Chapter 4. Water supply feasibility and pipeline route options

4.1 Overview

Based on the requirements of condition 2.2 of the Concept Approval, a Water Supply Feasibility Study for stage two development has been prepared and is included in Appendix B. This Chapter provides a summary of the study.

Condition 2.2(d) requires the preparation of:

> *"A Water Supply Feasibility Study developed in consultation with Council and DNR that quantitatively demonstrates water availability for the combined cycle gas turbine facility operation and the viability of these water sources for sustainable use over the life of the project. Consideration shall be given to security of supply, current and future water demand in the region, and in the event water source sharing is proposed, how the proposal will likely impact on potentially affected users."*

As part of the 2006 environmental assessment, GHD prepared a Water Cycle Management Report, completed in December 2005 (Appendix G of the environmental assessment). The Water Cycle Management Report built on work undertaken by Parsons Brinkerhoff (the Bamarang Gas Turbine Water Supply Options Investigation Report, April 2005) and assessed the water requirements for the project, and the management of the water cycle and stormwater. The Water Cycle Assessment considered additional alternative water sources including surface water runoff and industrial water (including likely quality, volumes, general treatment requirements). The report also considered process, domestic and irrigation water requirements and a whole of site integration of water use and management.

Following the environmental assessment, a Water Supply Options Study (GHD, 2007) was prepared to assess identified potential supply options and provide a recommendation of the preferred option/s for water supply.

The Water Supply Options Study considered options for an overall water servicing strategy based on the following water supply options:

- Purchase of water trading licence/s from upstream irrigators;
- Desalinated water provided by a project specific desalination plant constructed in the tidal flats;
- Industrial effluent from Manildra Starches;
- Reclaimed effluent from Shoalhaven Water under the REMS scheme.

The requirements for each option were outlined and an assessment of their relative advantages and disadvantages undertaken. The options (as developed into water supply strategies) were then assessed on the basis of economic and non-economic evaluations. All of the options were found to have significant limitations with respect to providing the 8.4 ML/d specified as being required for a wet cooling process.

Delta has since indicated a preference for dry cooling rather than wet cooling, as dry cooling requires significantly lower volumes of water, within the plant, than the wet cooling process.

The key objectives of the Water Supply Feasibility Study were:

- Summarise the current and future water demand for the region;
- Summarise all the potential water supply options, as identified by Delta, Shoalhaven City Council and Shoalhaven Water (a division of Shoalhaven City Council) and previous reports to meet the water demand for stage two of the Bamarang power facility; and
- Identify preferred water supply option, quantities available and security of supply. Develop concept for connection of water source to enable environmental assessment.

4.2 Project water demand

It is noted that the water requirements (for the option of wet cooling) were raised as an issue in the Department of Planning's Director-General's Assessment Report and hence drove the requirements for a Water Supply Feasibility Study. As noted in Section 1.3.1, Delta Electricity has now indicated their preference for dry cooling over wet cooling due to its significantly lower water demands.

For the stage two plant (based on dry cooling), Delta requires water supply for both domestic and process uses, as follows:

- Domestic water – estimated to be in the order of 400 kL/a (Water Cycle Management Report, 2005); and
- Process water – For the dry cooling process, water requirements are reportedly some 0.5 ML/d (based on PB, 2005). This is significantly less than the estimated 8.4ML/d required for wet cooling.

  In the dry cooling process, water is predominately lost from the system due to boiler blowdown (which involves the discharging water from the boiler circuit to maintain the chemistry to avoid possible scaling and corrosion of parts).

It is noted that the process water requirements are considered a conservative estimate and could potentially be lower.

Overall, the total annual water use is not expected to exceed around 200 ML/a (in comparison the wet cooled plant, which was expected to have an annual water use of around 3,000 ML/a). Thus, the relatively small demand of Delta's power facility would be assumed to fit readily within the proposed growth in demand of non-residential water use, as described in detail in Appendix B. The demand fits well within the 830 ML/a non-residential (specifically commercial) growth allowed for within Council's Integrated Water Cycle Management Plan (IWCM) (and does not take into account potential water reductions from existing non-residential water users).

A comparison of Delta's water demands against those for the Shoalhaven LGA (as provided in the IWCM) is shown in Table 4.1.

