by industry.

Table 7.1 – Concentration limits for Munmorah Power Station and Groups 2, 5 and 6

Numbers in bold indicate Munmorah limits are equivalent to either Group 5 or 6 limits

Pollutant	Units of Measure (1)	Munmorah Limits (2)	Group 2	Group 5 limits	Group 6 limits
Cadmium	mg/m^3	**1**	-	**1**	0.2
Chlorine (3)	mg/m^3	**200**	200	**200**	**200**
Mercury	mg/m^3	**1**	-	**1**	0.2
NO_2 or NO or both expressed as NO_2 equivalent	mg/m^3	2,500	2,500	800	500
Flourine, as HF equivalent	mg/m^3	**50**	50	**50**	**50**
Hydrogen chloride (3)	mg/m^3	400	400	100	100
Total solid particles	mg/m^3	**100**	250	**100**	50
Smoke emissions Approved circumstance (4) Other circumstances	% opacity (ringelmann)	- -	60 (3) 20 (1)	60 (3) 20 (1)	60 (3) 20 (1)
Sulfuric acid mist and sulfur trioxide (as SO_3)	mg/m^3	200	100	100	100
Type 1 and type 2 substances in aggregate (5)	mg/m^3	**5**	-	**5**	1
VOCs as n-propane equivalent	ng/m^3	-	-	-	0.1
Hydrogen sulphide (3)	mg/m^3	-	5	5	5

Source: POEO Regulation Schedule 3 Standards of concentration for scheduled premises: activities and plant used for specific purposes

NOTE:
(1) 100 percentile concentration limit
(2) Munmorah Power Station EPL 759 – 24 August 2009
(3) Source: POEO Regulation Schedule 4: Standards of concentration for scheduled premises: general activities and plant
(4) Approved circumstance (a) smoke is emitted as a result of blowing soot from a boiler, for a period of no more than 10 minutes per 8 hours, and (b) that all practicable means are employed to prevent or minimise the emission of smoke during that period.
(5) Type 1: antimony, arsenic, cadmium, lead or mercury. Type 2: Beryllium, chromium, cobalt, manganese, nickel, selenium, tin and vanadium. Type 1 included in Group 2 and Type 1 and Type 2 included in Group 5.

Table 7.2 – Air quality goals/standards as stipulated by the DEC (2005) and as part of the NEPM (2003)

Pollutant	Goal		Averaging period	Reference
	ppb	µg/m^3		
Sulfur dioxide (SO_2)	250	712	10-minute	NSW DECCW
	200	570	1-hour	NSW DECCW, NEPM
	80	228	Daily	
	20	60	Annual	
Nitrogen dioxide (NO_2)	120	246	1-hour	NSW DECCW, NEPM
	30	62	Annual	
Photochemical oxidants as Ozone (O_3)	100	214	1-hour	NEPM
	80	171	4-hour	
PM_{10} – Particulate matter of aerodynamic diameter <10 µm		50	Daily	NSW DECCW, NEPM
		30	Annual	NSW DECCW
$PM_{2.5}$ – Particulate matter of aerodynamic diameter <2.5 µm [1]		25	Daily	NEPM
		8	Annual	
Fluoride (as HF)		1.5	Daily	NSW DECCW
		0.8	7-day	
		0.4	30-day	
		0.25	90-day	
Cadmium (Cd)		0.018	1-hour	
Mercury (Hg)		1.8	1-hour	
Dioxins and furans (PCDD/F)		2.0 pg/m^3 [2]	1-hour	

NOTE: [1] Advisory reporting standard.
[2] pg/m^3 – pico grams per metre cubed of ambient air (pico – 10^{-12})

Table 7.3 – NEPM air toxics (2004) goals – monitoring investigation levels

Pollutant	Goal		Averaging period
	µg/m^3	ppm	
Benzene		0.0003	Annual
Formaldehyde		0.04	Annual
Toluene		1	Daily
		0.1	Annual
Xylene		0.25	Daily
		0.20	Annual
PAH [1]	0.30 ng/m^3		Annual

NOTE: [1] Polycyclic aromatic hydrocarbons

7.4 Existing ambient environment

The two compliance air monitoring stations in the Central Coast, located at Wyee and at Lake Munmorah Primary School (LMPS), have been established to monitor the worst case air quality impacts from Munmorah Power Station. The major sources that contribute to the observed air quality at these sites include fugitive sources (ie road traffic regional particulates) and stationary sources from Munmorah, Vales Point and Eraring power stations (Figure 7.1). These sources contribute to the background air quality.

It is noted that the emissions from the Colongra Gas Turbine facility (currently undergoing commissioning testing) and recently approved additional generation from Eraring Power Station are not reflected in the historical air quality data. The contribution of Munmorah to ambient air quality between 1999 and 2009 is shown in the following Figure 7.2.

