

7.1 Introduction

The study of the likely impact of the Marulan Gas Turbine Facilities on air quality covered the following three components:

- greenhouse gasses;
- local air quality; and
- aviation safety.

The air quality assessment summarised in this chapter investigated the combined impact of the emissions from both the Delta Electricity and EnergyAustralia Facilities. This chapter provides a summary of this assessment and the full assessment is presented in the respective *Project Applications* for each Facility. Impacts of the Facilities individually are also presented in the respective *Project Applications* for each Facility.

A comprehensive greenhouse gas assessment including quantitative modelling has been conducted and is presented in full in the respective *Project Applications* for each Facility.

In August 2005, the New South Wales Environment Protection Authority (NSW EPA), currently incorporated in the NSW Department of Conservation and Climate Change (DECC), updated the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*. (referred to herein as the *Approved Methods*). The assessment of the impact of local air quality used a largely conservative approach, in accordance with the *Approved Methods*. This chapter provides a summary of this assessment and the full assessment is presented in the respective *Project Applications* for each Facility.

An aviation safety assessment has been conducted for the project to determine compliance with the Civil Aviation Safety Authority's (CASA) Advisory Circular "Guidelines for Conducting Plume Rise Assessments" (June, 2004). This summary is presented in more detail in the respective *Project Applications* for each Facility.

7.2 Greenhouse Gas Assessment

7.2.1 Policy Context

Global and national greenhouse gas policy is complex and while the Kyoto protocol came into force internationally in 2005 and in Australia in March 2008, the practical implications are still being finalised. This section briefly summarises the policy issues.

International Policy

The Kyoto Protocol to the United Nations Framework Convention on Climate Change was signed in 1997 and entered into force in 2005. Its aim is to limit greenhouse gas emissions of countries that ratified the protocol by setting individual mandatory greenhouse gas emission targets in relation to those countries' 1990 greenhouse gas emissions. It sets out three "flexibility mechanisms" to allow greenhouse gas targets to be met:

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- The Clean Development Mechanism;
- Joint Implementation; and
- International Emissions Trading.

The definitions of the three mechanisms above are complex but effectively they allow greenhouse gas reductions to be made at the point where the marginal cost of that reduction is lowest. Essentially, an industrialised country sponsoring a greenhouse gas reduction project in a developing country can claim that reduction towards its Kyoto Protocol target and those greenhouse gas reductions can be traded.

Australian Policy

In December 2007, the Australian Government ratified the Kyoto Protocol which effectively states that greenhouse gas emissions not to be more than 8 % above 1990 levels. This came into force in Australia in March 2008.

Australia's Climate Change Policy

Australia's Climate Change Policy was released in July 2007 (Department of the Prime Minister and Cabinet, 2007a) and sets out the Commonwealth Government's focus on reducing emissions, encouraging the development of low emissions and emission reduction technology, climate change adaptation, and setting Australia's policies and response to climate change within a global context.

Existing monitoring and reporting programs at a national level include the following:

- National Greenhouse Gas Inventory (NGGI);
- Greenhouse Challenge Plus, including the Generator Efficiency Standards;
- National Pollutant Inventory;
- ABARE Fuel and Energy Survey;
- Energy Efficiency Opportunity Assessment subset of the NFEE;
- Mandatory Renewable Energy Trust (MRET); and
- Greenhouse Friendly.

National Emissions Trading Scheme

The recently released report of the Prime Ministerial Task Group on Emissions Trading (Department of the Prime Minister and Cabinet, 2007b) has foreshadowed a national emissions trading scheme to help Australia address the global issues of climate change. The initial information is that this will be a "cap-and-trade" scheme, and will be developed by 2010.

Key features of the proposed scheme are:

- setting of a long-term emissions abatement goal;
- setting of an initial low target to establish a low starting price for carbon;

- implementing progressively more stringent targets, to help drive deeper emission reductions and longer-term technology development;
- establishing maximum practical coverage of all emission sources and sinks and of all greenhouse gases;
- permit liability placed on direct emissions from large facilities and on upstream fuel suppliers for other energy emissions;
- practical considerations include initial exclusion of agriculture and land use emissions;
- allocates permits for trade-exposed emission-intensive industries to reduce short-term impacts while encouraging abatement and energy efficiency;
- recognition of a wide range of credible domestic and international carbon offset regimes; and
- capacity, over time, to link to other national and regional schemes in order to provide the building blocks of a truly global emissions trading scheme.

National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* establishes a single, national system for reporting greenhouse gas emissions, abatement actions, and energy consumption and production by corporations from 1 July 2008. Data reported through the system will underpin the Australian Emissions Trading Scheme (AETS). The ability to monitor, report and verify businesses' emissions data will be essential for maintaining the environmental and financial integrity of the trading system.

AETS requires "controlling corporations" to register and report if its "corporate group" or "facilities" under its "operational control" emit greenhouse gases, produce energy or consume energy above specific thresholds. AETS commences in July 2008 and will facilitate collection of data for an emissions trading scheme.

The Facilities will be subject to mandatory reporting under the *National Greenhouse and Energy Reporting Act 2007* as per the requirements outlined in the *Greenhouse Gas Emissions and Energy Reporting Policy Paper* issued for comment in February 2008.

Greenhouse Challenge Plus

The Greenhouse Challenge Plus program, run by the Australian Greenhouse Office, encompasses reducing emissions from electricity infrastructure, buildings, fleet, manufacturing operations and end-use waste. EnergyAustralia and Delta Electricity have been members of the Greenhouse Challenge Plus program since 1997.

Energy Efficiency Opportunities (EEO)

The Energy Efficiency Opportunities legislation came into effect in 2006, and requires large energy users (over 0.5PJ of energy consumption per year) to participate in the program. The objective of this program is to drive ongoing improvements in energy consumption amongst large users, and businesses are required to identify, evaluate and report publicly on cost effective energy savings opportunities.