Table 4.1 Comparison of the facility's water demands against current and future water demands for the Shoalhaven LGA

	Units	2005	2035
Licensed extractions (from Burrier Pump Station , Danjera Dam and Flatrock Creek)	ML/a	22,902	22,902
Annual Water Demand for the Shoalhaven LGA (ML/a)	ML/a	14,798	20,731[1]
Proportion Residential Demand	%	63	
Proportion Commercial Demand	%	14 (approximately 2070ML/a)	14[2] (approximately 2900ML/a or an increase of 830ML/a)
Delta Water Demand	ML/a	200	200

Notes:
1. Baseline Forecast (Traditional approach) as reported in the Shoalhaven City Council, IWCM Concept Study, Draft (MWH, 2006)
2. Assumed to remain consistent given that non-residential growth was assumed to increase in proportion to residential growth in the area

Even if the predicted water demands within the IWCM Study did not allow for the additional demand that the proposed gas power facility would place on the Shoalhaven LGA water supply, there is adequate spare capacity between the total predicted demand of 21,000ML/a (IWCM) and the licensed extractions (some 23,000ML/a) to cater for the additional 200 ML/a demand of the proposed facility.

The required water demand of the proposed facility represents less than 1% of the water demand for the Shoalhaven LGA based on both current and future water demands. Furthermore, this water demand fits well within the licensed extractions to which Shoalhaven Water is entitled. Thus, Shoalhaven Water have indicated that Delta's water demand can comfortably be accommodated within its water supply system.

4.3 Water supply options

4.3.1 Wet cooling

Previous reports have identified eight options for water supply for the stage two wet cooling process of the Bamarang Power Station. These options are described and considered in the Water Supply Feasibility Assessment (Appendix B), and the results are summarised in Table 4.2.

Table 4.2 Summary of water source options for wet cooling

Option	Limitation
Reclaimed effluent	Water already allocated elsewhere.
Industrial effluent	Low level of security of supply for required high security demand. Potential high cost (financial and economic) of transfer.
River/raw water	Limited water and licences available making the likelihood of securing supply very low.
Ground water	Limited volumes available on a sustainable basis.
Stormwater	Insufficient volumes available (even in combination with other options).
Site wastewater	Insufficient volumes available (even in combination with other options).
Potable water	Supply not available for required quantities.
Desalinated water	High capital and operational costs together with high energy usage and brine disposal issues.

Due to these limitations in securing a long term available water supply for wet cooling, dry cooling was selected as the preferred option. The water source options for dry cooling are described in Section 4.3.2 below.

4.3.2 Dry cooling

Due to the reduced quantity of water required for the dry cooling process, water supply options close to the Delta Electricity site were seen to be the most viable. The closest water source options to the site are potable and raw water pipelines, which are operated by Shoalhaven Water.

Discussions have been undertaken with Shoalhaven Water regarding access to the required volumes (~0.5 ML/d). Shoalhaven Water has agreed to provide the water from either their raw water or treated (potable) water supplies.

Shoalhaven Water has identified one possible connection point for raw water and three possible connection points for treated water.

Raw water

The Bamarang Reservoir is located to the immediate west of the proposed power facility site and is a source of reticulated water supply for Nowra (via the Nowra Water Treatment Plant). This water source currently supplies industries within the Nowra region (with the raw water pipeline passing to the north west of the power facility site). Shoalhaven Water has indicated that the stage two water requirement is available from the raw water pipeline at the north west of the site.

Shoalhaven Water have advised of one possible connection point for raw water, as shown in Figure 4.1.