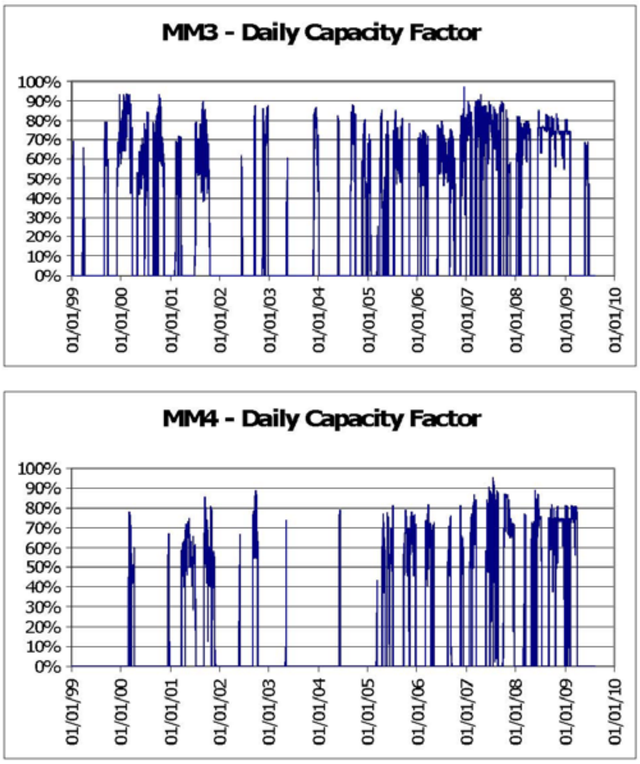

Figure 7.2 – Munmorah Power Station capacity factor for 1999 to 2009

7.4.1 Observed SO_2 data

The following analysis of ambient SO_2 records from Wyee and LMPS air monitoring stations for encompasses the period from 1994-2008 and examines annual average, daily, one hour and ten minute ambient SO_2 air quality. The analysis demonstrates that annual average, daily and one hour ambient concentrations have been significantly below the relevant air quality goals.

Annual Average

The profile of annual average ground level concentrations is presented in Figure 7.3.

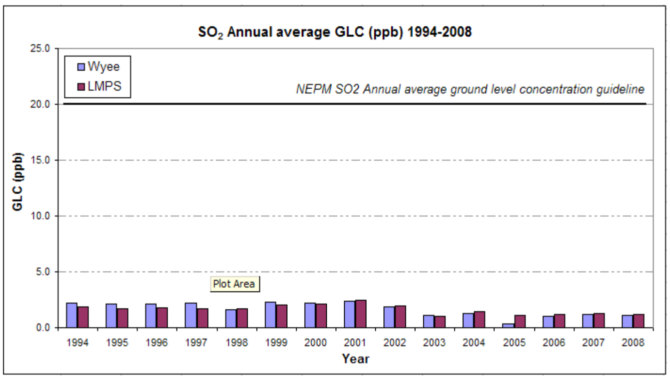

Figure 7.3 – Observed annual averaged SO_2 concentrations, from 1994 to 2008 at the Wyee and LMPS air monitoring stations

This profile of annual average statistics shows that the observed annual average ambient SO2 concentrations are low, close to an order of magnitude below the regulated NEPM and NSW DEC air quality limits.

Hourly Average

Peak and percentile SO_2 ground level concentrations observed are presented in the following figures for Wyee (Figure 7.4) and LMPS (Figure 7.5) air monitoring stations. The frequency distribution of the observed data from 1994 to 2008 shows that for more than 99% of the hours in any given year the observed data are below < 20 ppb (17% of the air quality goal).

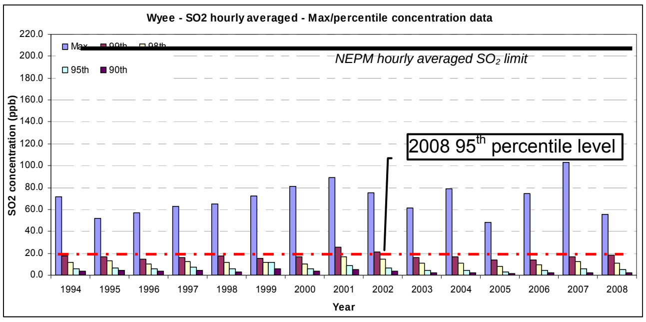

Figure 7.4 – Observed hourly averaged SO_2 concentrations, from 1994 to 2008 at Wyee air quality monitoring station

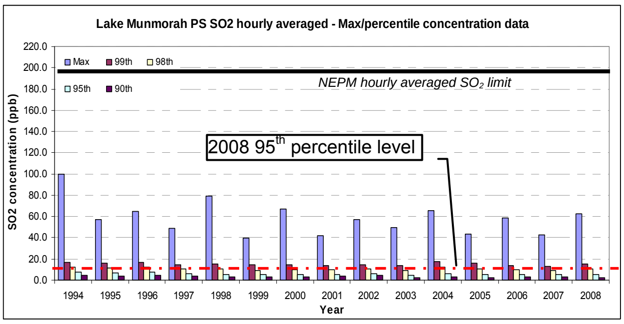

Figure 7.5 – Observed hourly averaged SO_2 concentrations, from 1994 to 2008 at LMPS air quality monitoring station.

