3.1 Introduction

A number of alternatives were considered for the Facilities. In particular, the type, scale and location of the Facilities were assessed in relation to:

- power generation technology options;
- Facility options:
  - gas turbine options;
  - emission control options;
  - site selection options;
  - joint Site infrastructure;
- Facilities' water supply;
- Facility footprint options.

This chapter presents the alternatives assessment for the EnergyAustralia Facility. Refer to the *Concept Application* for the alternatives assessment for the Common Shared Works and the Delta Electricity Facility.

3.2 Power Generation Technology

Most power plants burn fuel such as coal, oil, natural gas and biomass, which creates steam to drive a turbine to generate electricity. Sometimes nuclear or solar energy creates the steam to drive the turbine. Combustion turbines are based on jet engines. In combustion turbine technologies, the natural gas is burned, creating superheated gas, which is then pressurised in pipes and used to drive the turbine. Other technologies include hydro, wind and solar.

EnergyAustralia made a decision to propose gas powered generation on the basis that an open cycle gas turbine facility is viewed as the most efficient way to supply peaking loads and having a similar thermal efficiency to coal fired power stations but with lower greenhouse gas emissions per unit of energy generated. The combustion of natural gas produces only a fraction of the nitrogen oxide and carbon dioxide emissions of oil and coal, and also results in much smaller quantities of particulate matter and sulphur dioxide emissions. Natural gas therefore becomes an attractive "transition" fuel, as the energy supply moves away from greenhouse intensive sources such as coal and towards cleaner, less greenhouse intensive technologies.

Chapter 3 Alternatives

3.3 Gas Turbine Technology

EnergyAustralia proposes to use the rigid frame (E Class) and aero-derivative units. The proposed Facility would comprise two open cycle gas turbines, each with approximately 175 MW capacity producing a total nominal output of 350 MW. Except for emergencies allowed in the operating licence, the Facility would operate on an as-required, intermittent basis for a total maximum period of up to 10 % of any year.

3.4 Site Options

EnergyAustralia considered a number of sites in close proximity to Sydney. These were assessed over several studies to varying levels of detail and included a review against the criteria listed below:

- assessment of any electrical transmission constraints;
- assessment of gas transmission constraints;
- the cost of connection to gas and electricity transmission;
- sufficient and suitable land availability;
- environmental status and likelihood of approval; and
- specific site constraints such as average temperature, elevation and humidity.

Fifteen sites were considered by EnergyAustralia. A summary of the findings of the study is provided below:

- ***Tomago:*** Tomago is located adjacent to the major loads of the smelter with connections to the heavily loaded network from the Hunter Valley to Newcastle and Sydney. There would be constrained connection for a new power plant until connection upgrade by TransGrid on the 500 kV transmission network between Bayswater and Eraring Power Stations is achieved. Gas supply would require a 4 km extension.
- ***Wagga Wagga***: Wagga is supplied by 330 kV transmission lines from the Snowy Mountains Scheme and NSW-Victoria interconnection and is characterised by high power flows. The proposed power plant would be connected to the Wagga switching station via the local 132 kV transmission line on the site and would compete with the Snowy and Victorian generation for export to Sydney. Access to the gas pipeline is favourable as it passes through the site.
- ***Bamarang:*** Connection to the 132 kV system is Nowra (via 6 km overhead transmission line along existing corridors) and underground transmission line through residential areas. Gas supplies are available from nearby Eastern Gas Pipeline with a 1 km lateral. Delta Electricity owns the site.
- ***Hunter:*** Muswellbrook/Scone: A number of sites were identified by EnergyAustralia focussing on those it owns or has rights to. There is no gas pipeline currently in the Hunter area. Transmission networks to Newcastle and Sydney are highly loaded by generators in the Hunter Valley and Central Coast.

- ***Dubbo:*** Gas supply from the Marsden to Dubbo pipeline is available. Plant would be connected via the 132 kV transmission network with some upgrades necessary to the Wellington substation, which is a major local distribution hub for western NSW and connected by a 330 kV transmission line to the network supplying Sydney.

