Mt Piper Power Station Extension

ENVIRONMENTAL ASSESSMENT

CHAPTER 9 – AIR QUALITY IMPACTS

- September 2009

Contents

9. Air Quality Impacts

The Director-General's requirements

The Environmental Assessment must include 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) considering worst case operating scenarios and meteorological conditions, representative monitoring and receiver locations and cumulative impacts, as applicable, from the nearby Mount Piper and Wallerawang Power Stations.

The Environmental Assessment must address air quality impacts at a local, regional and interregional level and the potential impacts of emissions on photochemical smog formation in the Sydney basin. The assessment must demonstrate that the project would meet the impact assessment criteria in Section 7 of the Approved Methods and the requirements of the Protection of the Environment Operations (Clean Air) Regulation 2002.

The Environmental Assessment must clearly demonstrate that the project has been designed to include the application of Best Available Control technology (BACT) in relation to air emissions. The assessment must include a framework for the mitigation, management and monitoring of air quality impacts, particularly with respect to sensitive receptors likely to be significantly impacted by cumulative air quality impacts in the local area.

9.1 Emissions Standards and Air Quality Criteria

Air quality impacts from industry are regulated by means of air emission standards which specify stack discharge limits and ambient air quality criteria. The air quality assessment is provided in **Appendix E**.

9.1.1 Air Emissions Standards

The *Protection of the Environment Operations (Clean Air) Regulation 2002* (the Regulation) sets, among other parameters, the maximum limits on emissions from activities and plant for a number of substances. Activities are grouped according to the activity carried out, start date of operation and continued operation. The Mt Piper Power Station Extension belongs to Group 6. Schedule 3 of the Regulation provides standards of concentration that can be emitted from the plant (Group 6). These standards are provided in **Table 9-1**.

Table 9-1 Emission limits for electricity generation (Clean Air Regulation)

Air Impurity	Activity or plant	Standard of concentration
Solid particles (Total)	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel.	50 mg/m^3
Nitrogen dioxide (NO_2) or nitric oxide (NO) or both, as NO_2 equivalent	Any boiler operating on a fuel other than gas, including a boiler used in connection with an electricity generator that forms part of an electricity generating system with a capacity of 30 MW or more.	500 mg/m^3
	Any turbine operating on gas, being a turbine used in connection with an electricity generating system with a capacity of 30 MW or more.	70 mg/m^3
Fluorine (F_2) and any compound containing fluorine, as total fluoride (HF) equivalent	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel.	50 mg/m^3
Type 1 substances and Type 2 substances (in aggregate)	Any activity or plant using a non-standard fuel.	1 mg/m^3
Cadmium (Cd) or mercury (Hg) individually	Any activity or plant using a non-standard fuel.	0.2 mg/m^3
Dioxins or furans	Any activity or plant using a non-standard fuel that contains precursors of dioxin or furan formation.	0.1 ng/m^3
Volatile organic compounds (VOCs), as n-propane equivalent	Any activity or plant using a non-standard fuel.	40 mg/m^3 VOCs or 125 mg/m^3 CO
Smoke	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel – in approved circumstances.	Ringelmann 3 or 60% opacity
	Any activity or plant using a liquid or solid standard fuel or a non-standard fuel – in other circumstances.	Ringelmann 1 or 20% opacity

In addition to the standards defined above, the DECCW has placed licence conditions on emission points at the existing power station. The Mt Piper Power Station licence states that concentrations at each discharge point must not exceed those provided in **Table 9-2**.

Table 9-2 Stack emission licence limits at Mt Piper Power Station

Pollutant	Maximum concentration	Units of measure
Cadmium	0.2	mg/m^3
Chlorine	200	mg/m^3
Mercury	0.2	mg/m^3
Nitrogen oxides	1.5	g/m^3
Volatile organic compounds	40	mg/m^3
Dioxins and furans	0.1	ng/m^3
Hydrogen chloride	100	mg/m^3
Solid particles	50	mg/m^3
Sulphuric acid mist and sulphur trioxide (as SO_3)	100	mg/m^3
Total fluoride	50	mg/m^3
Type 1 and Type 2 substances in aggregate	1.0	mg/m^3

9.1.2 Ambient Air Quality Criteria

The DECCW regulates air quality criteria in NSW. **Table 9-3** lists the air quality assessment criteria from the DECCW that are relevant to pollutants assessed in this study (DEC, 2005). These levels are generally set for the protection of human health.