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Energy Efficiency Opportunities is designed to lead to:

- improved identification and uptake of cost-effective energy efficiency opportunities;
- improved productivity and reduced greenhouse gas emissions; and
- greater scrutiny of energy use by large energy consumers.

Generators and distribution companies are currently exempt for three years from EEO with respect to energy generation and losses associated with transmission and distribution. Accordingly it is not mandatory for Delta Electricity or EnergyAustralia to participate in the program.

State-based Policy

NSW Greenhouse Plan (2005)

The NSW Government Greenhouse Plan was released in November 2005. The plan provides a strategic approach to combating climate change in NSW. The NSW Greenhouse Plan outlines new and ongoing actions to limit greenhouse emissions in NSW, and achieve key emission reduction targets announced by the NSW Government. Key principles and goals of the Greenhouse Plan are to:

- raise awareness of climate issues within the broader community;
- recognise that climate change is a global, long term and complex issue with no easy solution;
- promote understanding of the likely impacts on NSW, and identify strategies for adaptation to the environmental, social and economic impacts of climate change;
- limit the growth of greenhouse gas emissions and reduce these emissions in NSW. The Plan outlines targets, strategies and actions to achieve significant emission reductions;
- promote climate change partnerships through co-operative approaches by Government, individuals, industry, business and community groups;
- reduce business uncertainties by establishing carbon constraints in order to promote new investment and innovation; and
- identify key strategic areas for cooperative work with other Australian jurisdictions including the development and establishment of a Kyoto compliant national emissions trading scheme.

The NSW Greenhouse Gas Reduction Scheme

The NSW Greenhouse Gas Reduction Scheme (GGAS) (formally known as the NSW Greenhouse Gas Abatement Scheme) commenced on 1 January 2003 with the aim of reducing greenhouse gas emissions from the production and use of electricity. It uses a “baseline and credit” approach to abatement, where project-based activities generate offsets that can be used to abate greenhouse gas emissions.

The tradable unit in the GGAS is a New South Wales Greenhouse Abatement Credit (NGAC), equivalent to one tonne of abated CO₂-e. A more generic name for these credits in GGAS is Abatement Certificate. Retailers are liable for a certain number of NGACs calculated on the basis of their share of the NSW electricity market. Therefore, retailers provide the demand for NGACs, and other parties supply NGACs into the market.

NSW Energy Savings Plan and Fund

High energy users in NSW are required to prepare Energy Savings Action Plans. The Government introduced new legislation in May 2005 to encourage a better understanding of energy use by business, government agencies and local councils and establish detailed plans of action for savings.

The NSW Energy Efficiency Strategy

This initiative was announced in early December 2007 by the NSW Premier; however, functional details are as yet to be developed and announced.

7.2.2 Methodology

The greenhouse gas emission inventory for the Facilities is based on the methodology detailed in the *Greenhouse Gas Protocol* (WBC for SD&WRI, 2004) (referred to herein as the Protocol), and the relevant emission factors in the *National Greenhouse Accounting (NGA) Factors* (DECC 2008). The Protocol was first established in 1998 to develop internationally-accepted accounting and reporting standards for greenhouse gas emissions from companies.

The Greenhouse Gas Protocol is based on the concept of emission “scopes”:

- Scope 1: Direct greenhouse gas emissions. Direct greenhouse gas emissions occur from sources that are owned or controlled by a company. For example:
 - emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.;
 - emissions from chemical production in owned or controlled process equipment.
- Scope 2: Electricity indirect greenhouse gas emissions. This accounts for greenhouse gas emissions from the generation of purchased electricity consumed by the Facility. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the various generators which provide power to the transmission network when the proponent’s electricity consumption (purchase) occurs.
- Scope 3: Other indirect greenhouse gas emissions. This is an optional reporting class that accounts for all other indirect greenhouse gas emissions resulting from a company’s activities, but occurring from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation and extraction of purchased fuels; and use of sold products and services.

This greenhouse gas assessment has been conducted using the Australian Greenhouse Office’s quantitative methodology. Based on estimated plant operation, total emissions (CO₂-e) have been calculated and compared to state and national greenhouse gas inventories for both the energy sector, and the sum of all sectors.

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7.2.3 Greenhouse Gas Inventory

Greenhouse gas emissions from gas fired turbines comprise primarily carbon dioxide (CO₂) with small amounts of methane (CH₄) and nitrous oxide (N₂O).

The greenhouse gas assessment encompasses the operational stage of the Facilities. The construction and decommissioning phases have not been included. Due to the small size of the project and relatively short construction duration, greenhouse gas emissions during construction and decommissioning are considered insignificant (as compared to plant operation) in the calculation of emissions over the lifetime of the project.

The greenhouse gas inventory for the Facilities has included Scope 1 and Scope 3 emissions in order to account for the direct (Scope 1) and indirect (Scope 3) emissions from the project. The operational boundary is defined as the boundary of the Site. Scope 3 emissions are limited to upstream emissions from the production of gas fuel used for electricity generation.

Given that the Facilities are generators of electricity, where the power generated has been quantified as net power sent out (i.e. generator output minus electricity required to power auxiliary plant and equipment), electricity consumption associated with Scope 2 has been addressed in the forecast of electricity sent out.

The Facilities would operate on natural gas and estimated fuel consumption and power generated per year (electricity sent out) are presented in **Table 7-1**. These figures have been based on the maximum proposed operating duty of 500 hours per annum (per turbine) during Delta Electricity Facility Stage 1 and 90 % of the year during Delta Electricity Facility Stage 2. The EnergyAustralia Facility has been based on the maximum proposed operating duty of 10 % of the year per turbine.