Due to a number of constraints identified for the sites listed above, an assessment of other potential sites for gas turbine Facilities was carried out. Focusing on gas supplies, only the main pipelines between Moomba and Sydney met the requirements of a large gas turbine Facility. North of Sydney, the available gas supply from the main pipeline is limited. Spur connections to regional centres in NSW may have sufficient capacity for small generation units but are also likely to suffer supply limitations.

The electrical transmission network includes extensive 132 kV and 330 kV systems across NSW as well as several 500 kV transmission lines connecting the major generation centres of the Sydney region. The network north of Sydney to Newcastle and the Hunter Valley is currently heavily loaded while other areas also suffer localised constraints (e.g. supplies from the Snowy Mountains Scheme).

The proximity of the Moomba to Sydney Pipeline and the TransGrid switchyard, along with the availability and suitability of land, deemed the Marulan Site to meet EnergyAustralia's site selection criteria and accordingly was considered the most appropriate site. Furthermore, the advantages of collocating the EnergyAustralia Facility within close proximity to the gas pipeline and TransGrid switchyard would relatively reduce the environmental footprint.

3.5 Air Emissions Control Options

The EnergyAustralia Facility would be fitted with Dry Low NO_x technology which is considered to be the most suitable emission control technology for the Marulan Site. This technology was chosen as Dry Low NO_x technology is not reliant on the use of water as part of the emission control process. This technology, at full load, can achieve NO_x emission control to 25 ppm (average period 1 hour) for each unit.

As discussed in **Chapter 7,** the air dispersion modelling assessment for the EnergyAustralia Facility concluded that under worst case meteorological conditions (with all units operating all hours), the predicted impacts on ground level concentrations of nitrogen dioxide (NO_2), particulate matter (PM_{10}), carbon monoxide (CO), sulphur dioxide (SO_2) and Hazardous Air Pollutants when added to peak background concentrations were with in the NSW DECC regulatory criteria.

3.6 Facilities' Water Supply

3.6.1 Water Demand

The potential sources for water have been considered for the combined requirements of both the Delta Electricity and EnergyAustralia Facilities.

Based on an average operation of 10 % per annum for the EnergyAustralia Facility and 500 hours per annum for Stage 1 of the Delta Electricity Facility, the total operational water requirement for the Facilities would be approximately 14 ML per annum. During Stage 2 of the Delta Electricity Facility, the total operational water requirement of the Facilities would be approximately 76 ML per annum. These water requirements are discussed in **Chapter 4** and also in more detail in **Chapter 14**.

Chapter 3 Alternatives

The EnergyAustralia and Delta Electricity Facilities' total water requirements are summarised in **Table 3-1**. It is noted that **Table 3-1** considers Delta Electricity Facility, as a combined cycle facility (Stage 2) as this provides the highest estimate for the total water demand.

Table 3-1 Summary of Indicative Water Demand Scenarios

Staging	Preliminary	Scenario 1	Scenario 2	Scenario 3 [4]
Works / Operations		EnergyAustralia Facility	EnergyAustralia Facility	EnergyAustralia Facility Delta Electricity Facility
Construction Activities	EnergyAustralia Facility		Delta Electricity Facility	
Year[3] (indicative timing only)	late 2008 – mid 2010	mid 2010	2012 – 2013	2013/2014 – onwards
Potable (ML pa)	Assumed minimal	0.04	0.04	0.74
Demineralised (ML pa)		0.0012	0.2012	0.0
Non-Potable (ML pa)	11.6[2] (construction activities)	**12.0** (+ 7.4 EA startup[1])	**12.0** + 11.6[2] (construction)	**75.5** (+ 53.5 Delta Electricity Facility startup[1])
Total Water Demand[1] (ML pa)	11.6	12.0	23.6	76.2

Source: GHD, 2008.

Notes: 1 . Startup volumes not included in total water demand (one off demand only). They will be required at the startup of the EnergyAustralia Facility and Delta Electricity Facility only.
2. The construction demand assumes 7 kL/day plus 100 kL/day for 3 months/yr. Assumed a non-potable demand. Other construction water demands for potable water are assumed minimal.
3. Dates provided in the table above are indicative only and may be subject to change.
4. For water demand calculations it has been assumed that the Delta Electricity Facility Stage 2 is directly constructed without an intermediary Stage 1 to provide the worst case water demand scenario.