9.2 Existing Environment

9.2.1 Dispersion Meteorology

Meteorological conditions are important for determining the direction and rate at which pollutant emissions would disperse. The meteorology in the project area would be influenced by several factors including the local terrain and land use. On a relatively small scale, winds would be largely affected by the local topography. At larger scales, winds are affected by synoptic scale winds, which are modified by convective processes in the daytime and also by a complex pattern of regional drainage flows that develop overnight. Given that the project area contains relatively diverse terrain and land use, there would be variations in wind patterns at different locations.

Table 9-3 Relevant air quality assessment criteria

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)
Sulphur dioxide (SO_2)	10 minutes	712
	1 hour	570
	24 hours	228
	Annual	60
Nitrogen dioxide (NO_2)	1 hour	246
	Annual	62
Carbon monoxide (CO)	1 hour	30,000
	8 hours	10,000
Photochemical oxidants (as ozone)	1 hour	214 (100 ppb)
	4 hours	171 (80 ppb)
PM_{10}	24 hours	50
	Annual	30
TSP	Annual	90
Fluoride (as hydrogen fluoride)	90 days	0.5
	30 days	0.84
	7 days	1.7
	24 hours	2.9
Antimony	1 hour	9
Arsenic	1 hour	0.09
Beryllium	1 hour	0.004
Cadmium	1 hour	0.018
Chromium III	1 hour	9
Chromium VI	1 hour	0.09
Lead	Annual	0.5
Mercury (inorganic)	1 hour	1.8
Nickel	1 hour	1.8
Dioxins and furans	1 hour	0.000002
PAH	1 hour	0.4

Data from a meteorological station at the Mt Piper Power Station were assessed for suitability to the meteorological and air dispersion modelling. This station is located approximately one kilometre to the north of the power station. Delta Electricity have provided data for 2001 to 2005 and **Table 9-4** shows a range of statistics from each year of available data

▪ **Table 9-4 Comparison of meteorological data statistics for 2001 to 2005**

Year	Data recovery	Mean wind speed	Percentage of calms
2001	100% (8760 hourly records)	2.5 m/s	4.9%
2002	96% (8394 hourly records)	2.4 m/s	11.8%
2003	96% (8397 hourly records)	2.4 m/s	7.0%
2004	99% (8704 hourly records)	2.2 m/s	7.4%
2005	41% (3611 hourly records)	2.1 m/s	21.2%

All years between 2001 and 2005 experienced a similar pattern of winds with the most common winds from the west-southwest.

9.2.2 Atmospheric Stability

Dispersion models typically require information on atmospheric stability. The atmospheric stability class is a measure of the turbulence of the atmosphere and, in the Pasquill-Gifford stability class assignment scheme, ranges from Class A to Class F. Class A is associated with highly unstable or turbulent conditions, while class F relates to stable conditions and typically at night when a temperature inversion is present.

Table 9-5 provides the frequency of occurrence of the six stability classes as determined by CALMET (a meteorological model) for the power station site.

▪ **Table 9-5 Frequency of occurrence of atmospheric stability classes**

Stability class	Frequency of occurrence, as predicted by CALMET for the Mt Piper Power Station site (%)
A	0.9
B	6.3
C	14.8
D	42.2
E	5.6
F	30.1
Total	**100**

From **Table 9-5**, the most common stability class is determined to be D-class, at around 42%. Pollutant dispersion is rapid under D-class stabilities since these conditions are generally associated with overcast conditions and with moderate to strong winds.

9.2.3 Climatic Information

The Bureau of Meteorology collects climatic information from Lithgow, to the east of the study area. The area is characterised by mild to warm summers and cold winters. January is typically the warmest month with a mean daily maximum temperature of 26°C. July is the coolest month with a mean daily minimum temperature of 10°C. In summer, the average maximum temperature ranges from 25 to 26°C and the minimum temperature ranges from 10 to 12°C. In winter, the average maximum temperature ranges from 10 to 12°C and the minimum temperature ranges from 1 to 2°C.