The power stations are the only known major source of SO_2 in the region. A directional analysis of hourly averaged SO_2 ground level concentrations observed at the Wyee and LMPS in 2004 (the reference year for subsequent modelling) provided in appendix E allows consideration of the likely source of peak records. The analysis illustrates the low likelihood of the coincidence of maximum impacts from Munmorah with the maximum impact with the other sources and suggests that the contribution of Munmorah Power Station to SO_2 levels is much lower than contributions from other sources.

10 Minute average

The peak 10 minute averaged levels over the last 3 years have been observed to reach up to 400 µg/m3 (Limit = 712 µg/m3). An in depth analysis of SO2 impacts carried out by Holmes Air Sciences (2005) demonstrated the negligible nature of observed air quality impacts over the most monitoring period.

It is noted that the percentile levels have largely remained constant over the 15 year period analysed. It is also noted that the peak level observed through 2004 reference year is one of the years through which worst case impacts were observed compared to other years.

7.4.2 Observed NO_2 data

The analysis of ambient NO_2 records from Wyee and LMPS air monitoring stations encompasses the period from 1994-2008 and examines annual average, daily, one hour and ten minute ambient NO_2 air quality. The analysis demonstrates that annual average, daily and one hour ambient concentrations have been significantly below the relevant air quality goals.

Annual Average

The annual average ground level concentrations profiles demonstrate that the observations are less than a third of the regulated NEPM and NSW Dec air quality limits. A downward trend in annual average NO_2 concentrations is observed over the period. This data indicates that air quality through this region is good.

Hourly average

A summary of the hourly average ground level concentration records of NO_2 concentrations from the Wyee and LMPS monitoring stations for the period from 1994 to 2008 is provided in Figure 7.6 and Figure 7.7. The 2008 95th percentile level is provided as a reference (dotted line) to assist with the following interpretation.

Wyee

It is observed that the maximum observed NO_2 concentrations are significantly less than the hourly average limit of 120 ppb.

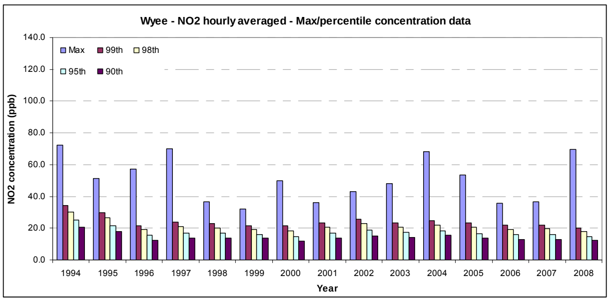

Figure 7.6 – Summary of NO_2 percentile and peak hourly averaged ground level concentrations (ppb) 1994-2008 at Wyee

While concentrations have remained relatively steady over the 15 year period the maximum concentrations recorded have been more variable.

This variability in peak concentrations may be attributable to variability in worst case meteorological conditions from year to year or to the proximity of other nearby non-power station NO_2 sources (motor vehicles).

LMPS

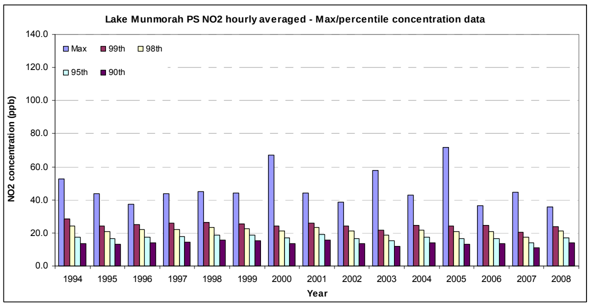

Figure 7.7 – Summary of NO_2 percentile and peak hourly averaged ground level concentrations (ppb) 1994-2008 at LMPS

The summary data of NO_2 concentrations recorded at the LMPS air monitoring station shows that there has not been a single exceedance in the guideline limit over the period examined. The maximum concentration recorded in 2008 (< 40 ppb) was less than a third of the hourly averaged limit.

The NO_2 concentration in 95% of the records examined are less than one fifth of the NEPM limit. The temporal differences in the observed 99^{th}, 98^{th}, 95^{th} and 90^{th} percentile levels are all largely negligible as the dotted reference line illustrates.