3.6.2 Potential Water Sources and Servicing Options

Based on the indicative water demand presented in **Table 3-1**, the assessment addressed the potential supply options and considered which of the identified options warranted further consideration as shown in **Table 3-2**.

Table 3-2 Summary of Water Supply Options

Water Type / Demand	Source Options	Comment	Will it be considered further for sourcing water? (Y-Yes, N-No)
Potable	Goulburn water supply network	Water source is more remote and there is adequate water supply available within Marulan's supply.	N
	Marulan water supply network	Preferred source for potable water supply. Water could be piped or tankered to Site. Some 10 ML pa is available over the first four years.	Y
Non-potable	Marulan's sewage treatment plant (STP) Effluent	STP is some 12 km from the Site. STP upgrade / augmentation by Goulburn Mulwaree Council is already required to cater for future Marulan population growth and EnergyAustralia / Delta Electricity demands could provide an opportunity to assist Goulburn Mulwaree Council in this upgrade. Effluent would need to be transferred to the Site. Current volumes available are in the order of 0.2 ML/d (approx 73 ML pa)	Y
	Wingecarribee Council Moss Vale sewage treatment plant treated effluent	Source is some 30 km northeast of the Site. Effluent would need to be transferred to the Site. Some 600 ML pa available.	Y
	Industrial Effluent	Limited industrial effluent is available and it already passes to Marulan STP. Source was not considered further.	N
	Groundwater	Groundwater is likely to be of unreliable yield and quality.	N
	Wollondilly River Water	It is likely that there would be issues with obtaining an extraction licence, community acceptability and potential water quality issues.	N
	Stormwater Runoff	The amount available for use as a non-potable source is dependent on the storage available. Approximately 110 ML pa is available based on 20 ML storage.	Y
	Onsite wastewater recycling (domestic)	Insufficient domestic wastewater available to meet requirements. It is anticipated that this would be treated and disposed of onsite or alternatively, tankered to Marulan STP.	N
	External sources	Water could be sourced from other sites such as Sutton Forest (potable water) and tankered to the Site. Given the higher cost of water (relative to other sources) and transport requirements this is more likely to be a 'back-up' option.	N

Source: GHD, 2008.

Chapter 3 Alternatives

The Goulburn region has been suffering through drought conditions for a number of years. In turn, these conditions have placed the region's water systems under stress. Notably, the Wollondilly River is under a moratorium of further water extractions. A consequence of these conditions has been the funding of a potable water pipeline from Wingecarribee to Goulburn to supplement supply. A number of water servicing options were developed for further investigation (**Table 3-3**)**.** It is possible that a combination of the water servicing options would be used to satisfy water demand (considering both volumes and qualities required) for both Facilities and further investigations would be undertaken into the preferred option mix(es).

Table 3-3 Water Supply Servicing Options Available

Water Type	Target Water Supply volumes	Water Servicing Option			Comments
	(ML pa)	Option 1	Option 2	Option 3	
Potable Water	0.74	Tank Delivery	-	-	10 ML per annum potable water available from Marulan WTP.
Demineralised Water	0.2012	Truck delivery for Scenario 1 (i.e. maximum required across Scenario 1).	-	-	Quantities of water involved are minimal (less than a tanker truck per month).
Non-potable Water	75.5	Capture and onsite storage of rainwater. Offsite storage to be considered if not found to be practical during concept design. Top up with potable water.	Supply of recycled water from an upgraded Marulan STP	Alternate (currently available) supply of recycled water sourced from Wingecarribee Shire.	A decision on an option or combination of options would be made following further assessments and negotiations.

Source: GHD, 2008.

It should be noted that any of the water servicing options identified in **Table 3-3**, for each of the water types (e.g. potable, non-potable) could be adopted in conjunction with the other options (e.g. potable water Option 1 with non-potable water Option 2). A decision would be made on the preferred option following appropriate assessment of economic and non-economic factors.

3.6.3 Availability and security of potential water supply

As indicated above, a number of the water sourcing options were influenced by the actions and proposed programs of Goulburn Mulwaree and Wingecarribee Shire Councils.