January is usually the wettest month with mean rainfall of 94 mm, falling over an average of 11 days in the month. The lowest monthly rainfall on average is September, with a mean monthly rainfall of 59 mm over 10 rain days. The mean annual rainfall is 858 mm with an average of 126 rain days each year.

9.2.4 Existing Air Quality

Air quality monitoring stations are located at Blackmans Flat and Wallerawang. Historically, there has been up to six ambient air quality monitoring locations (since 1992), including sites at Bowenfels, Springvale, Cullen Bullen and Portland. In 1996, Pacific Power reviewed all monitoring data between 1992 and 1995 and found that there was no evidence to suggest that the commissioning of the Mt Piper Power Station had increased short-term or long-term NO_x and SO_2 concentrations (Pacific Power, 1996). The NO_x and SO_2 monitoring sites at Bowenfels, Springvale, Cullen Bullen and Portland were subsequently decommissioned. Monitoring at Blackmans Flat and Wallerawang continued as these two sites had measured the highest short-term concentrations of all sites.

A summary of the recorded ambient air quality from Blackmans Flat and Wallerawang for the year modelled (2001) is presented in **Table 9-6**.

- **Table 9-6 Summary of ambient air quality monitoring for 2001**

Pollutant and averaging time	Blackmans Flat	Wallerawang	DECCW assessment criteria (µg/m^3)
Maximum 1-hour average NO_x (µg/m^3)	302	269	-
Annual average NO_x (µg/m^3)	16	16	-
Maximum 1-hour average NO_2 (µg/m^3)	79	59	246
Annual average NO_2 (µg/m^3)	10	10	62
Maximum 1-hour average SO_2 (µg/m^3)	353	424	570
Maximum 24-hour average SO_2 (µg/m^3)	70	47	228
Annual average SO_2 (µg/m^3)	13	7	60

The data from **Table 9-6** shows that NO_2 concentrations are well below DECCW criteria. Maximum 1-hour average concentrations have reached 79 µg/m^3 at Blackmans Flat and 59 µg/m^3 at Wallerawang, both of which are below the 246 µg/m^3 criterion. Similarly, annual average NO_2 concentrations have not exceeded the DECCW's 62 µg/m^3 criterion. At Blackmans Flat, the maximum NO_x level occurred with winds from the north, potentially influenced by Mt Piper emissions, but the link between winds from power stations and high concentrations is not strong. At Wallerawang, the highest NO_x concentrations occurred when the winds were from the west-northwest and while this is not the direction to either the Mt Piper or Wallerawang power stations, it is possible that some recirculation of stack pollutants has influenced the monitored levels. A summary of the NO_x monitoring data from 2002 to 2008 has also been obtained and these data show that annual average NO_x (NO_2 data were not available) concentrations have remained relatively constant at Blackmans Flat while average levels at Wallerawang have fallen in recent years. Maximum 1-hour concentrations show some large fluctuations from year to year.

From **Table 9-6** the SO_2 concentrations for maximum 1-hour average concentrations are below DECCW criteria with 353 µg/m^3 at Blackmans Flat and 424 µg/m^3 at Wallerawang, both of which are below the 570 µg/m^3 criterion. Similarly, 24-hour average and annual average SO_2 concentrations have not exceeded their respective DECCW criteria. At Blackmans Flat, maximum hourly levels occurred with winds from the northwest and north, which suggests that SO_2 emissions from Mt Piper are detectable at Blackmans Flat. The link between winds from power stations and high concentrations is not strong.

At the Wallerawang monitoring site, the highest SO_2 concentration occurred when the wind direction (at Mt Piper) was from the west-northwest. This direction is not consistent with the directions to either the Mt Piper or Wallerawang power stations, although there were also some elevated concentrations under north-northwest and east-northeast winds that could be more definitively linked to Mt Piper or Wallerawang power station emissions.

A summary of the SO_2 monitoring data from 2002 to 2008 has also been obtained and these records show that the annual averages have remained relatively constant at Blackmans Flat, while average levels at Wallerawang have shown some larger fluctuations. An exceedance of the 570 µg/m^3 criteria was recorded at Blackmans Flat in 2002 although hourly records were not available to carry out a more detailed assessment of this event; that is, to potentially identify the contributing source. Similarly, two exceedances of the 1-hour average SO_2 criteria were recorded at Wallerawang in 2003 and 2006 and there have been some large fluctuations in the maximum 1-hour concentrations.

