3.1 Introduction

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

- power generation technology options;
- Facility options:
  - gas turbine options;
  - emission control options;
  - inlet air cooling options;
  - site selection options;
- Facilities' water supply; and
- Facility footprint options.

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

3.2 Power Generation Technologies

3.2.1 Renewables

Hydro-electric power stations

Hydro-electric power stations can provide peak load supply to the National Electricity Market. However, in NSW, the opportunities have been exhausted to develop hydro-electric power stations for large scale electricity generation to meet the projected peak demand requirements identified by NEMMCO. While this option is appealing as it utilises renewable energy, it is not considered a feasible alternative as a means of generating about 600 MW of competitively priced electricity to meet peak demand supply.

Wind and Solar

Generation from solar and wind power are not suitable for peak load power stations due to the intermittent nature of the resource. In addition, the storage technology is not sufficiently advanced to store large amounts of energy for later use. Therefore, these technologies do not provide suitable alternatives that can service peak load demand.

3.2.2 Coal-Fired Power Stations

Peak Load

Coal-fired power stations can meet peak load demand by operating at levels higher than the rated capacity. However, this practice is generally limited to very short periods of time due to additional stresses placed on the plant and a subsequent increase in maintenance requirements. This limits the capacity of these base load generators to service peak demand periods. The relatively long start-up and shut-down times for coal fired power stations also limit the ability of plant that is out of service to meet peak load demand. A traditional coal-fired power station would also result in greater greenhouse gas emissions than a gas fired power station.

Base Load

Base load generation coal plants tend to be more expensive and take longer to build than gas-fired plants, but have lower direct fuel costs and therefore can be a cheaper source of base load power. However, the major problem with coal plant technologies is that they are relatively greenhouse intensive compared to other fossil fuel-fired generation options. The relative greenhouse intensity of coal-fired generation means that its cost is likely to increase under any national or international greenhouse emissions trading scheme. If the costs of greenhouse emissions are included, the economics of coal-fired generation change considerably. In addition to greenhouse gas emissions, coal plants can have other local and regional environmental impacts including sulphur oxides, nitrogen oxides and particulate emissions, and ash generation.

3.2.3 Gas Turbines

Open Cycle Gas Turbines

Gas turbine power stations are referred to as operating in open cycle mode when no heat is recovered from the exhaust gas to drive a steam turbine. Open cycle gas turbines have a similar thermal efficiency to coal fired power stations but with lower greenhouse gas emissions per unit of energy generated. The typical establishment time for designing and commissioning of open cycle gas turbine units is around two years, which is significantly less than for a coal fired power station. Open cycle gas turbine units can be at full capacity within thirty minutes from cold start, compared to a minimum of eight hours for a coal fired power station. Given the relatively short start-up and shut down times for these systems, open cycle gas turbine units are ideal for operations to meet peak load demand and generally represent best practice technology for this type of use.

Combined Cycle Gas Turbines

Combined cycle gas turbine power stations consist of one or more gas turbine units coupled to a steam turbine. Steam is generated using the residual heat from gas turbine units which is then used to drive a steam turbine. Combined cycle gas turbine units have the advantage of offering greater thermal efficiencies than open cycle gas turbine power stations and coal-fired power stations. Combined cycle gas turbines are more suited to intermediate or base load operations as they require greater start-up and shutdown periods than open cycle gas turbine units and have a lower operating cost.

3.2.4 Selection of the preferred power generation technology

Delta Electricity proposes to construct an electricity generating Facility consisting of two open cycle gas turbines. This type of generating system can supply electricity to the grid at short notice and is therefore well suited to providing electricity in peak demand periods. Gas turbines represent one of the most effective options to provide electricity for short term demand. At a later stage, Delta Electricity proposes to convert the open cycle gas turbines to combined cycle turbines to generate intermediate / base load electricity.

As supported by the findings of the Owen Inquiry, combined cycle gas turbines are capable of running efficiently at high capacity factors and combined cycle turbine technology is amongst the most attractive for Facilities catering to intermediate load generation. It is further noted that combined cycle turbines have less than half the carbon emissions of new coal-fired power stations.