Discussions with Goulburn Mulwaree Council identified that;

- Council undertook a *Sewerage Master Plan for the Marulan Township Development* in 2005, however the then anticipated rate of developments have not materialised and as such Goulburn Mulwaree Council is currently in discussions with current and potential high water demand customers to determine its strategy forward.
- Goulburn Mulwaree Council's current water and waste water strategies are set out in its *Management Plan 2008/09* (available on Council Web Page) which makes provisions for:
  - Development of an Integrated Water Cycle Management Plan (*ongoing asset),* targeted for completion in December 2008.
  - Marulan Sewerage Treatment Plant Investigation and Design (*new asset*) commencing in the 2010/11 financial years.
  - A Sewer Pumping upgrade of the Marulan Pumping Station over the next four years.
  - Identified Marulan STP Investigation and then construction in its *'Forward Capital Works Plan'* for the next four years as a '*forward capital'*.
  - Identified a Marulan Raw Water Mains, Pumping Station upgrade though this is included in Council "*Projects NOT able to be included '*, as funds are not available.

Discussions with Wingecarribee Shire Council identified that;

- Some 600 ML per annum of recycled water available for the Moss Vale sewage treatment plant.
- Effluent is currently discharged to Whites Creek with no immediate plans for alternative effluent management.
- Plant augmentation is to be considered as part of a feasibility study to meet future requirements (nominally around 2010) which will also include consideration of reuse options.

3.6.4 Summary of Water Supply Options

A number of current and potential water sources, including potable, recycled and stormwater have been identified to provide water quantities which can meet and exceed the requirements of the proposed Facilities. The potential sources for water have been considered for the combined requirements of both the Delta Electricity and EnergyAustralia Facilities. Water source options include:

- Marulan water supply network;
- Marulan sewage treatment plant;
- Moss Vale sewage treatment plant; and
- Site stormwater runoff.

Chapter 3 Alternatives

Any of the above water servicing options for each of the Facilities' water demands could be adopted in conjunction with the other options. A decision would be made on the preferred option or option mixes following appropriate assessment of economic and non-economic factors.

It is proposed that water would be trucked to the Site to meet the operational requirements for the EnergyAustralia Facility and Delta Electricity Facility as these water requirements are relatively low. A new pipeline may be considered to meet the combined operational needs for EnergyAustralia and Delta Electricity Stage 2 Facilities; however, the pipeline would be subject to further consultation, detailed design and approvals.

3.7 Location of Footprint within the Site

An area of approximately 6 to 8 ha has been assumed for each of the Facilities. Some changes in the overall size of the Facility site may be necessary during the detailed design stage when specific equipment details and sizes are available and the Facility layout is refined.

The Marulan Site is an irregular shape comprising approximately 116 ha of pasture land and woodland in total. The Site contains a mix of vegetated areas and cleared areas closer to the River, which continues on the higher ground east of the Wollondilly River.

The Site is situated on a bench approximately 20 m above the river's edge at elevations ranging from approximately 590 m to 620 m Australian Height Datum (AHD). Overall the Site slopes gently west towards the river. The Site as a whole is elevated compared to the southern side of the Wollondilly River in this area. The Site is also relatively undulating with some of the cleared areas being located on a small hill. The Site is located adjacent to the TransGrid switchyard which is located at an elevation of approximately 620 m AHD.

Consideration was given to the location of the Facility footprint within the proposed Marulan Site. These factors included:

- proximity to the Wollondilly River in relation to flooding issues and required setbacks;
- potential visual catchment;
- flora and fauna implications; and
- noise implications.

Wollondilly River considerations

The Marulan Site is located adjacent to the Wollondilly River within the Wollondilly River subcatchment of the Warragamba catchment and is part of the Sydney Drinking Water Catchment. The Sydney Catchment Authority (SCA) has stated (refer to SCA correspondence in **Appendix B**) that effluent management areas are to be located at least 150 m from the Wollondilly River, 100 m from a creek or gully and 40 m from a drainage depression. The 150 m distance for the Facilities as a whole has been adopted to account for domestic sewerage systems for staff facilities and the Facilities water treatment systems.

The potential for flooding of the area has also influenced the location of the Facilities and is discussed in more detail in **Chapter 14**. Based on the flooding considerations, the ground level for the Facilities has been set at a minimum of approximately 605 m AHD in order to minimise the potential for flooding of the Facility, and to minimise any off-site impacts.