9.2.5 Emission Estimates

Pollution emissions from the Mt Piper Extension would arise from the combustion of coal (USC case) or from the combustion of gas (CCGT case). It is anticipated that NO_x and SO_2 concentrations would be the most critical pollutants for the project. Other pollutants (CO, TSP, HF and individual air toxics) are also discussed, but the assessment places less emphasis on these pollutants, due to significantly lower impacts.

Table 9 in the *Air Quality Assessment* shows that the in-stack emissions concentrations for the USC and the CCGT comply with the *Protection of the Environment Operations (Clean Air) Regulation* and the current Mt Piper licence requirements.

Table 9-7 shows the key model scenarios that were developed for the cumulative assessment.

Table 9-7 Cumulative model scenarios

Scenario and description	Source			
	Mt Piper A	Mt Piper B (USC)	CCGT x 6	Wallerawang
Scenario 1 (Mt Piper and Wallerawang)*	X			X
Scenario 2 (Mt Piper and USC)*	X	X		
Scenario 3 (Mt Piper and CCGT)*	X		X	
Scenario 4 (Mt Piper, USC and Wallerawang)	X	X		X
Scenario 5 (Mt Piper, CCGT and Wallerawang)	X	X		X

** Denotes the scenarios that were developed into contour plots*

It should be noted that the emissions for the existing Mt Piper turbines relate to two 660 MW units. These two units have subsequently been upgraded and now operate at 700 MW each at full capacity. The existing measurements of in-stack NO_x concentrations for Units 1 and 2 and were analysed and these data to extrapolate potential concentrations at 700 MW. The analysis suggested that in-stack NO_x concentrations would have increased by between 4 and 7% over the modelled existing Mt Piper source. These changes are indicative of expected changes to model predictions for the existing Mt Piper source.

9.3 Emission Control Technology

For conservative reasons, no additional emission control measures (over the proposed technology) have been assumed for modelling the USC and CCGT plants. Four emission control technologies have been identified which can be used to minimise emissions.

9.3.1 Low NO_x combustors

Low NO_x combustors are an effective NO_x emissions control technique. In most jurisdictions, the use of low NO_x combustors for gas firing would be considered best available control technology (BACT) for NO_x emissions from gas turbines. The emission estimates for the CCGT modelling in this assessment assume dry low NO_x (DLN) combustors are being used.

In DLN burners, the formation of thermal NO_x is reduced by creating lean-premix conditions in the combustion system to reduce the flame temperature. The combustion process is controlled such that temperatures above 1500°C are avoided and relatively little NO_x is generated.

In NSW the *Clear Air Plant Equipment Regulation 2002* requires that all new gas turbine plants (Group 6) achieve less than 25 ppm (51 mg/Nm^3) NO_x on gas. This is consistent with what is achievable for DLN systems. The option for a CCGT plant would incorporate DLN burners. For coal-fired boilers, the *Clear Air Plant Equipment Regulation 2002* specifies a limit of 500 mg/Nm^3 NO_x, based on low NO_x combustors.

9.3.2 Selective Catalytic Reduction

While DLN is probably the most widely used NO_x control in gas turbine power plants, selective catalytic reduction (SCR) is also an effective mechanism for reducing NO_x emissions. SCR is a post-combustion process that is used to convert NO_x, with the presence of a catalyst, into diatomic nitrogen (N_2) and water (H_2O). A gaseous reductant is also added to the flue gas stream which is absorbed onto the catalyst. Commercial SCR systems may typically reduce NO_x emissions by 70 to 95% for coal-fired power stations, but with high capital and operating costs.

9.3.3 Flue Gas Desulphurisation

Flue gas desulphurisation (FGD) is a technology for removing SO_2 emissions, mainly from exhaust flue gases associated with coal or oil fired power plants. There are a variety of methods with the most common being:

- Wet scrubbing using a slurry of alkaline sorbent;
- Spray-dry scrubbing using similar sorbents;
- Wet sulphuric acid process; and
- Dry sorbent injection systems.