A similar variability in peak concentrations recorded over the period was observed with the worst case levels being observed in 2000 and 2005.

Discussion

Previous studies have confirmed that the Wyee and LMPS ambient monitoring stations are located in areas where peak NO_2 ground level concentrations from the operation of Munmorah Power Station are expected to occur (See Section 7.6, Holmes Air Sciences 2005),.

The observed NO_2 data indicates that the air quality in the region is very good. The 99^{th} percentile NO_2 concentration recorded at Wyee and LMPS indicates that the peak concentrations are well below the NEPM hourly averaged limit and that they occur as isolated events through the year.

The 2008, 95^{th} percentile of the observed hourly averaged NO_2 concentrations during the period analysed is less than one fifth of the NEPM NO_2 limit.

It is noted that the Wyee compliance air monitoring stations is located near the Sydney-Newcastle Freeway (> 40,000 veh/day, ~ 500 m to edge of carriageway) and LMPS is located near the Pacific Highway (20-40,000 veh/day, ~ 100 m to edge of carriageway) (RTA, 2006).

An analysis of the highest NO_2 concentrations observed in 2004 at Wyee air monitoring station (Table 7.4) shows that, the peak levels correspond to evening traffic flow peaks on weekdays between 6 and 7 pm.

The highest NO_2 concentrations also coincide with low SO_2 concentrations (< 10 ppb), which supports the suggestion that emissions power stations are not the main cause of the observed NO_2 air quality impact. The observed data, considered with SO_2 records suggest that emissions from motor vehicles provide the main contribution to these higher records.

A similar analysis of the ten highest NO_2 concentrations observed at LMPS monitoring station (Table 7.5) illustrates that emissions from motor vehicles as opposed to the emissions from the power station are more likely to contribute to peak NO_2 events in this region.

Seven of the ten highest levels occur through periods that correspond to morning and evening traffic flow peaks. Three of these events coincide with higher SO_2 levels, however the corresponding wind directions do not place Munmorah down wind of the site.

Table 7.4 – Ten highest NO_2 ground level concentrations (ppb) observed at Wyee in 2004

Date/time	NO_2	SO_2	Wind direction
2/03/2004 11:00	68.3	ND	131
26/03/2004 19:00	35.0	1.0	282
1/04/2004 18:00	37.3	1.0	311
27/08/2004 4:00	32.3	1.3	291
17/09/2004 19:00	31.8	1.8	348
27/09/2004 20:00	32.8	1.0	305
12/10/2004 18:00	32.8	1.3	300
13/10/2004 18:00	35.8	0.7	339
14/10/2004 0:00	33.7	9.7	354
30/11/2004 19:00	32.2	0.7	313

Table 7.5 – Ten highest NO_2 ground level concentrations (ppb) observed at LMPS in 2004

Date/time	NO_2	SO_2	Wind direction
7/05/2004 17:00	42.8	3.2	132
9/03/2004 13:00	37.7	51.3	340
1/04/2004 19:00	37.3	2.8	253
7/05/2004 16:00	37.2	2.8	130
16/05/2004 17:00	36.7	1.7	122
20/12/2004 1:00	35.7	0.0	192
9/03/2004 12:00	35.5	47.2	344
7/05/2004 18:00	35.2	2.7	55
8/05/2004 18:00	34.3	3.3	92
11/05/2004 17:00	33.5	5.5	31

7.4.3 Fine particulate matter (PM_{10})

The observed levels of fine particulate matter (PM_{10}) in this region were analysed using the DECC Ambient Air Monitoring Reports for 2004; the air monitoring stations in the Lower Hunter being Beresfield, and Wallsend to represent the background level of PM_{10}. This data, shown in Table 7.6 was used to estimate cumulative air quality impacts.

Table 7.6 – Monthly PM_{10} maxima at DECC monitoring stations at Beresfield and Wallsend

PM_{10} daily averaged (µg/m^3)	Beresfield	Wallsend
Jan	33	19
Feb	44	43
Mar	40	34
Apr	48	34
May	44	38
Jun	34	20
Jul	38	25
Aug	33	29
Sept	30	29
Oct	49	43
Nov	38	36
Dec	56*	53*

* Single exceedance in the NEPM PM_{10} daily averaged guideline limit of 50 µg/m^3 through the month of December at both DECC Air monitoring sites.

Exceedances in the daily averaged NEPM ambient air quality guideline for PM_{10} were observed at both of these stations through the month of December through the reference year (2004). The majority of the exceedances in PM_{10} air quality goals through this region through the summer months (as in this case) can be attributed to local dust events, and/or bushfires events which enable the transport of large amounts of particulate matter over large distances. The data also indicates that the maximum daily averaged levels observed at Beresfield are consistently higher than those observed at the Wallsend air monitoring station.