Table 7-1 Estimated Gas Consumption and Electricity Sent Out

Parameter	Project Stage	Value	Units
Gas combusted	Delta Electricity Stage 1	2	PJ/yr
	Delta Electricity Stage 2	32	
	EnergyAustralia	3*	
Electricity sent out	Delta Electricity Stage 1	150	GWh/yr
	Delta Electricity Stage 2	3500	
	EnergyAustralia	219	

Note: Electricity sent out for Delta Electricity sourced from Burns and Roe Worley (2006) and electricity sent out for EnergyAustralia sourced from EnergyAustralia.

* Rounded value presented. Assessment calculations have used the estimation of 2.96 as provided by EnergyAustralia.

The following parameters were not included in the assessment as they contribute negligibly to the Facilities' greenhouse gas inventory:

- fuel combusted by offsite vehicle use;
- loss of biomass due to construction;
- liquid refrigerant losses; and
- Sulphur Hexafluoride (SF₆) emissions from switchgear.

Table 7-2 summarises the direct and indirect greenhouse gas emissions from both the Delta Electricity Facility and EnergyAustralia Facilities.

Table 7-2 Cumulative Greenhouse Gas Inventory for Delta Electricity and EnergyAustralia Facilities

Parameter	Greenhouse Gas Emissions (Mt CO ₂ -e per year)			% Contribution represented by the combined Facilities
	Delta Electricity		EnergyAustralia	
	Stage 1	Stage 2		
Total Direct Greenhouse Gas Emissions	0.102	1.641	0.152	-
Total Indirect Greenhouse Gas Emissions	0.028	0.454	0.042	-
Total combined Greenhouse Gas Emissions for each Facility	0.131	2.096	0.194	-
Total combined Greenhouse Gas Emissions (assuming Delta Electricity Stage 2 and EnergyAustralia)	2.29			-
NSW Electricity generation sector	57.8			3.96 %
Total NSW GHG emissions	158.2			1.45 %
Australia Electricity generation sector	194.3			1.18 %
Total Australian GHG emissions	559.1			0.41 %

Table 7-3 shows greenhouse gas emissions for the Facilities over the lifetime of the Project on the basis that only Delta Electricity Stage 2 operates, as the operating period for the Delta Electricity Stage 1 development is currently uncertain. Long term market trends define the operating duty, and ultimately the commercial life of the Facilities; hence there exist large uncertainties in potential emissions over the Project lifetime.

Table 7-3 Cumulative Greenhouse Gas Inventory for Delta Electricity and EnergyAustralia Facilities on a Project Lifetime Basis

Greenhouse Gas Emissions Parameter	Units (Mt CO ₂ -e over 30 years)	
	Delta Electricity (assumed Stage 2)	EnergyAustralia
Direct	49.2	4.6
Indirect	13.6	1.3
Total (each Facility)	62.9	5.8
Total combined Emissions	68.7	

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Total greenhouse gas emissions in Australia for 2005 (the most recent available at the time of this assessment) were estimated to be 559.1 million tonnes of CO₂-e (Australian Greenhouse Office 2005¹), while NSW was estimated to emit 158.2 million tonnes CO₂-e from all sources (28.3 % of emissions from all states). Most of the greenhouse gas emissions in NSW come from stationary energy sources (48 % of NSW emissions).

The use of natural gas for the Facilities results in electricity production at a lower greenhouse intensity than the NSW average. Progression of the Delta Electricity Facility to combined cycle operation further improves greenhouse efficiency to approximately half that of conventional coal-fired generation. For this reason, natural gas fired, combined cycle generation is widely considered to be an important transitional mode of generation for the achievement of long-term greenhouse reduction targets.

Detailed plant selection for the Facilities is yet to be made. The technology employed would be typical of current best practice, both in terms of both technology type (OCGT/CCGT), and detailed equipment selection.

This assessment has incorporated relatively coarse estimations of annual fuel consumption and net electricity sent out. As these are annualised figures, they also incorporate fuel consumption associated with start up, shut down, testing and operation at lower loads (the Facilities' turbines would operate between around 60-100 % load). This means that the annualised intensities are indicative of the scale of annual greenhouse emissions from the Facilities. However, the coarser resolution of the annualised intensities means that they are not suitable for marginal comparisons of generator greenhouse intensity when considering the type of generating technology employed.

7.2.4 Participation in Greenhouse Gas Programs

Delta Electricity

Delta Electricity has long recognised the growing concern by communities and governments of the issues of global warming and emissions of greenhouse gases from the combustion of fossil fuels. Delta Electricity monitors GHG emissions and thermal efficiency at each power station site and implements programs to improve operational performance and reduce emissions.

These programs include:

- development of renewable energy generation sources including two 30 MW biomass fired co-generation facilities on the north coast of NSW, biomass co-firing in existing power stations and mini hydro generators;
- development of gas fired power stations to provide a lower greenhouse alternative for future electricity demand;
- participation in the Greenhouse Challenge Program since 1997;

¹ Australian Greenhouse Office 2007 *Australia's National Greenhouse Accounts, State and Territory greenhouse gas Inventories 2005*, Australian Greenhouse Office, 2007

- participation in the Generator Efficiency Standards (GES). Delta Electricity was the first generator to agree to legally binding targets under the Australian Government's Generator Efficiency Standards (GES);
- participation in the NSW Greenhouse Gas Abatement Scheme and creation of 200,000 to 300,000 NGACs/year; and
- implementation of Environmental Management System ISO 14001:2004 standard.

Delta Electricity is not proposing to implement any greenhouse gas offsets specifically for this Project.

EnergyAustralia

EnergyAustralia is responding to the challenge of climate change by encouraging the use of alternative, cleaner sources of energy. EnergyAustralia is at the forefront of the energy industry's efforts to reduce greenhouse gas emissions and finding more sustainable solutions for our energy supply. EnergyAustralia is involved in a variety of renewable energy generation projects, ranging from solar and wind energy to biomass and hydro.