For a typical coal-fired power station, FGD would remove 95% or more of the SO_2 in the flue gases. No specific capital or operating and maintenance costs have been determined for FGD on the USC plant for this assessment, although it is estimated that these costs may be in the range of US$200-4000 per tonne of SO_2 removed, depending on the SO_2 removal method.

9.3.4 Fabric Filters

Fabric filters (or baghouses) use filtration to remove particulates from exhaust gases. They are one of the most efficient types of dust collectors available with collection efficiencies of 99% or more for fine particulates. The option for a coal-fired (USC) plant would incorporate fabric filters and particulate emissions would be maintained below the *Clear Air Plant Equipment Regulation 2002* limit of 50 mg/Nm^3.

9.3.5 Application of Emission Control Technologies

The discussion above shows that there are some commercially available technologies that can further reduce NO_x and SO_2 emissions from the proposed USC or CCGT plants. The review also highlights a potentially high cost with implementation and operation of some of these technologies, relative to the initial capital costs.

Based on the historical monitoring data, the conservatism in the modelling and from the current and historical performance of the model, the project is unlikely to adversely affect air quality for either the USC or CCGT options, based on the currently proposed technology, and DLN for the CCGT plant and low NO_x combustors and fabric filters for the USC plant.

9.4 Impact Assessment

This assessment has followed the DECCW's *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005), which provides guidance on how air quality impact assessments should be undertaken.

Ground-level pollutant concentrations have been predicted using CALPUFF (Version 6.263). CALPUFF simulates the dispersion of emissions by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs would overlap and the serial release would represent a continuous release. CALPUFF can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions.

The model predicts the pollutant concentrations at a set of receptors covering a region of 25 km by 25 km. Gridded receptors with spacing of 500 m were used for the entire model domain while a finer spaced set of discrete receptors was added for areas close to the Mt Piper and Wallerawang power stations. Spacing between the discrete receptors was set finer (approximately 100 m spacing) in areas closer to the emission sources and coarser in areas further from sources.

9.4.1 Model Results and Performance Assessment

Results from the dispersion modelling indicates that NO_2 and SO_2 have the highest potential to cause exceedances of the DECCW criteria (Table 11 of the *Air Quality Assessment*). These pollutants are the focus of the assessment. All other pollutants are predicted to comply with DECCW by one or more orders of magnitude at the most affected ground-level location for all assessment scenarios.

The performance of the model has been investigated by comparing the results with monitored data, for the Blackmans Flat and Wallerawang monitoring sites. The purpose of the performance assessment was to gauge how close the model predictions might be to actual levels (as measured), both with and without the project.

The comparison is shown below in **Table 9-8**, where cumulative model results for the existing Mt Piper and Wallerawang sources were used, based on hourly varying emissions (Holmes Air Sciences 2005) and flow rates from each source. Only SO_2 predictions have been evaluated, as there would only be a minor contribution from other, non-modelled, sources for this pollutant. That is, ambient SO_2 concentrations in the region would be influenced largely by emissions from the modelled power station stacks.

- **Table 9-8 Comparison of model predictions with measured concentrations**

Pollutant and averaging time	Blackmans Flat		Wallerawang	
	Measured	Predicted	Measured	Predicted
Maximum 1-hour average SO_2 (µg/m^3)	353	269	424	795
Maximum 24-hour average SO_2 (µg/m^3)	70	34	47	41
Annual average SO_2 (µg/m^3)	13	1.8	7	2.0

Table 9-8 shows that, for the Blackmans Flat site, maximum 1-hour average SO_2 concentrations were under-predicted by about 30%. This would generally be regarded as a good performance for a dispersion model. However, at the Wallerawang monitoring site, the model prediction was nearly twice as high as the maximum measured level. These results provide some insight into the expected performance of the model when assessing future scenarios.

The predictions for maximum 24-hour average SO_2 concentrations show that there was under-prediction for Blackmans Flat, but very good agreement for Wallerawang. Predicted annual average SO_2 concentrations were lower than measured levels, presumably because the model cannot fully capture all residual background SO_2 concentrations in the area.