Location of the Facilities closer to the Wollondilly River would require engineering solutions related to:

- filling the Site and associated engineering design; and / or
- engineering design of the Facilities to mitigate increasing flood risk.

If the Facilities were located closer to the Wollondilly River, a possible engineering solution would be to construct an engineered pad of fill under the Facilities footprint to achieve the required elevation in order to avoid potential flood impacts. Consideration would need to be given to sourcing and importing fill from off-site and potential delays to construction and design time. Consideration would also need to be given for the potential impact on local traffic from additional truck deliveries and associated additional traffic noise. Location of the Facilities on significant areas of fill would also require additional foundation design potentially requiring deep foundations. This was considered to bear a financial risk in terms of the engineering design for the Site.

Another engineering solution for location of the Facilities low on the floodplain would be bunding the Facilities to protect them from the estimated extreme flood level. Bunding the Facilities may also require importing of fill with the associated issues identified above.

For both of the above options, encroachment into the floodplain would reduce the area available for water storage during flood events with the potential to impact the flood regime of the immediate area of the Site and create additional backwater issues upstream. This approach would also need to be considered in the context of increased hazard for the Facility should the bund fail.

It was considered that minimising the need for significant engineering solutions would be achieved by siting the Facilities close to the existing 605 m contour. This approach is in accordance with the NSW Government's Flood Prone Land Policy where the objectives are to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property and to reduce private and public losses resulting from floods.

Landscape and visual considerations

From a landscape and visual perspective, the selected footprint would avoid the need for excavation through the top of the spur. This would allow existing tree cover to be retained as much as possible in order to provide a vegetated 'backdrop' for views from the south / south west. The preference is to place the Delta Electricity Facility to the south east and for the EnergyAustralia Facility to be located in an adjacent north west alignment.

Flora and fauna considerations

The Marulan Site contains a mosaic of cleared pasture, native woodlands and riparian and aquatic ecosystems that are associated with the Wollondilly River. The previous uses of the Site for agriculture and infrastructure development have removed much of the original woodland vegetation and replaced it with exotic pasture grass. This has led to degradation of some habitats including gully erosion in drainage lines and localised weed infestations. Despite this, substantial stands of relatively intact native woodland remain and, although not of high quality old growth, the woodland contains branch

hollows, hollow logs and feeding resources of value to locally occurring native fauna and birds in particular.

With respect to the biodiversity implications for the Site, the proposed location of the Facilities avoids clearing significant areas as far as possible whilst meeting other Site constraint conditions.

Various locations within the Site have different implications for clearing of woodland for the Facilities footprint (considering minimal differences in the clearing for infrastructure between different Facility footprint locations within the Site). Locating the Facilities in the north-eastern portion of the Site would require clearing of approximately 16 ha of woodland over the entire footprint of the Facilities and is not in accordance with the intention to minimise clearing of the Site. Avoidance of excavation through the top of the spur and retention of as much existing tree cover as possible for visual considerations would similarly be affected.

Locating the Facilities in the western portion of the Site adjacent to the Wollondilly River requires consideration of constraints relating to setbacks from the Wollondilly River and potential flooding issues (discussed above in relation to flooding considerations).

In addition, locating the Facilities as identified on **Figure 1-3** would result in approximately 50% of the Facilities footprint to be within cleared areas. Locating the Facilities further north-east would potentially result in the need to clear 100% of the woodland within the footprint.

Noise considerations

Based on a preliminary noise assessment, it was considered that there may be a marginal preference to locate the Delta Electricity Facility to the south east of the EnergyAustralia Facility, west of minor ridgelines to maximize the shielding where possible.

Further detailed assessment undertaken as presented in **Chapter 8** addressed the reasonable and feasible noise mitigation for the Facilities.

Facility location

Considering the cumulative effect of the above constraints, the proposed location of the Facilities is in the area within the Marulan Site identified on **Figure 1-3**. Some changes in the overall size of the Facility site may be necessary during the detailed design stage when specific equipment details and sizes are available and the Facility layout is refined.

3.8 Do Nothing Scenario

Both NEMMCO in its Statement of Opportunities and the NSW Government have demonstrated a need for additional electricity generation in NSW each year from 2013 / 2014. Without additional generation capacity there is a risk of electricity supply disruptions in the future.