EnergyAustralia is also committed to supporting customers to reduce greenhouse gas emissions, and offsetting production of greenhouse gas emissions in a variety of other ways. EnergyAustralia achieved the highest abatements and offsets of greenhouse gas emissions of all retailers under the NSW Greenhouse Gas Reduction Scheme, and has been a member of the Greenhouse Challenge (now Greenhouse Challenge Plus) since 1997.

EnergyAustralia also participates in the federal government's Mandatory Renewable Energy Target (MRET) scheme. MRET requires an additional 2 % of electricity purchased in Australia to be generated from renewable resources such as wind, biomass, hydro and solar power. The target is to generate 9,500 GWh of energy nationally from renewable resources by 2010.

In order to comply, EnergyAustralia is required to purchase and surrender Renewable Energy Certificates (RECs) which are produced by renewable energy creators such as wind farms and hydro power plants. These certificates support the development of the renewables industry and are administered by the Office of the Renewable Energy Regulator. EnergyAustralia has been compliant since the scheme's introduction in 2001. In 2005 EnergyAustralia surrendered around 400,000 RECs. In 2010 this target will increase to around one million RECs.

The GGAS commenced on 1 January 2003. It is one of the first mandatory greenhouse gas emissions trading schemes in the world. GGAS aims to reduce greenhouse gas emissions in NSW by 5 % per capita below 1989/90 levels by 2007, by encouraging project based activities to offset the production of greenhouse gas emissions.

The scheme is measured and monitored by the issue and surrender of certificates called NGACs (NSW Greenhouse Abatement Certificates), as well as Renewable Energy Certificates (RECs). Each NGAC represents the abatement of a single tonne of carbon dioxide. NGACs may be created from certain emission-reduction activities, including:

- low emission generation of energy (generation);
- activities that result in the reduced consumption of electricity (demand side abatement); and
- the capture of carbon from the atmosphere in forests (carbon sequestration).

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GGAS requires NSW electricity retailers to meet mandatory targets for reducing or offsetting the emission of Greenhouse gases from the production of the electricity they supply or use. EnergyAustralia has been compliant since the scheme commenced and achieved the highest level of abatement or offsets in greenhouse gas emissions of all retailers under GGAS and were the first to trade carbon sequestration in March 2005 under the scheme. In 2005 EnergyAustralia surrendered about 2.5 million NGACs. The target will increase to around 6 million by 2009.

EnergyAustralia is not proposing to implement any greenhouse gas offsets specifically for this Project.

7.3 Air Quality Impacts

7.3.1 Methodology

The Environmental Assessment Requirements require the air quality assessment to be prepared in accordance with the *Approved Methods*. The *Approved Methods* identify a number of stages in an air quality impact assessment:

- 1) Input data collection.
- 2) Dispersion modelling.
- 3) Processing dispersion model output data.
- 4) Interpretation of dispersion modelling results.
- 5) Preparation of an impact assessment report.

The first step in the impact assessment is the collection of information required to complete the dispersion modelling. This includes development of an air emissions inventory, compilation of meteorological data, background air quality data and terrain data. A summary of the meteorology and background data is presented in **Section 7.3.2**.

For Step 2 of the assessment it is noted that three dispersion models are generally endorsed by DECC for development approvals, namely AUSPLUME, TAPM and CALPUFF. The TAPM and CALPUFF models both incorporate site-specific factors such as terrain influences, regional-scale winds and inversions to predict ground-level concentrations.

Given the significance of this assessment, it was considered that the use of two models provided greater reliability in the prediction of the potential impacts. The CALPUFF model better handles calm atmospheric conditions and was used to generate the majority of results, with TAPM providing validation of the CALPUFF model concentrations. The results presented in **Section 7.5.2** therefore present the results from the CALPUFF modelling. The TAPM and CALPUFF model results are in close agreement hence the use of CALPUFF in this assessment was considered valid. A discussion of the validation of these results using TAPM modelling is presented in the respective *Project Applications*.

Due to the different operational scenarios for each of the Delta Electricity (both stages) and EnergyAustralia Facilities and the varying emission characteristics, several scenarios were required to be modelled. The modelling scenarios are discussed further in **Section 7.3.4**. Additional “combined Facility” scenarios were modelled and the results are provided in the respective *Project Applications*, however only the worst case results have been presented and discussed in this chapter.

Step 4 of the impact assessment is the interpretation of dispersion modelling results. The outputs of the dispersion modelling are added to existing maximum background concentrations of pollutants to determine the predicted ground level concentrations. These ground level concentrations are compared with the DECC's impact assessment criteria. DECC states in the *Approved Methods* that "compliance indicates the proposal is unlikely to result in adverse air quality impacts".

The proposed Facilities would be situated in a rural area and emissions from surrounding industrial sources are negligible. Consequently, the impact of the Facilities on local air quality is expected to be minor. Similarly, given the distance of the Facilities from the greater metropolitan regions of Sydney and Wollongong, a detailed regional air quality assessment was not considered warranted.

Air Quality Criteria

There are three main types of air quality criteria relevant to industrial developments such as the Delta Electricity and EnergyAustralia Facilities:

- *Emission Standards* – which are maximum allowable pollutant emission concentrations (stack concentrations) specified for particular types of equipment;
- *Air Impact Assessment Criteria* – which are designed for use in air dispersion modelling studies and air quality impact assessments for new or modified emission sources; and
- *Ambient Air Quality Standards* – which set standards against which ambient air quality monitoring results may be assessed.

In general, Emission Standards and Air Impact Assessment Criteria are used to evaluate the expected impact of air emissions on air quality and the effectiveness of plant design and any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant Ambient Air Quality Standards.

The *Approved Methods* also state that cumulative impacts from adjacent facilities must be taken into consideration. Thus this chapter discusses the impacts from the combined Delta Electricity and EnergyAustralia Facilities.