The model performance assessment has therefore shown that:

- The second or third highest prediction might be a better indicator of expected maximum 1-hour average levels, rather than the highest prediction, for some locations;

- Modelled 24-hour averages provide a reasonable indication of expected impacts. That is, within a factor of 2; and
- Modelled annual averages would require more emphasis on background levels.

While the assessment that follows is based on the very highest model predictions, it is also important to consider the outcomes of the model performance assessment described above. Further, a number of similar studies (HAS, 2005 for example) have evaluated the performance of CALPUFF, particularly for predicting short-term (1-hour average) ground-level concentrations. These studies have indicated that the model has a tendency to over-estimate short-term concentrations under convective meteorological conditions, where the extreme model predictions are much higher than observed levels.

9.4.2 Operational Impacts

Nitrogen Dioxide

Nitrogen oxides are produced in most combustion processes. During high-temperature processes there would be a variety of nitrogen oxides formed including nitric oxide (NO) and NO_2. Generally, at the point of emission, NO would comprise 95% of the NO_x volume. The remaining 5% would be mostly NO_2. It is the NO_2 which is linked to health effects.

However, all nitric oxides emitted into the atmosphere are oxidised to NO_2 and then further to other higher oxides of nitrogen. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions and the presence of other substances in the atmosphere such as ozone. If the oxidation is rapid and the dispersion slow then high concentrations of NO_2 can occur.

The highest 1-hour average NO_2 concentration due to the existing Mt Piper power station is predicted to be 249 µg/m^3. This result is above the 246 µg/m^3 criterion and assumes that 30% of the NO_x is NO_2.

If the coal option were to be adopted, the modelling suggests that:

- Maximum 1-hour average NO_2 concentrations would increase from 249 to 338 µg/m^3, and the maximum number of hours above 246 µg/m^3 would increase from 1 to 2 hours per year, due to Mt Piper sources, and
- The highest levels would be close to the plant (that is, within 2 km).

If the CCGT option were to be adopted, the modelling suggests that:

- There would be no change to maximum 1-hour average NO_2 concentrations. That is, the highest 1-hour average NO_2 concentrations would be 249 µg/m^3, with a maximum of 1 hour above the criterion.

- The highest levels would be close the plant, with no exceedances of 246 µg/m^3 at any sensitive receptor location.

The results above show that the number of additional exceedances of short-term NO_2 criteria due to Mt Piper would be small, for either the coal or CCGT options. Adoption of a less conservative fraction of NO_2 in the NO_x (e.g. between 21 and 26% instead of 30%) would result in lower predictions of 1-hour average NO_2 concentrations than those predicted.

The predicted impacts of Wallerawang power station show that maximum 1-hour average NO_2 concentrations may exceed the 246 µg/m^3 criterion, due to Wallerawang emissions. The impacts are likely to be close to the source. However, it is outside the scope of this study to assess any predicted exceedances of criteria due to this source. The coal option potentially increases the maximum number of existing (Mt Piper plus Wallerawang) NO_2 exceedances from 1 to 2 hours per year. For the CCGT option, no increases in the maximum number of hours above the criterion are predicted.

The annual average NO_x concentration of all scenarios, is 10.2 µg/m^3. This demonstrates compliance with the DECCW criterion 62 µg/m^3, even when assuming all the NO_x is NO_2. Adding background NO_2 concentrations to predictions would not result in cumulative levels exceeding the 62 µg/m^3 criterion.

Sulphur Dioxide

In the case of SO_2, ambient concentrations in the region would be influenced largely by emissions from the power station stacks, discussed in this assessment. There would only be a minor contribution from other, non-modelled, sources.

The highest levels of the maximum 1-hour average SO_2 concentrations are predicted to exceed the 570 µg/m^3 criterion for all cumulative scenarios, and also due to individual modelled sources. The predicted maximum 1-hour average SO_2 concentrations are much higher than those which are currently, and have historically, been monitored in the region. This suggests that the model has over-estimated maximum short-term SO_2 concentrations.

Of all the sources, Wallerawang is predicted to have the highest individual contribution to maximum ground-level SO_2 concentrations at 1,767 µg/m^3, with a predicted maximum of five hours above the 570 µg/m^3 criterion per year.