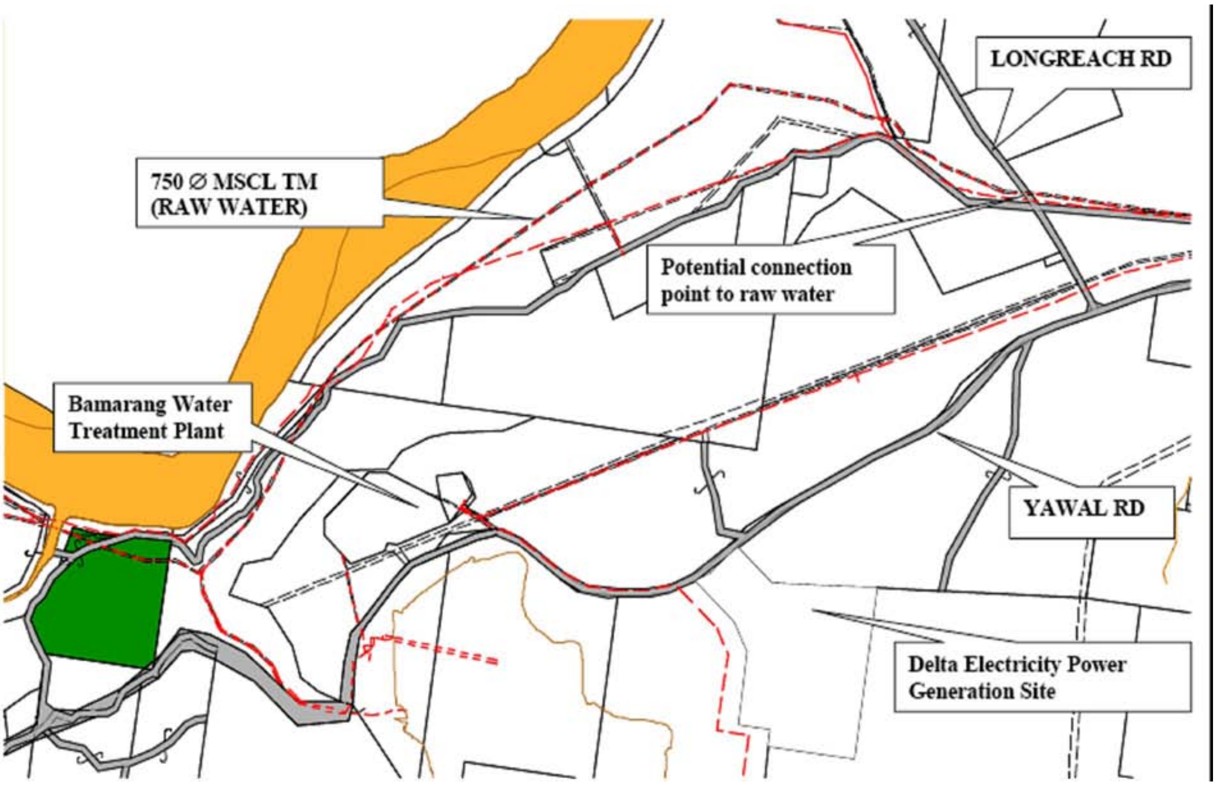


Figure 4.1 Potential raw water connection point

Source: Shoalhaven Water

This represents a tapping point from the raw water supply line from Shoalhaven River. For the raw water to reach the Delta site, the pipeline would need to be extended approximately 1.8 km along Longreach and Yalwal roads, which will entail trenching and installation of the pipe adjacent to the roads.

This option was discarded as the required pipeline length for raw water is longer compared to the pipeline required for treated water.

Treated water

Water from Bamarang Dam is currently pumped to the adjoining water treatment plant and then reticulated to Nowra.

Figure 4.2 shows the three possible treated water connection points, as advised by Shoalhaven Water. The possible connection points and the associated pipeline routes are:

» DN 600 Hobas Rising Main, located along the western boundary of the site. This is the closest connection point to the site. Connection would occur on the site's western boundary (with a pipeline of approximately 140m in length)or along the road reserve of Yalwal Road (via a pipeline of approximately 90m in length);

» DN 750 MSCL, approximately 440m to the north of the Delta site. The connection point would occur along the existing transmission line and water pipeline easement, and the proposed pipeline would travel south to the Delta site, following the easement for the approved transmission line connection to the facility; and

» DN 750 MSCL, to the north-east of the Delta site on Longreach Road. The connection point would be on Longreach Road and the pipeline would need to be extended along Longreach and Yalwal roads, or alternatively along the existing and proposed electricity transmission line easements.