3.3 Gas Turbine Options

The following gas turbine options are being considered for the Delta Electricity Facility:

- rigid frame (E Class, F Class and H Class) and aero-derivative units; and
- single fuel and dual fuel gas turbine facility.

3.3.1 E Class Turbines

“E Class” gas turbines have a nominal capacity of 150 MW. Examples of machines in this class include the Alstom GT 13E2, General Electric Frame 9E, Mitsubishi 701DA and Siemens SGT5-2000E (V94.2).

These mid range industrial gas turbine designs were developed in the late 1970’s / early 1980’s and are characterised by firing temperatures in the region of 1100 °C and pressure ratios of 11 to 15. These machines continue to be installed throughout the world and have significant operating experience and proven reliable performance.

3.3.2 F Class Turbines

In the 1990s most manufacturers released designs with higher combustion temperatures in the region of 1300 °C and increased pressure ratios (17 to 32). Examples of machines in this class include Alstom GT26, General Electric Frame 9FA, Mitsubishi 701F and Siemens SGT5-4000F (V94.3A).

These “F Class” machines have a nominal capacity between 250 MW and 280 MW with efficiencies of 33 % to 35 % in open cycle. In combined cycle, plant capacities around 400 MW with net efficiencies up to 49.5 % are achievable. These levels of performances approach best practice requirements of the Generator Efficiency Standard. For the output proposed for the Delta Electricity Facility, one F Class gas turbine could potentially replace two E Class gas turbines. In comparison to a plant with two E Class gas turbines, a single F Class gas turbine plant:

- can achieve higher efficiency, lower fuel usage and lower emissions;
- typically has a slightly lower plant capacity (it is noted not all E and F Class machines can meet the specified 400 MW combined cycle capacity criteria particularly with derating at site conditions);

- requires less space (up to 20 % smaller site);
- typically has a lower specific capital cost ($/kW);
- has similar or lower operating and maintenance costs;
- requires higher gas supply pressure (due to higher pressure ratios) although pressures in the main gas pipeline should be sufficient to avoid the need for gas compressors for most gas turbines;
- provides less flexibility in operation as the single machine plant offers only a large capacity increment and potentially prolonged part load reduced efficiency operation. Two smaller machines allow smaller capacity increments, staggered starting / stopping to better match demand profile and maximise efficiency and improved reliability of at least one machine starting; and
- provides less redundancy with only one machine.

3.3.3 H Class Turbines

The next class of gas turbines, referred to as “H Class”, is currently under development and has not yet reached commercial operation. These machines in combined cycle applications will have a single unit output of around 480 MW. These machines are designed for combined cycle and incorporate features aimed at improving performance but reduce their suitability for open cycle operation (e.g. steam cooling of turbine blades).

3.3.4 Aero-derivative turbine options

At the opposite end of machine size, several manufacturers offer large aero-derivative gas turbines with capacities around 50 MW and efficiencies of 35 % to 38 % in open cycle. In combined cycle, capacities are around 65 MW and net efficiencies are up to 45.5 %. General Electric is also developing an open cycle gas turbine with capacity of 100 MW and efficiency of 41 %. These levels of performance approach or exceed best practice requirements.

Generally these machines represent well proven technology and benefit from the incorporation of many of the latest design features. These light, high performance machines have high efficiency in open cycle but their low energy exhaust means only marginal benefit is available in combined cycle. Multiple machines provide great operational flexibility and redundancy (particularly with their faster start capability) however the large number of machines required to achieve the target capacity increases the specific capital and operating costs.

The GE LMS100 is the latest development in aero-derivative technology and is capable of achieving very high efficiency and fast start capability in open cycle. However, it is noted that these turbines need water injection for NO_x control and have lower performance without water injection, additional capital cost for the intercooler equipment (and development costs), and have limited commercial operating experience.