Hence cumulative impacts in this instance are assessed in a manner similar to the DECCW Level 2 Ozone Limiting Method (OLM) discussed in greater detail in Appendix E.

7.4.4 Adopted background conditions

Based on a consideration of the preceding discussion, the background conditions adopted to model worst case cumulative impacts for NO_2, SO_2, PM_{10} and O_3 are provided in Table 7.7. The NO_2 and SO_2 background levels were adopted from the 2004 LMPS and Wyee datasets, to be consistent with the reference year used for the meteorological and air dispersion modelling.

As emissions from the currently operating Munmorah Power Station are included in the background ambient air quality data for the region, the DECCWs preference for adopting the 100th percentile background level for the assessment of cumulative air quality impacts may be regarded as being conservative where this leads to double counting in the predictive modelling. The use of 2004 as the reference year, which had the lowest annual output from Munmorah (see Figure 3.1 and 7.2), minimises this effect.

Table 7.7 – Summary of adopted background conditions from representative ambient NSW DECCW campaign and Delta air quality monitoring stations (Wyee and LMPS)

Pollutant	Averaging period	Background level ppb ($\mu g/m^3$)	Notes
SO_2	10 min	113 (334)	Peak level observed at Wyee ambient air monitoring station in reference year 2004.
	1 hour	79.2 (226)	
	Daily	9.5 (27.2)	
	Annual	1.3 (3.7)	
NO_2	Hourly	37.7 (77.3)	Refer discussion in Section 3.1.2
	Annual	8.3 (17)	Annual average level observed through 2004.
O_3	Hourly	87.8 (188)	Average of the maximum hourly averaged ground level concentrations recorded at all NSW DECC air monitoring stations in the Lower Hunter region (Beresfield, Wallsend and Newcastle) over the period from 2003-2008.
PM_{10}	Daily	56 $\mu g/m^3$	Peak PM_{10} daily averaged ground level concentration observed through 2004 at Beresfield air monitoring station.
	Annual	25 $\mu g/m^3$	

7.5 Power station emissions

The objective the rehabilitation of Munmorah is to improve the efficiency of the power station by generating more electricity form the same input of energy (the same coal equivalent input). In this regard the rehabilitation is not predicted to result in any significant changes to the fundamental operation of the current power station.

Minor changes to the plant and the proposed provision for gas firing, would result in a number of changes that affect the emissions characteristics of the existing power station. The most significant change in relation to coal firing is the provision of low NO_x burners which will reduce NO_x emissions.

Comprehensive technical investigations of the effects of the rehabilitation are described in Appendix C. The results of these investigations and the detailed air emissions considerations discussed in appendix E are summarised in this section for the purpose of highlighting the nature and significance of any changes to emission s to the atmosphere that will occur.

7.5.1 Technical Investigations

A significant aspect of the technical investigation was the prediction of unit performance over a range of gas firing scenarios. The predicted thermal performance levels were then used to estimate emissions of sulfur dioxides, nitrogen oxides, particulates and carbon dioxide. The investigations also addressed stack exit conditions.

PROATES (PROcess Analysis for Thermal Energy Systems), a whole plant modelling package for analysing and improving power plant steady state thermal performance was used for the modelling of the plant. A detailed discussion of this modelling is provided in Appendix C.

The original design performance and performance test results during the life of the power station show that when the plant was new, the design performance levels were not achieved. Further deterioration in performance occurred over the intervening decades.

A significant reason for the reduced performance levels is the change in turbine heat rate - a 14% higher heat rate was measured in 2006 compared to the original design.

Table 7.8 summarises the predicted thermal performance for the range of possible boiler firing scenarios from 100% coal up to 75% gas firing of the boilers (Aurecon 2009)

Table 7.8 – Predicted performance for proposed rehabilitated Units

Parameter	Units	Predicted Performance			
Target load	MW-Gen	350	350	350	350
Gas input energy	%	0	25	50	75
Coal input energy	%	100	75	50	25
Natural gas flow	kg/s	0.0	4.3	8.6	13.1
Coal flow	kg/s	40	31	21	10
Coal rate	t/GWh-gen	416	316	214	108
Flue gas O2	%	3.2	2.4	2.4	2.4
Boiler efficiency	%	88.9	88.8	88.3	87.7
Turbine heat rate	kJ/kWh	8109	8109	8109	8109
Turbine efficiency	%	44.4	44.4	44.4	44.4
Unit efficiency - gen	%	39.5	39.4	39.2	38.9

The predicted performance assumes full load operation and as new condition. In making these predictions the following assumptions were made:

- From the results in Table 7.8 it can be seen that here is a slight reduction in boiler efficiency with increasing gas proportion. This is due to the greater hydrogen content of natural gas and increased losses due to moisture in flue gas.
- The key parameter for the estimation of emissions is the fuel flow rates for the different configurations.