Emission Standards

The Protection of the Environment Operations (Clean Air) Regulation 2002 sets emission limits for air impurities from stationary plant and equipment. The current standards, taken from Schedule 3 (Electricity Generation) of the Regulation, relevant to the Facilities are presented in **Table 7-4** for solid particulates and oxides of nitrogen. The plant is classified as a Group 6 source, as it will commence operation after 1 September 2005.

Table 7-4 Emission Standards for Electricity Generation

Pollutant	Applicability	Limit
Solid Particulates (Total)	-	50 mg/m ³
NO ₂ or NO or both as NO ₂ equivalent	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 as NO ₂

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Air Impact Assessment Criteria

The *Approved Methods* specifies a range of impact assessment criteria for toxic and odorous air pollutants. The impact assessment criteria for these pollutants associated with the Facilities are shown in **Table 7-5**.

Table 7-5 DECC Impact Assessment Criteria for Modelled Pollutants

Pollutant	Concentration		Averaging Period
	(ppm)	(µg/m³)	
Criteria Pollutants			
NO ₂	0.12	246	1 hour
	0.03	62	Annual
PM ₁₀	-	50	24 hour
	-	30	Annual
SO ₂	0.25	712	10 minutes
	0.20	570	1 hour
	0.08	228	24 hours
	0.02	60	Annual
CO	87	100,000	15 minutes
	25	30,000	1 hour
	9	10,000	8 hours
Hazardous Air Pollutants			
Acetaldehyde	0.023	42	1 hour
Acrolein	0.00018	0.42	1 hour
Benzene	0.009	290	1 hour
Ethylbenzene	1.8	8000	1 hour
Formaldehyde	0.018	20	1 hour
Total PAH	-	0.4	1 hour
Toluene	0.09	360	1 hour
Xylenes	0.04	190	1 hour

Ambient Air Quality Criteria

The ambient air quality criteria adopted by NSW are provided by the *National Environment Protection Measure (NEPM) for Ambient Air Quality* (referred to herein as 'NEPM for Ambient Air Quality'), published by the National Environment Protection Council (NEPC) (1998). The NEPM for Ambient Air Quality sets out national standards and goals for six common ambient air pollutants (NEPC, 1998) namely nitrogen dioxide (NO₂), carbon monoxide (CO), photochemical oxidants (as ozone), sulfur dioxide (SO₂), lead and particulates as PM₁₀. When reviewing the standards and goals set out in the NEPM for Ambient Air Quality, it should be noted that they are designed for use in assessing regional air quality and are not intended for use as site boundary or atmospheric dispersion modelling criteria. Consequently, proposed Facility emissions have not been assessed directly against NEPM guidelines, however it should be noted that the NEPM guidelines for NO₂, PM₁₀, SO₂ and CO are identical to the DECC criteria, as shown in **Table 7-5**.

The NSW Government has also published an *Air Quality Management Plan* (NSW EPA, 2006) for the Greater Metropolitan Region (GMR) of NSW. In August 2006, the DECC updated and re-issued 'Action for Air' - the NSW Government's 25-year Air Quality Management Plan, which was originally published in 1998. The proposed development Site is situated slightly outside the GMR, thus the management plan does not strictly apply to this development. However, the National Standards and Goals provided in 'Action for Air' acknowledge the NEPM criteria, which are considered to be identical to the values adopted for this assessment.

In 2004 the NEPC released the *Air Toxics NEPM* (NEPC, 2004) that presented a number of monitoring investigation levels for some key Volatile Organic Compounds (VOCs). The air investigation levels were derived on the basis of the long term protection of human health within regional areas. The purpose of the Air Toxics NEPM is the collection of ambient air concentration of VOC "...at locations where elevated levels are expected to occur and there is a likelihood that significant population exposure could occur." (NEPC, 2004 p 2). Similarly to the Ambient Air Quality NEPM, the Air Toxics NEPM is designed for use in assessing regional air quality and not intended for use as site boundary or atmospheric dispersion modelling criteria. Thus, the predicted concentrations of Hazardous Air Pollutants (HAPs) are compared against the DECC criteria.

7.3.2 Existing Environment

Climate and Meteorology

A summary of the climatological data collected at the Goulburn (Airport) station by the Bureau of Meteorology is provided in the respective *Project Applications*. The Goulburn Meteorological Station is located 37 km south west of the Site, and is considered to be representative of the region, including the proposed development Site. These data indicate the region experiences hot summers and cold winters. The records show the average maximum daily temperature for summer is approximately 27 °C, with temperatures as high as 40 °C being recorded. The area has moderate rainfall with an average annual rainfall of 513.8 mm.

As site specific meteorology was not available, the meteorological data used in the dispersion modelling was generated using the CSIRO's *The Air Pollution Model* (TAPM) (Hurley, 2005) using data from automatic weather stations (AWS) located at the following locations:

- Goulburn Airport AWS (located approximately 37 km south west of the Site);
- Lynwood AWS (located approximately 12 km south south west of the Site); and
- Berrima AWS (located approximately 28 km east north east of the Site).

Background Air Quality and Concentrations Used for Modelling

Background air quality is generally a function of regional industrial and residential air emission sources. The *Approved Methods* requires that the peak concentration of a criteria pollutant measured by an appropriate ambient air quality monitoring station is used to represent the background concentration of that pollutant for a region. This results in a conservative assessment as concentrations of an individual pollutant may vary over different time scales. While the maximum concentration of a pollutant may be elevated due to unusual events (for example PM₁₀ is elevated during dust storms and bushfires), the concentrations for the remainder of the year may remain low, hence the use of the maximum background value provides a conservative measure of impact.

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The background data for NO₂ and SO₂ was taken from the DECC air monitoring site at Bargo (2006). Background PM₁₀ and CO are not measured at Bargo and were taken from the closest available DECC monitoring stations at Oakdale and Macarthur.