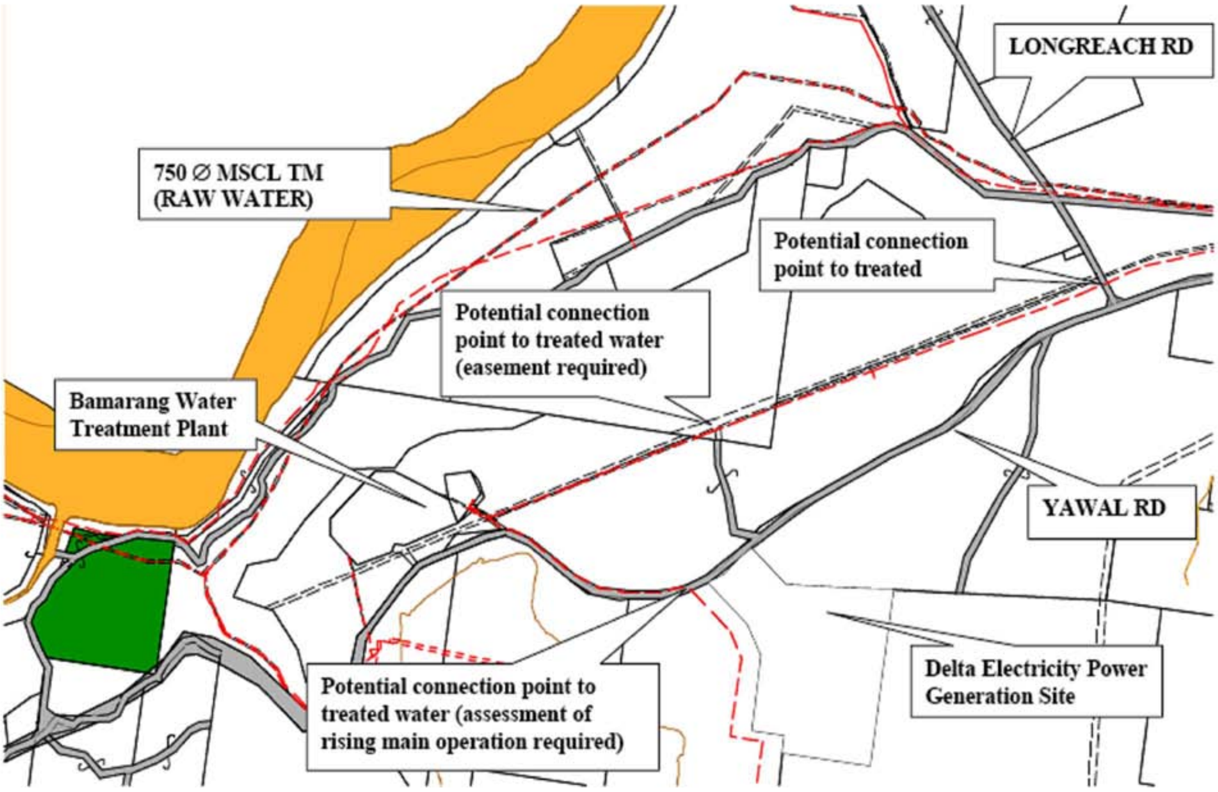


Figure 4.2 Potential treated water connection points

Of these, the preferred option is the DN 600 Hobas Rising Main due to its proximity to the site, to be connected either on the site's western boundary (requiring an internal pipeline of approximately 140m) or along the Yalwal Road road reserve (via a pipeline of approximately 90m in length). The connection to the DN 600 Hobas rising main would also require an additional buffer tank on site, due to the operational nature of the rising main.

The DN 750 MSCL accessible via the easement, is considered the second preferred option due to Delta Electricity already gaining regulatory approval for clearing of the easement, for transmission line placement. Additional approval from the roads authority (in this case Shoalhaven City Council) would still be required for the connecting pipeline to cross Yalwal Road. However, this road crossing will be located within approved transmission line easement, and is not expected to result in additional environmental impacts to the surrounding area. Approval is not being sought for this pipeline route at this stage.

The DN 750 accessible at Longreach Road is not the preferred connection option due to the length of pipeline that is required (i.e. it is the furthest of the three possible connection points to the site).

4.4 Preferred option

The DN 600 Hobas Rising Main runs along the western boundary of the site. The pipe to feed the proposed gas power facility would travel through the site along the shortest route to the onsite buffer tank.

A Reduced Pressure Zone Device (RPZD) would also need to be fitted to the connection to the DN 600 pipe for backflow prevention.

Council have indicated that the connection point from the main to the site is open to negotiation with Delta Electricity as long as the requirements for water meter access are met (the water meter must be accessible at all times). An indicative pipeline route showing the preferred water meter and connection route to the site is provided in Figure 4.3.