Stack Exit Conditions

The stack exit conditions were estimated from the PROATES modelling and other information described in Appendix C (calculated for the 100% coal case only, with both Units operating at 350 MW).

A comparison between the historical and the predicted conditions for the rehabilitated plant is provided in Table 7.9.

Table 7.9 – Comparison of stack exit conditions in the historical case and the predicted conditions for the rehabilitated plant

Munmorah stack exit conditions (Stack ø7.9 m)	Average volumetric flow (Am^3/s)	Exit velocity (m/s)	Stack exit temperature (K)
Historical plant	892	18.2	403
Rehabilitated plant (1)	951	19.4	426
Percentage change	+6.6%		+5.7%

NOTE: (1) 2009 PROATE Modelling

7.5.2 Emission Characteristics

NO_x Emissions

The NO_x emissions with the new burners will be better than the current performance and less than 500 mg/Nm^3(SKM 2009). The use of gas will require new burners, which may also be specified as 'low NO_x, with a limit on emissions consistent with the new coal burners. The use of gas will therefore not impact NO_x missions compared to the 100% coal case.

The existing records versus load and expected change in the NO_x emissions following rehabilitation are shown in Figure 7.8.

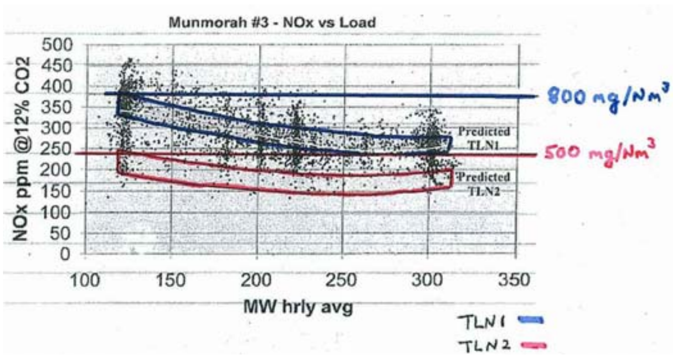

Figure 7.8 – Rehabilitated (red line predicted:TLN2) NO_x performance versus plant load overlaid with current NO_x performance scatter plot (Worley Parsons, 2008)

SO_x Emissions

The stack SO_x emissions have been predicted based on typical coal qualities provided by Delta Electricity and the assumption that all sulfur in the fired coal is converted to sulfur dioxide (SO_2). It is also assumed that natural gas does not contain any sulfur. The SO_2 emissions have been calculated using Aurecon's boiler efficiency model, which has been verified and refined over a number of years (Aurecon 2009).

The SO_2 concentrations have been calculated using the reference conditions as outlined in the "Protection of the Environment Operations (Clean Air) Regulation 2002". Schedule 5 of this regulation states reference O_2 levels of 7% are to be used for SOx emissions for coal boilers.

The SO_2 concentration was calculated for the 100% coal case, and subsequently scaled for each gas option based on the percentage of coal fuel used. The results of the SO_2 emission concentration calculations for wet flue gas are summarised in Table 7.10

Table 7.10 – Predicted SO_2 emissions from proposed Munmorah upgrade

	100% Coal	25% Gas	50% Gas	75% Gas
SO2 (ppm v/v)	341	256	171	85

In order to reduce the potential for Munmorah to contribute to higher short term (10 minute) ambient SO_2 ground level concentrations, Delta Electricity is proposing to reduce the EPL fuel quality limit at Munmorah to a maximum average monthly concentration of 0.7% sulfur in coal (Rae, et. al. 2008), 0.3 % down from the current 1%.

The sulfur emission rate based on this worst case ~0.7% sulfur grade coal (SO_2 = 582 (ppm v/v) is used in the air quality assessment. This emission rate is some 30% higher than the emissions that result from the typical coal currently consumed at the station. The SO_2 emissions for

The co-combustion of low sulfur coal with natural gas would reduce emissions rates from the base case scenario. As can be seen from Table 7.10, SO_2 emissions significantly reduce as the proportion of gas firing increases.

Monitoring of SO_2 and sulfuric acid mist and sulfur trioxide (as SO_3) from the existing power station has indicated that levels are very low. If it is assumed that there is a direct relationship between SO_2 and sulfuric acid mist and sulfur trioxide (as SO_3) the proposed reduction of maximum coal quality should result in a 30% reduction in the maximum potential emissions of SO_3 and sulfuric acid mist.

7.5.3 Emissions based on Stack Testing

A review of air emissions concentrations based on historical performance data for the relevant pollutants stipulated under Schedule 3 of the POEO (Clean Air) Act 2002 has been provided by Delta Electricity (Malfroy 2007). The effect of the rehabilitation on these emissions is also provided in the following table.