The PM₁₀ data for Bargo showed one exceedance of criteria during 2006, on 1st November. This 24 hour averaged result of 57.3 µg/m³ was due to a local bushfire at Lake Burragorang (DECC 2007). In accordance with the *Approved Methods* this value was excluded from the assessment. The next highest 24 hour averaged concentration was found to be 40.0 µg/m³, which occurred on the 22nd of November 2006. This elevated value is likely to be a result of bushfires occurring in the Blue Mountains (DECC, 2007) but has been used in this assessment on the basis of conservativeness.

It should also be noted that the Macarthur monitoring station is located adjacent to the Hume Highway and between the heavily trafficked Narellan and Menangle Roads, consequently the background CO concentrations used in this assessment are considered conservative as the proposed development Site is situated away from heavily trafficked roads and industrial areas.

A summary of the background air quality concentrations used in this assessment, as measured by DECC, is provided in **Table 7-6** and a map showing the location of the ambient air quality stations is provided in the respective *Project Applications*.

Table 7-6 Summary of Background data used in Air Quality Modelling - 2006

Species	Averaging Time	DECC Monitoring Station Data	Maximum Background Concentration (µg/m ³)	Air Quality Criteria (µg/m ³)
NO ₂	1 hour	Bargo	116.9	246
	Annual average	Bargo	13.7	62
PM ₁₀	24 hour	Oakdale	40.0	50
	Annual	Oakdale	14.0	30
SO ₂	10 minute	Bargo	36.8	712
	1 hour	Bargo	25.7	570
	24 hour	Bargo	5.7	228
	Annual average	Bargo	1.2	60
CO	15 minute	Macarthur	3299	100,000
	1 hour	Macarthur	2500	30,000
	8 hour	Macarthur	2250	10,000

7.3.3 Potential Discharges to Air during Construction

Bulk earthworks for the two Facilities should they occur at the same time, are anticipated to take approximately 6 months to complete. The Delta Electricity Facility would be constructed in two stages with the Stage 1 assumed to take 12 months and Stage 2 assumed to take 18 months. The EnergyAustralia Facility would be constructed entirely in one stage and is assumed to take 12 months to complete. These construction periods may or may not overlap.

During the construction phase, there is the potential for dust to be generated due to the excavation and handling of soils, site grading activities and vehicles movements.

7.3.4 Potential Discharges to Air during Operation

The detailed discussion of the inputs to the modelling including operational emission parameters, pollutant data and turbine exhaust stack characteristics used in the dispersion modelling are contained in full Air Quality Assessment in each of the respective *Project Applications*.

Emissions

The potential emissions during operation include:

- **Oxides of Nitrogen** - Oxides of nitrogen (NO_x) are the sum of nitric oxide (NO) and nitrogen dioxide (NO_2). Generally the NO_x emissions from a combustion source comprise approximately 90 % NO and 10 % NO_2 . In the atmosphere NO and NO_2 are linked in a circular reaction with oxidants such as ozone, which generate NO_2 from NO and sunlight which breaks NO_2 down to NO. Due to this reaction sequence, the exact amount of NO and NO_2 within emissions is often unknown, and consequently the sum emission of both species (i.e., NO_x) is quoted.
- **Particulate Matter** - Particulate matter with an aerodynamic diameter of 10 μm or less (PM_{10}) is acknowledged as a pollutant of concern due to its ability to be inhaled into the lungs. PM_{10} has been considered as part of this assessment. Gas turbine emissions operating on natural gas generally contain very low concentrations of particulate matter due to the fuel type and combustion process.
- **Sulfur Dioxide** - Given that sulfides are removed from natural gas as part of the “desulfurisation” process at the natural gas processing plant, sulfur dioxide emissions are likely to be low to negligible.
- **Carbon Monoxide** - resulting from the incomplete combustion of any fuel containing carbon.
- **Hazardous Air Pollutants (HAPs)** - in this assessment HAPs included Acetaldehyde, Acrolein, Benzene, Ethylbenzene, Formaldehyde, Toluene, Total PAHs, and Xylenes.

Emission Parameters

The stack emissions were the only sources assessed for the Project. EnergyAustralia has decided on an E class type turbine, however the turbines to be used in the Delta Electricity Facility are still to be decided. For the purposes of this project, an E class turbine was chosen to be representative of the stack emissions.

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Emission rates were calculated as the product of estimated stack concentrations and exhaust flow rate. Due to the potential frequency of starts for open cycle turbines, Start Up emissions are generally assessed. The infrequent nature of the Delta Electricity combined cycle (Stage 2) Start Up typically makes further assessment unnecessary.

More detailed discussion on the sources of the specific emission data is provided in the respective *Project Applications*.

Scenarios Modelled

Due to the different operational phases for each of the Delta Electricity and EnergyAustralia Facilities and the varying emission characteristics, several scenarios were required to be modelled (and are presented in the relevant appendices to the *Project Applications*) however only the worst case scenarios undertaken for the two Facilities are presented and discussed here. The two worst case modelling scenarios for the two Facilities together ('combined') were:

- **Scenario 1 – Combined:**
 - Delta Electricity Stage 1 start up; **with**
 - EnergyAustralia start up.
- **Scenario 2 – Combined:**
 - Delta Electricity Stage 2 operation; **with**
 - EnergyAustralia start up.

7.3.5 Assessment of Potential Impacts – Common Shared Works

The assessment for the Common Shared Works has addressed specifically the bulk works. During the bulk earthworks, there is the potential for dust to be generated due to the excavation and handling of soils, site grading activities and vehicle movements. Given the undeveloped nature of the Site, there is considered to be no significant potential for dust emissions from construction activities to contain contaminants, or for the works to give rise to odorous emissions. The distance to the nearest residential dwellings (approximately 1.5 km) provides a sufficient buffer zone between the main work area and neighbouring land uses to prevent nuisance dust impacts. Consequently emissions during construction have not been quantified.