The pipeline would traverse the site from the DN600 Hobas Rising main along the southeastern side of the water treatment plant (and within the required asset protection zone – APZ) to the access road (as shown in Figure 4.3). From this location water can be delivered to the water treatment plant / service water tank (serving the process water requirement) or domestic water requirements (e.g administration building, gatehouse) along designated pipeline routes. The pipeline length is some 140m from the rising main connection point to the service water tank.

The pipeline route across the site is in land to be cleared as part of the requirement for the asset protection zone (APZ), which is a cleared area to protect assets from bushfire hazards. Thus no additional clearing is required as part of the proposed pipeline route.

Should the pipeline be required to be located along Yalwal Road, investigations have indicated that a pipeline route could be defined without the need to remove significant vegetation.

The infrastructure and construction works required for connection include:

- Connection point to water main, including:
  - Water meter;
  - Required valving and RPZD to protect against contamination of potable water;
- Pipeline (as detailed above):
  - Preliminary pipe sizing indicates that a DN 100 pipe would be sufficient to supply the 0.5 ML/d to the site. There is sufficient sizing in the pipe for the 0.5 ML/d to be extracted over 12 hours;
  - A trench that is approximately 600 mm wide and 1200 mm deep will be needed to construct the pipe; and
- Onsite buffer tank.