Emissions over the period 2004-2006 comply with the current licensed emission requirements and they are generally compliant with Group 6 emission standards.

With the introduction of low NO_x burners, NO_x emissions the will be compliant with Group 6 emission standards under normal operating conditions.

Table 7.11 – Assessment of Emission against Group 6 emission limits

Substance	Limit	Averaging time	Munmorah 2004-2006 performance	Comment – data source	Expected Change Due to Rehabilitation	
					100% Coal Fired	With Gas Firing
Solid particles	50 mg/m^3	(1)	Unit 3: 11.5-51.6 Average 29.6 Unit 4: 3.4-13.6 Average 5.6	EPL – annual batch sample	No change	No expected change
NO_2 or NO or both expressed as NO_2 equivalent	500 mg/m^3	1 hour block	900 (~650@full load)	EPL – CEMS	Reduction to < 500 with low NO_x burner retrofit	
Fluorine, as HF equivalent	50 mg/m^3	(1)	Unit 3: 1.7-8.7 Average 4.1 Unit 4: 02-14.5 Average 5.6	EPL – annual batch sample	No change	Reduction in proportion to % gas
Type 1 and Type 2 substances in aggregate **(2)**	1 mg/m^3	(1)	Unit 3: 0.003-0.11 Average 0.05 Unit 4: 0.02-0.11 Average 0.06	EPL – annual batch sample (most results for individual metals <LOD. For calculations results assumed to equal the LOD.	No change	Reduction in proportion to % gas
Cd or Hg individually	0.2 mg/m^3	(1)	Cd Unit 3 &4: <0.00007-0.002 Average 0.00132 Hg Unit 3 & 4: <0.00007-0.004 Average 0.00030	EPL – annual batch sample. See comment above.	No change	Reduction in proportion to % gas
VOCs as n propane	40 VOC or 125 CO mg/m^3	1 hour rolling	Unit 3 & 4 2006 <5 No VOC peak detected	EPL – batch (measurement of CO not required by EPL)	No change	Increase in proportion to % gas
Smoke **(3)**	Ringlemann 3 or 60% opacity (Note 6) or Ringlemann 1 or 20% opacity (Note 7)	6 minutes rolling	<10% (4)	EPL – CEMS for *"undifferentiated particles"*	No change	No change
Hydrogen chloride	100 mg/m^3	(1)	Unit 3 and 4 0.2-4.5 Average: 4.1	EPL – annual batch sample	No change	Reduction in proportion to % gas
Chlorine (Cl_2)	200 mg/m^3	1 hour block	Unit 3 and 4: 0.005-0.4 Average: 0.16	EPL- annual batch sample	No change	No change

Substance	Limit	Averaging time	Munmorah 2004-2006 performance	Comment – data source	Expected Change Due to Rehabilitation	
Hydrogen sulphide	5 mg/m^3	1 hour block	Below level of detection (5)	Testing not required by EPL	No change	No change
Sulfuric acid mist or SO_3 or both expressed as SO_3 equivalent	100 mg/m^3	(1)	Unit 3 & 4: 0.9-2.1 Average: 1.4	EPL – annual batch sample	No change	Reduction in proportion to % gas
Dioxin or furans **(8)**	0.1ng/m^3		0.0013 ng/m3 (average of 2 tests)**(5)**	Testing not required by EPL	No change	Reduction in proportion to % gas

NOTE:

1. 1 hour, or minimum sampling period specified in the relevant test method, whichever is the greater
2. Type 1: antimony, arsenic, cadmium, lead or mercury
   Type 2: Beryllium, chromium, cobalt, manganese, nickel, selenium, tin and vanadium
3. Approved circumstances – as applicable to Munmorah;
   For a period of not more than 20 minutes per 24hours after lighting a boiler or incinerator for cold, being the period that the boiler or incinerator is brought up to normal operation and that all practical means are employed to prevent or minimise the emission or smoke during that period.
4. Opacity us bit recorded at Munmorah. Instruments output data in mg/m^3. Opacity data have been sourced form Vales Point Unit 6 which is now equipped with pulse jet bad filters and should be indicative of opacity in Munmorah ducts.
5. Based on measurements at Vales Point Power Station. Stephenson and Associates 1999.
6. In approved circumstances:
7. In other circumstances:
8. Dioxins or furans limit of 0.1ng/m^3, only applies to non-standard fuels containing precursors of dioxin or furan formation.

7.5.4 Particulate emissions (PM)

A comparison of historical levels (2004-06) against the Group 6 guidelines shows that the emission concentrations are generally well below the Group 6 standard of 50 mg/m^3 (Unit 3 ~ 8 mg/m^3 and Unit 4 ~29 mg/m^3 -), this is likely to remain largely unchanged for the 100% coal fired case.