At this stage, the additional capital and operational costs of multiple units and large site requirements makes these options less attractive, particularly for future conversion to combined cycle.

Summary of options

The supplier (and therefore the type) of the gas turbines would be selected through a competitive tender process as part of the overall procurement process. The type of turbine, therefore, has not been specified at this stage of the process for Delta Electricity; however, the Environmental Assessment of the Delta Electricity Facility has been conducted on the basis of operation of the E Class turbines as a representative technology for emissions and other potential environmental impacts.

3.4 Single and dual fuel facilities

Gas turbines can be designed to operate with a liquid fuel source in the event of gas supply irregularities or interruption. Alternative liquid fuels for the turbines include methanol, kerosene, diesel and heating fuels.

Given the availability of natural gas, no provision has been made for dual fuel capability which would allow operation on stored liquid fuel.

3.5 NO_x Emission Control Options

The emissions from gas turbines are discussed in detail in **Chapter 7**. The discussion of emission control options in this section has focussed on control technology of oxides of nitrogen (NO_x), NO_x being the precursor to photochemical smog pollution. Uncontrolled NO_x emissions from gas turbine technology can be in the order of 210 ppm. Various emission control technologies to reduce NO_x emissions are discussed below.

3.5.1 Water/steam Injection

One of the earlier forms of NO_x control is the injection of water or steam into the flame area of the combustor to lower the flame temperature and reduce thermal NO_x formation. Emissions of NO_x for this technology are approximately 42 ppm. However, the cost of purification of water and the limitations of water resources at the Site limits the application of this technology for this project.

3.5.2 Dry Low NO_x Combustors

Dry Low NO_x combustor technology premixes air and a lean fuel mixture that significantly reduces peak flame temperature and thermal NO_x formation. Conventional combustors are diffusion controlled where fuel and air are injected separately. NO_x emissions where Dry Low NO_x technology is implemented range from 9 to 25 ppm depending on plant and operating conditions. All gas turbine manufacturers guarantee emissions of 25 ppm under all conditions. Dry Low NO_x technology is widely used for the gas turbine technology being considered for the Delta Electricity Facility and the technology is constantly being developed.

3.5.3 Catalytic Combustion

Development of catalytic combustion is not yet commercialised in the marketplace for gas turbines larger than 15 MW. Catalytic technology features “flameless” combustion that occurs in a series of catalytic reactions to limit the temperature in the combustor. Catalytic combustion reduces NO_x emissions to 3 ppm. This technology is not suitable for the Delta Electricity Facility as each of the turbines would be in the order of 150 MW.

3.5.4 Selective Catalytic Reduction

Post-combustion NO_x control can be achieved using selective catalytic reduction to achieve NO_x emissions of 9 ppm. Ammonia is injected into the flue gas and reacts with NO_x in the presence of a catalyst to produce nitrogen and water although some ammonia is released into the exhaust plume. When operated in simple cycle mode the use of high temperature selective catalytic reduction or dilution to air to reduce exhaust temperature is required.

Selective catalytic reduction is generally not applied to the large frame turbines due to the high temperature mode of operation. Selective catalytic reduction acts to reduce the temperature of the exhaust gases to less than 200 °C from approximately 550 °C. Based on uncertain application of this technology on large gas turbines in open cycle mode, the environmental complications of ammonia use and the high set up costs coupled with low operating times for a peaking plant, this technology is not a feasible form of emission control for the Delta Electricity Facility.

3.5.5 Selected NO_x Emission Technology

Dry Low NO_x emission technology presents the most viable NO_x emission technology as it is widely used on turbines of the size proposed for Delta Electricity Gas Turbine Facility and all gas turbine manufactures can guarantee emissions of 25 ppm under all conditions. It is also noted that while not guaranteed, depending on plant and operation conditions, NO_x emissions as low as 9 ppm can be achieved.

3.6 Site Options

Delta Electricity has previously investigated a range of possible sites available for purchase meet the site location requirements.

The key selection criteria used to identify potential sites were:

- proximity to the high voltage electricity distribution system; and
- proximity to the gas supply.