The following observations were made from the model results of maximum 1-hour average SO_2 concentrations:

- Impacts due to existing sources (that is, Mt Piper and Wallerawang) are dominated by the contribution of Wallerawang emissions;

- There is a maximum of 5 hours per year when the SO_2 concentration is predicted to exceed 570 µg/m^3, due to existing (that is, Mt Piper and Wallerawang) sources;
- The maximum number of hours above 570 µg/m^3 is predicted to remain unchanged at 5 hours if either the coal or CCGT plants is added to all existing sources;
- The maximum number of hours above 570 µg/m^3 due to Mt Piper sources only, is predicted to increase from 2 to 4 hours if the coal plant is added; and
- The maximum number of hours above 570 µg/m^3 due to Mt Piper sources only, is predicted to remain unchanged at 2 hours if the CCGT plant is added, since the SO_2 emissions from the CCGT plant would be zero.

None of the cumulative options (that is, Mt Piper with coal or gas) would increase the maximum number of exceedances above the five hours per year, although for the coal case, some areas are predicted to experience one or two more exceedance hours, compared with the modelled existing situation.

The second highest model prediction may provide a better indication of the maximum 1-hour average SO_2 concentrations that would be measured. The extent of the 570 µg/m^3 contours is reduced (over maximum levels) for all scenarios. The results of the maximum 24-hour and annual average SO_2 predictions respectively were compliant with the DECCW criteria for all scenarios.

In addition to harmful effects on the human respiratory system, SO_2 can also have harmful effects on vegetation. The World Health Organization (WHO) has set an air quality guideline of 20 µg/m^3 as a mean winter and an annual average for forests and natural vegetation (WHO, 2000). The results indicate that all ground-level locations would experience annual average SO_2 concentrations less than the WHO guideline of 20 µg/m^3, for all assessment scenarios. This suggests that there would be no adverse impacts on vegetation.

Other Pollutants

Modelling has also been undertaken for other pollutants including carbon monoxide, fluoride (as HF), particulates, antimony, arsenic, beryllium, cadmium, chromium III and VI, lead, mercury (inorganic), nickel, dioxins and polycyclic aromatic hydrocarbons. The predicted ground-level concentrations of these pollutants and for all scenarios are well below the relevant criteria. Most of the predictions are more than an order of magnitude lower than the relevant criteria. These results suggest that the impact of the project, with respect to air quality, would be acceptable.

9.4.3 Construction Impacts

Construction activities may generate dust emissions and these emissions have the potential to cause nuisance impacts if not properly managed. In practice, it is not possible to realistically quantify impacts using dispersion modelling as knowledge of weather conditions would be required for the few weeks that work would be taking place at each location on the site. Air quality impacts during construction have therefore been assessed by identifying the main dust generating activities and noting the most effective measures to control emissions.

Dust emissions would arise primarily from the following activities:

- Clearing of vegetation and topsoil;
- Loading of material to trucks;
- Trucks travelling over unsealed roads; and
- Wind erosion from unsealed surfaces and stockpiles.

The construction activities listed above would be expected to be completed over a twelve month period.

9.4.4 Inter-Regional Transport

The foregoing assessment has focussed primarily on air quality impacts at the local scale (that is, within a domain of approximately 30 km around the Project site). At the regional and interregional scale, the complex chemical transformations that take place over long distances become more important and it is necessary to employ a modelling system that is designed to simulate these mechanisms. The three-dimensional modelling system (TAPM-CTM) is suitable for this analysis.

TAPM-CTM has been used to assess the impact of NO_x emissions from the Project on photochemical smog formation in the Sydney metropolitan region and surrounding areas, referred to as the Metropolitan Air Quality Study Region.

The main objective of the TAPM-CTM modelling was to predict regional levels of NO_2 and ozone (O_3), both with and without the Project. Ozone is of particular concern, due to observed exceedances of the DECCW's 1-hour and 4-hour average criteria (100 ppb and 80 ppb respectively) in recent years. The DECCW's 1-hour average criterion for NO_2 (246 µg/m^3 or 120 ppb) is rarely exceeded.

Three emission scenarios were modelled, as follows:

- Existing sources only ("base" case);
- Existing sources plus proposed USC ("test" case 1); and

- Existing sources plus proposed CCGT ("test" case 2).