The dust burden in the flue gas will reduce with the amount of natural gas firing. The precise impact of the gas firing on particulate emissions is unclear, as the combustion process may result in varying ash particle size distributions.

The emission of fine particles from fabric filters is a function of the bag condition and the effective management of the bag system rather than the load on them. The efficient maintenance and operation of fabric filters will lead to high levels of emissions control being achieved and particulate emissions levels being kept below regulated limits.

7.5.5 Other pollutants

Although the specifics of the proportions of coal and gas that will be co-fired is unknown at this stage, any reduction in the proportion of coal burnt will lead to a significant decrease in emissions of fine particulates. Proportional decreases in emissions of particulate bound pollutants including PAHs, persistent organic pollutants and trace metals would also occur.

Other pollutants include but are not limited to the emissions of trace elements including Type 1[1], Type 2[1] pollutants and Cd, Hg specifically), volatile organic compounds (VOCs) and subset groups including dioxins and furans. The comparison of Munmorah's historical emissions performance against the Group 6 standards demonstrates compliance, prior to plant rehabilitation. While some changes in emissions could occur, as noted in Table 7.11, the plant is predicted to remain compliant with emissions standards.

7.5.6 Discussion

A goal of the rehabilitation works at Munmorah Power Station is to achieve compliance with Group 6 emission standards. The shift from inefficient coal burners to rehabilitated low NO_x coal and gas burners (separate entities) will lead to a decrease in NO_x emission rates (g/s), when compared with historical conditions. The modelling results have demonstrated

[1] Type 1: antimony, arsenic, cadmium, lead or mercury; Type 2: beryllium, chromium, cobalt, magnesium, nickel, selenium, tin and vanadium.

that the improved thermal performance of the system will provide increased generation capacity as well as result in decreased NO_x emissions overall. That is, greater thermal efficiencies leads to greater generation efficiency i.e. a reduction in coal burnt per MW output.

The marginal change in the stack exit temperature and exit velocities will not have a significant impact upon the dispersion of air pollutants as they exit the stack tip. This is largely due to the relatively small increase in the respective parameters as compared to the historical levels. The expected air quality impacts on the local and regional atmospheric environments are shown to be acceptable and, with the exception of reduced NO_x emissions are not predicted to change substantially from current operations.

7.6 Air dispersion modelling

In addition to a review of the available air quality literature, Aurecon undertook air dispersion modelling at the request of DECCW. A full description of the model inputs and the detailed modelling results are available in Appendix E and are summarised in this section.

The assessment of impacts has been undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC 2005) (the Approved Methods) .

TAPM (v3.0) developed by the CSIRO was used for the predictive modelling. TAPM also produces meteorological data, upper air information and temperature profiles for the simulation period in three dimensions for all grid points across the area modelled. Further detail is provided in Appendix E. Ground-level concentrations of pollutants resulting from discharge of pollutants from a source change according to the weather conditions (particularly the wind) at the time. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere therefore meteorology should be carefully considered when modelling plume dispersion.

Plume rise is affected by ambient temperature and relative humidity at the release point. Plume dispersion over distance is influenced by:

Wind speed, profile and turbulence intensity, which are affected by terrain

Buoyancy affected by the temperature gradient which is determined from atmospheric stability

7.6.1 Meteorology

Ground-level concentrations of pollutants resulting from discharge of pollutants from a source change according to the weather conditions (particularly the wind) at the time. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere therefore meteorology should be carefully considered when modelling plume dispersion.

Plume rise is affected by ambient temperature and relative humidity at the release point. Plume dispersion over distance is influenced by:

Wind speed, profile and turbulence intensity, which are affected by terrain

Buoyancy affected by the temperature gradient which is determined from atmospheric stability

Mixing height which is the depth of the atmospheric boundary layer

Observed meteorological conditions

Meteorological conditions are generally recorded annually. 2004 was selected as the reference year for this analysis.

Observed wind speed data was obtained from the Munmorah, LMPS and Wyee monitoring stations. The data from these stations was assimilated into TAPM (The Air Pollution Model) to predict more complex meteorological parameters that feed into the air dispersion model. The temperature distributions and the wind roses developed from the observed datasets for the Munmorah, LMPS and Wyee stations are shown in the Appendix E.

7.6.2 Predicted meteorological conditions

The Air Pollution (TAPM) model

TAPM (v3.0) was used for the development of the meteorological data used in the modelling. The TAPM model produces meteorological data, upper air information and temperature profiles for the simulation period in three dimensions for all grid points across the area modelled. Further detail is provided in Appendix E.

Predicted wind speeds

The predicted wind rose and the frequency distribution of the stipulated wind classes is provided in Appendix E.