Other characteristics considered to be desirable included:

- availability of existing easements / corridors for electricity transmission;
- distance from built up areas;
- zoning of existing land that permits a power facility; and
- availability of an appropriately sized site that permits the facility to be adequately buffered from surrounding land uses.

Nine sites were considered by Delta Electricity. A summary of the findings of the study is provided below:

- ***Bamarang:*** Selected as one of three suitable sites and purchased in 2004. A peaking facility is currently approved for development at this site.

- ***Tomerong:*** Tomerong is a site owned by TransGrid for the location of a future substation connecting the 330 kV network to the South Coast 132 kV feeders. This substation would be required between 2010 and 2020 as load growth continues on the South Coast and the limitations of the 132 kV systems are reached. Delta Electricity investigated this site for collocation of a gas power facility; however the site is located in undisturbed bushland surrounded by National Parks.

- ***Goulburn/Marulan Hill:*** This region was identified as having good access to the 330 kV transmission infrastructure and Moomba to Sydney Pipeline. The Marulan Site was purchased in 2007 jointly with EnergyAustralia.

- ***Tallawarra:*** Delta Electricity was unable to purchase rights to the site when it was sold by Pacific Power by a public tender process. This site was benchmarked due to its clear potential for gas fired power generation. Approval was granted in 1999 for a 400 MW facility at the site, currently proposed for development by TRUenergy.

- ***Nerriga:*** Nerriga is located on the Eastern Gas Pipeline, south of Nowra. It was rejected as a potential site due to a lack of water supplies and high altitude/visibility.

- ***Wagga Wagga:*** A site at the Bomen industrial park did have prospects, as the relevant council owns a suitable site and was willing to enter into a lease option agreement. There is sufficient water available and access to the gas pipeline. The site was ultimately rejected, as the maximum size of the facility would be limited to 150 MW as a result of capacity constraints in the local transmission network.

- ***Tamworth:*** Development of this site would be reliant on a new gas pipeline being built from southeast Queensland to Newcastle. Although there was a site available in close proximity to the 330 kV transmission substation, at the time of the alternative site assessment the timing for the gas pipeline to be built was unknown. As a result, the site was not considered further.

- ***Munmorah:*** A study into options for re-powering the existing Munmorah power station with natural gas or developing a combined cycle gas turbine on the site using existing infrastructure was completed in 1999. A peaking facility is currently being developed at this site.

- ***Moss Vale:*** A site was considered near Moss Vale on the Hume Highway, which had access to both transmission and gas supplies. However, initial discussions with the relevant local council indicated that there would be concerns regarding conflicts with adjacent land uses. Pacific Power previously owned the site but disposed of it following disaggregation.

Potential Sites in the Marulan Area

Advantages of locating the site in the Marulan area include:

- proximity to Moomba to Sydney Gas Pipeline – the pipeline is located approximately 5 km to the south of the Site;

- proximity to high voltage transmission lines - direct connection from the Marulan Site to the nearby 330 kV high voltage transmission network at TransGrid’s switchyard is possible;

- availability of sites for purchase; and

- the land use zoning permits the proposed Facility.

On this basis, two sites were identified within the Marulan area:

- a site adjacent to the TransGrid switchyard; and
- Big Hill property.

Following initial assessment, the Marulan Site was identified as the preferred site for following reasons:

- access constraints to the Big Hill site at this time; and
- advantage of collocating the proposed facility within close proximity to significant infrastructure (TransGrid switchyard) and associated reduction in infrastructure (gas pipeline and electricity transmission lines) required.

3.7 Alternatives for Inlet Air Cooling

During hot periods, the performance of gas turbines can be reduced due to high turbine inlet air temperatures. In order to offset this degradation of performance, systems for turbine inlet air cooling using a chiller plant are often installed.

The most common air cooling system is evaporative type coolers, which spray demineralised water into the air stream. Evaporative systems are the lowest capital cost option, perform best in hot dry climates but consume demineralised/high quality water, which is discharged with the exhaust. As water availability is limited in the proposed location, evaporative coolers are not considered appropriate for this project.