Emissions of particulates (dust) would be specifically controlled through the implementation of mitigation measures, which would be incorporated into a Construction Environment Management Plan (CEMP) for the works. These measures may include the following:

- watering, spraying or covering earthworks during excavation and handling and on exposed surfaces and stockpiles;
- scheduling activities for more favourable meteorological conditions;
- ceasing earthmoving activities when wind speeds exceed 30 km/hr;
- covering or limiting truck soil loads;
- reducing speed limits on unsealed surfaces;

- cleaning soil off the undercarriage and wheels of trucks; and
- any long-term stockpiles or cleared areas would be stabilised using measures such as fast seeding grass or synthetic cover spray.

7.3.6 Assessment of Potential Impacts – Facilities

Construction

There is the potential for dust to be generated due to the excavation and handling of soils, site grading activities and vehicle movements, however, these emissions would be minimised through the implementation of a Construction Environment Management Plan (CEMP). The distance to the nearest residential dwellings (approximately 1.5 km) provides a sufficient buffer zone between the main work area and neighbouring land uses to prevent nuisance dust impacts.

Operation

A summary of the results from the dispersion modelling for the combined Facilities is provided in **Table 7-7**. The worst case impact for each species is shaded in the table.

The 'Maximum Cumulative Impact' (Column 6) presents the **sum** of the maximum background concentration (Column 4) and the maximum predicted ground level concentration of Column 5 in the table (shaded number in Column 5) (i.e., *Column 4 + maximum Column 5 = Column 6*).

However, the situation is more complex for the NO_x concentrations. For Scenarios 1 and 2 the quantification of peak NO₂ impacts required a refinement of the assessment in accordance with the *Approved Methods*. The concentrations of NO₂ were calculated using an equation for estimating the conversion of NO_x emitted from the Facilities to NO₂ (Janssen Equation). This conversion recognises that the highly conservative approach of assuming all NO_x is present as NO₂ leads to the impact being overstated.

Compliance with the Air Quality Criteria is illustrated in the Table (Column 8). None of the modelled species were shown to exceed the DECC regulatory criteria.

Sensitive receptor locations and selected dispersion model contour plots for criteria pollutants are provided in the respective *Project Applications*.

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Table 7-7 Summary of predicted Ground Level Concentrations

Column 1	Column 2	Column 3	Column 4	Column 5		Column 6	Column 7	Column 8
Species	Averaging Period	Frequency	Background Concentration	Scenario Modelled ^A		Maximum Cumulative Impact	Air Quality Criteria	Compliance with Air Quality Criteria
			µg/m ³	1- Combined	2 - Combined	µg/m ³	µg/m ³	YES/NO
NO _x (as NO ₂)	1 hour	100%	116.9	113.0 ^B	71.2 ^B	229.9 ^B	246	YES
	Annual	100%	13.7	0.67	0.60	14.4	62	YES
PM ₁₀	24 hour	100%	40.0	0.93	1.29	41.3	50	YES
	Annual	100%	14.0	0.04	0.08	14.1	30	YES
SO ₂	10 minute	100%	36.8	12.7	36.0	72.8	712	YES
	1 hour	100%	25.7	8.85	25.14	50.8	570	YES
	24 hour	100%	5.7	0.740	1.304	7.0	228	YES
	Annual	100%	1.2	0.0256	0.080	1.3	60	YES
CO	15 minute	100%	3299	1795.2	1218	5094	100,000	YES
	1 hour	100%	2500	1360.5	923.1	3861	30,000	YES
	8 hour	100%	2250	329.5	166.2	2580	10,000	YES
Acetaldehyde	1 hour	99.9%	-	0.563	0.034	0.563	42	YES
Acrolein	1 hour	99.9%	-	0.090	0.006	0.090	0.42	YES
Benzene	1 hour	99.9%	-	0.169	0.010	0.169	290	YES
Ethylbenzene	1 hour	99.9%	-	0.450	0.028	0.450	8000	YES
Formaldehyde	1 hour	99.9%	-	9.990	0.610	9.990	20	YES
Toluene	1 hour	99.9%	-	1.829	0.112	1.829	360	YES
Total (PAH)	1 hour	99.9%	-	0.031	0.002	0.031	0.4	YES
Xylenes	1 hour	99.9%	-	0.901	0.055	0.901	190	YES

Notes:

^A: Worst case concentrations are shaded^B: For Scenarios 1 and 2 Combined, peak NO₂ impacts showed that a more refined assessment was required in accordance with the *Approved Methods*. The concentrations of NO₂ were estimated using an equation for estimating the conversion of NO_x emitted from the Facility to NO₂ (Janssen Equation).**Oxides of Nitrogen**

Modelling of the combined sources used the Janssen Method to estimate NO₂ concentrations for the 1 hour average. When added to the maximum background NO₂ concentration, a cumulative concentration was calculated to be 229.9 µg/m³ which is below the DECC regulatory criteria of 246 µg/m³.

The annual average NO₂ concentrations were estimated on the conservative basis that NO_x existed as NO₂, and assuming the Facilities were operating every hour of the year. The results provided in **Table 7-7** showed that all scenarios were below the criteria of 62 µg/m³. Given the background concentration of 14.0 µg/m³, and the predicted worst case impact of concentrations at or less than 0.67 µg/m³, long term impacts are considered negligible.

Photochemical Smog

Photochemical smog is produced during extended periods of light winds (several hours to several days) accompanied by strong sunlight, as a result of reactions involving the precursor pollutants including NO_x and non-methane hydrocarbons (NMHCs) / volatile organic compounds (VOCs). There are few major industrial sources of hydrocarbons in the area and ambient levels of NO_x and VOCs from vehicles would be significantly lower than the levels experienced in major metropolitan air sheds such as Sydney and Melbourne. Thus the potential for smog generation in Marulan is considered to be low and photochemical smog is unlikely to occur due to operations of the Facilities.