Model results for base case scenarios showed good agreement with measured concentrations. **Table 9-9** provides a summary of the regional maximum NO_2 and O_3 concentrations, as predicted by TAPM-CTM. The results from **Table 9-9** show that:

- Regional maximum 1-hourly average NO_2 concentrations may increase by up to 3.3 ppb for the USC plant and up to 2.6 ppb for the CCGT plant;
- Regional maximum 1-hourly average O_3 concentrations may increase by up to 4.8 ppb for the USC plant and up to 2.2 ppb for the CCGT plant; and
- Regional maximum 4-hourly average O_3 concentrations may increase by up to 2.9 ppb for the USC plant and up to 1.3 ppb for the CCGT plant.

While the emissions from the options are unlikely to cause additional exceedances of NO_2 or O_3 criteria, some areas outside the Sydney basin are predicted to experience increases in hourly O_3 of up to 15 ppb. These increments are predicted for existing concentrations between 40 and 70 ppb.

- **Table 9-9 Summary of regional maximum NO_2 and O_3 concentrations**

Case-study period	Base case	Base case plus USC	Base case plus CCGT
Maximum 1-hour average NO_2 concentrations (ppb)			
6-8 February 1997	66.5	67.5	69.1
25-27 October 1997	98.5	101.4	100.4
11-13 March 1998	90.8	93.2	92.8
6-8 February 2004	109.0	112.3	111.1
Maximum 1-hour average O_3 concentrations (ppb)			
6-8 February 1997	117.8	119.1	118.2
25-27 October 1997	88.5	90.0	89.3
11-13 March 1998	100.7	103.4	101.4
6-8 February 2004	126.1	130.9	128.3
Maximum 4-hour average O_3 concentrations (ppb)			
6-8 February 1997	98.2	99.3	98.5
25-27 October 1997	74.7	75.2	75.0
11-13 March 1998	92.5	95.4	93.3
6-8 February 2004	112.9	114.6	114.2

9.5 Mitigation Measures

9.5.1 Management Measures during Operation

In this assessment, emissions from proposed new sources have been evaluated for the potential to adversely affect ambient air quality at nearest sensitive receptors. The predictive modelling has clearly shown that while there is conservatism in the assessment, NO_2 and SO_2 have the highest potential to affect local air quality. Although the Environment Protection Licence for Mt Piper Power Station (13007) does not specify a requirement to monitor ambient air pollution levels, continuation of the existing monitoring program would be useful to quantify any change in air quality at the closest populated areas.

The current Blackmans Flat and Wallerawang monitoring sites remain suitable sites for quantifying any changes to air quality at the closest populated areas for the following reasons:

- They both include monitoring of SO_2 and NO_x;
- The Blackmans Flat site is one of the closest residential areas to the Mt Piper Power Station, and is also be downwind of the station under the frequently occurring westerly winds; and
- The Wallerawang site is predicted to experience close to the maximum ground-level short-term concentrations due to both the Mt Piper and Wallerawang power stations, whilst also being situated in a populated area.

These two monitoring locations would continue to be useful for both Mt Piper and Wallerawang power stations to identify contributions from emission sources to sensitive receptor locations. Periodic review and analysis of the monitoring data would provide the necessary information on whether the project is affecting local air quality and whether any operational adjustments are necessary.

9.5.2 Management Measures during Construction

Emissions from the construction activities can be readily controlled through the following measures:

- Ensuring that all unsealed trafficable areas are kept sufficiently damp (with water) during working hours to minimise wind blown or traffic generated dust emissions;
- Ensuring that all equipment used and all facilities erected are designed and operated to control the emission of smoke, dust, fumes and other pollution into the atmosphere;
- Minimisation of areas of surface disturbance to ensure dust generation is kept to a minimum;
- Stabilisation of working areas as soon as practicable to prevent or minimise wind blown dust;

- Covered or watering of stockpile, wherever practicable;
- Restricting traffic to defined roads;
- Imposing a low speed limit on unsealed roads; for example, 20 km/h or less; and
- Covering of truck loads to prevent wind blown emissions and spillage.

These measures would ensure that dust emissions are subject to a high level of control. Given that the nearest residences are approximately two kilometres from the site (Blackmans Flat), it is unlikely that a suitably managed construction site would result in any off-site air quality impacts.