An alternative is to install chillers to produce chilled water which passes through finned cooler elements in the air intake assembly to cool the air entering the gas turbine compressor. A by-product of this intake air cooling is the condensation of moisture on the cooler elements when the chilled air temperature is less than the ambient wet bulb temperature. The amount of water produced depends on the ambient temperature and humidity conditions and the design of the chiller plant. The water produced can be used as a source of high quality raw water.

Two types of chillers are available; vapour compression and absorption and these are discussed below.

Vapour Compression Chillers

In vapour compression chillers, refrigerant is compressed in a compressor (screw, reciprocating or centrifugal) and then cooled in a condenser. Heat from the condensing vapour is dissipated to atmosphere by fin-fan heat exchangers. The refrigerant from the condenser (now a saturated liquid) is expanded through a valve or a capillary tube and the cooled liquid/vapour mix passes through the evaporator. The evaporator heat exchanger transfers heat from the chilled water circuit to the refrigerant which is vaporised before again entering the compressor. The vapour compression cycle is driven by the mechanical energy provided by the compressor, which can be driven by electric motor or small gas turbine or engine. As a result, the capital and operating costs of these mechanical vapour compression chillers are high.

Absorption Chillers

Absorption chillers use the same condensation, expansion and evaporation processes as the vapour compression refrigeration cycle. However, a different process is used to compress the refrigerant. In the absorption cycle, the refrigerant used is soluble in a liquid transport medium and forms a liquid solution on leaving the evaporator. This liquid solution is then pumped to high pressure and then heated to separate the refrigerant from the solution, whereupon the refrigerant enters the condenser to continue the refrigeration process. While some pumping is involved, the absorption cycle is mainly driven by the heat input to accomplish the above dissolution process and while the capital cost is high, absorption chillers using waste heat have low operating costs.

Due to their high capital cost and energy demands, chillers provide maximum benefit when installed on base load plants in locations with high ambient temperatures and high humidity (e.g. tropical locations). A preliminary assessment for Delta Electricity concluded that such conditions are not typical for the Marulan area. Ambient temperature data for the Goulbourn region has been obtained from Bureau of Meteorology. An assessment of the annual ambient temperature and relative humidity frequency distributions for the 2004 calendar year indicates that temperatures are generally low while humidity would be described as mid range (i.e. median 12 °C and 70 %). The data also indicates there are only a few hot days (i.e. more than 35 °C for 3 hours per year). As a result, chillers would not appear necessary for performance enhancement.

The assessment indicated the dominant conditions for the Facility are low temperatures and mid range humidity, while humidity tends to decrease with higher ambient dry bulb temperature. These conditions make chillers installed primarily for the production of water (by condensation from the atmosphere) ineffective as:

- chiller operation is restricted during periods of high humidity (and high production potential) because ambient temperatures are typically low and the gas turbine protection limits inlet air temperatures to about 5 °C to avoid ice formation. The result is the chillers normally operate at part load or are taken out of service; and
- when the chillers are fully loaded at high ambient temperatures, the quantities of possible condensation are generally small as the corresponding humidity tends to be low.

Specialised systems designed to produce sufficient “atmospheric” water for automatic gas turbine compressor washing have been developed for offshore exploration applications (i.e. normally high humidity), however in a drier inland application such as the Marulan area, quantities of water available are limited.

From the above assessment, chillers are not considered suitable for performance enhancement at the Delta Electricity Facility due to their high cost and energy demands, while ambient conditions and gas turbine limits combine to restrict their capability to produce water from the atmosphere.

No inlet air cooling systems will be provided; as limited water availability precludes evaporative type cooling while capital cost, climatic conditions and limited operation makes mechanical chiller plants unattractive.

3.8 Facilities’ Water Supply

3.8.1 Water Demand

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

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.

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.

3.8.3 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.

3.8.4 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.

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.

3.9 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.

3.10 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.