Particulate Matter

The maximum measured 24 hour average background concentration of PM₁₀ was shown to be 40.0 µg/m³, which is approaching the regulatory limit of 50 µg/m³. Given the maximum 24 hour averaged impact from Scenario 1 or Scenario 2 is 1.3 µg/m³, PM₁₀ impacts from the Facilities are considered minor. Similarly, the annual PM₁₀ impact was shown to be minor with a maximum predicted concentration of 14.1 µg/m³, being less than the annual criteria of 30 µg/m³.

Sulfur Dioxide

All sulfur dioxide results were shown to be significantly below the regulatory criteria. Consequently, no adverse impacts on air quality are expected as a result of the discharge of sulfur dioxide from the Facilities.

Carbon Monoxide

All carbon monoxide results were shown to be significantly below the regulatory criteria. Consequently, no adverse impacts on air quality are expected as a result of the discharge of CO from the Facilities.

Hazardous Air Pollutants

In accordance with the *Approved Methods*, HAPs were assessed for incremental impact and were below regulatory criteria. The most significant incremental impact was formaldehyde, for which the worst case 1-hour concentration of 9.99 µg/m³ constituted 50 % of DECC criteria.

Summary

The assessment of background data showed that NO₂, PM₁₀, CO, and SO₂ and HAPs were not in exceedance of regulatory criteria. The dispersion modelling predicted the impact of the Facilities emissions on air quality based on both Facilities operating all hours of the year. Whilst the Facilities, when operating in peaking mode, are likely to operate for less than 10 % of the year, this conservative approach was taken to assess the impacts under worst case operating and atmospheric conditions.

In conclusion, no exceedences of DECC regulatory criteria were observed and it is considered that the impacts on air quality from this development would be minor and adverse impacts are unlikely.

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7.3.7 Assessment of Potential Impacts – Gas Pipeline

Construction activities for the gas pipeline would be typical of modern pipeline projects. The following construction activities may cause potential impacts to air quality (dust):

- vehicle movements;
- clearing vegetation and site grading; and
- excavation of a trench in which to lay the pipeline.

The potential dust emissions from the above activities would be managed and minimised through the implementation of a Construction Environment Management Plan (CEMP).

It is not expected that emissions from the gas pipeline during operation would be significant.

7.4 Aviation Safety

7.4.1 Methodology

Due to the plume rise from the Facility stack emissions, an aviation hazard analysis was performed and is presented in the respective *Project Applications*.

The statistics have been compiled in accordance with the Civil Aviation Safety Authority's (CASA) Advisory Circular "Guidelines for Conducting Plume Rise Assessments" (June, 2004). Where there is potential for an exhaust plume with a vertical velocity greater than 4.3 m/s at the Obstacle Limitation Surface (OLS) of 110 m, a hazard analysis is required.

7.4.2 Assessment

This assessment involved the use of the TAPM model which was used to create site-specific meteorological data, including meteorology for the upper atmosphere. TAPM was also used to calculate plume rise trajectories for the stack emissions.

Due to the various development scenarios possible, the most conservative plume rise scenario was chosen, namely Delta Electricity Stage 1 (Operation) and EnergyAustralia operating for all hours of 2006 (the modelled year).

The modelling results show that the combined Facilities would produce exhaust plumes with vertical velocities that exceed 4.3 m/s above the OLS for approximately 60 % of the year, assuming both Delta Electricity and EnergyAustralia Facilities were running at full load for all hours of the year. The maximum, minimum and average heights at which the plume velocity is greater than 4.3 m/s are provided in **Table 7-8**.

Table 7-8 Maximum, Minimum and Average Critical Plume Extents

	Critical Vertical Plume Extent (m)	Critical Horizontal Plume Extent (m)
Maximum	852	262
Minimum	58	37
Average	133	92

7.4.3 Management

Whilst this assessment is considered conservative with respect to the modelled operating times and operating conditions, consideration would be given for the Facilities to be designated a potential hazard to aircraft operators in the area. The implementation of such a designation would be at the discretion of CASA.

Further consultation with CASA would be undertaken following detailed design. It is understood that CASA would require confirmation of any changes to the design that may affect the plume rise assessment. Prior to operation of the Facilities, CASA would need to be provided with the following information:

- “as constructed” coordinates in altitude and longitude of the Facilities;
- final height (in AHD) of the exhaust stacks; and
- ground level of the Site (in AHD).

7.5 Mitigation Measures

A summary of the mitigation measures in regard to air quality for the combined Facilities is provided in **Table 7-9**. The phase of implementation is indicated in the table by *Cons* – Construction, *Ops* – Operation, Design and Planning.

Table 7-9 Summary of Mitigation Measures

Mitigation Measures	Implementation of mitigation measures		
	Common Shared Works	Facilities	Gas Pipeline
Liaise with CASA to address the issue of potential aviation hazard of the plant.		✓ (Ops)	
The CEMP would consider the most appropriate dust mitigation method suited to the activity and circumstances. This would likely include measures such as: • watering, spraying or covering earthworks during excavation and handling and on exposed surfaces and stockpiles; • scheduling activities for more favourable meteorological conditions; • covering or limiting truck soil loads; • reducing speed limits on unsealed surfaces; and • cleaning soil off the undercarriage and wheels of trucks, when required.	✓ (Design & Cons)	✓ (Design & Cons)	✓ (Design & Cons)
Any long-term stockpiles would be stabilised (for example using measures such as fast seeding grass or synthetic cover spray).	✓ (Cons)	✓ (Cons)	✓ (Cons)
Delta Electricity and EnergyAustralia both monitor GHG emissions and thermal efficiency and when possible, implement programs to improve operational performance and reduce emissions.		✓ (Ops.)	