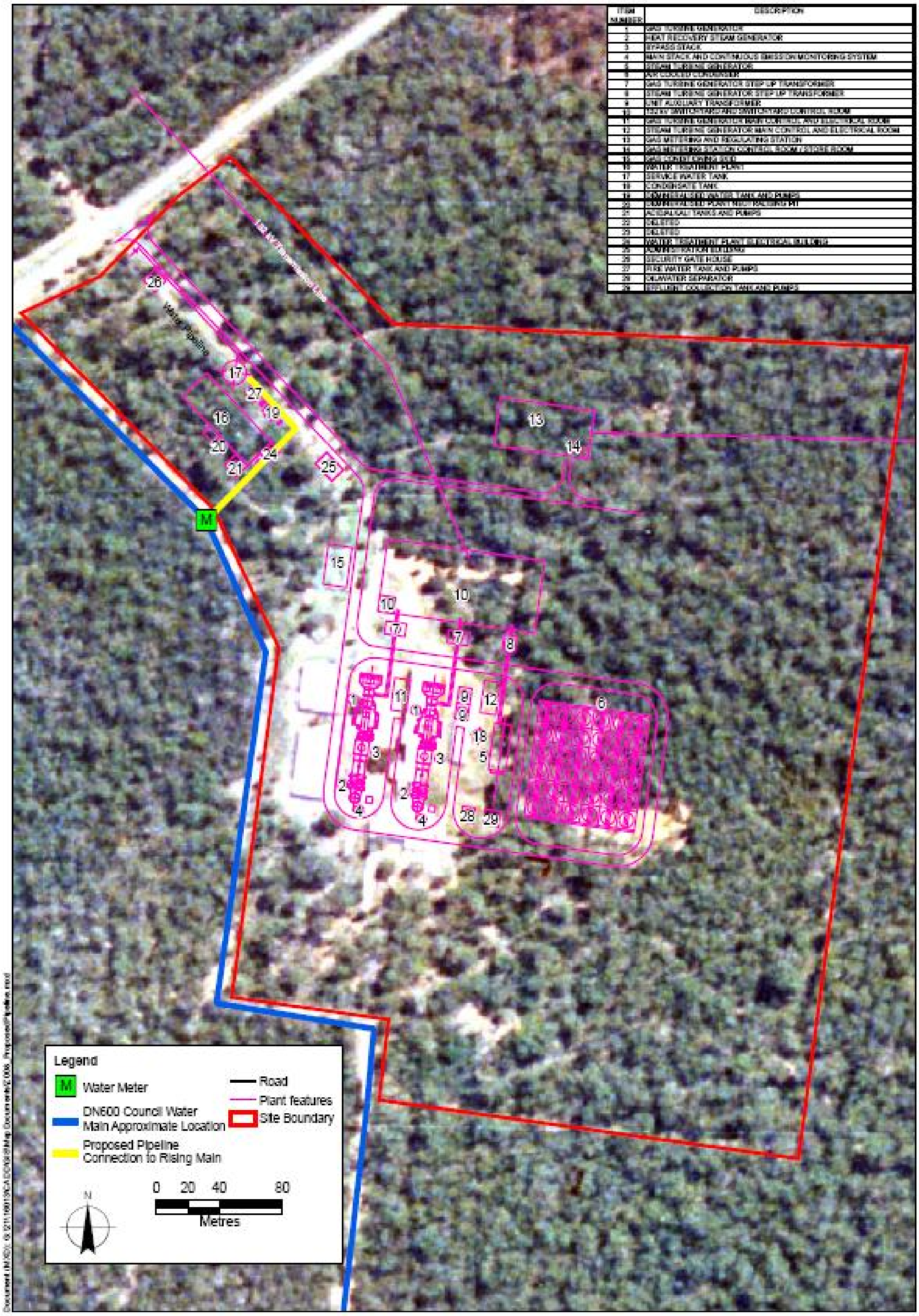


Figure 4.3 Proposed pipeline route for connection to DN 600 Hobas Rising Main

4.5 Summary of feasibility assessment and preferred pipeline option

Previous reports identified and assessed a number of water supply options (for a wet cooling process requiring some 8.4 ML/d). These include:

- Reclaimed effluent;
- Industrial effluent;
- River/raw water;
- Ground water;
- Stormwater;
- Site wastewater;
- Potable water; and
- Desalinated water.

As these options were found to have a number of restrictions in supplying the volume required for a wet cooling process, a dry cooled plant configuration was chosen. This has decreased the total water demands to approximately 0.5 ML/d, consisting of 1 kL/d domestic and estimated 0.5 ML/d process water (based on PB, 2005).

The required water demand of the proposed facility represents less than 1% of the water demand for the Shoalhaven LGA based on both current and future water demands. Furthermore, this water demand fits well within the licensed extractions to which Shoalhaven Water is entitled. Thus, Shoalhaven Water have indicated that Delta's water demand can comfortably be accommodated within its water supply system.

The preferred water supply is a potable source from the DN 600 Hobas Rising Main that runs along the eastern boundary of the site. It would be connected by a pipeline on the Delta site of some 140m in length from the rising main connection point to the service water tank. Alternatively, it would be connected via a 90m long pipeline in the road reserve of Yalwal Road.

Chapter 5. Description of the project for which approval is sought

5.1 Overview

Delta is seeking project approval for the construction and operation of infrastructure required to enable the Bamarang gas turbine power facility to operate in combined cycle configuration as a base load facility and provide a constant supply of electricity. These works and infrastructure are referred to as 'the project' for the purposes of this environmental assessment and were described as part of 'stage two – base load facility' by the 2006 environmental assessment.

To operate as a combined cycle (base load) facility, it would be necessary to install, on site, two heat recovery steam generators, a steam turbine, a cooling system and associated facilities (as described in Section 5.2). These equipment items/infrastructure are in addition to those for which project approval has already been received (as described in Section 1.2.2).

In combined cycle configuration, heat recovery steam generators are added to the gas turbines to capture heat from the gas turbine exhaust. A steam turbine is also installed so that steam produced in the heat recovery steam generators can power a steam turbine generator to produce additional electric power. Use of the otherwise wasted heat energy in the turbine exhaust gas results in higher thermal efficiency.

Waste steam from the steam turbine would be directed to a cooling system where it would be condensed by transfer of heat to a cooling medium. An air cooled condenser is proposed as the cooling system. Condensate is then directed straight back to the heat recovery steam generator.

The combined cycle facility would be able to generate a constant supply of approximately 400 megawatts of electricity.

The 2006 environmental assessment indicated that the proposed gas power facility would be constructed in a staged manner, with stage one being constructed first and the facility operating in open cycle configuration, producing electricity during peak periods only. Stage two was expected to be constructed at a later time, with the facility then operating in combined cycle configuration, producing constant (base load) electricity.

However, the recent Owen Inquiry into Electricity Supply in NSW found that new base load electricity generation is required in order to avoid potential energy shortfalls. As such, it is possible that the proposed gas power facility may not be staged in the manner originally proposed.

As the base load power generation may be required sooner, stages one and two may be constructed concurrently. Should this occur, the infrastructure required for both stages would be constructed at the same time, and the facility would operate as a base load facility from the commencement of operation.

It is also possible, however, depending on the future electricity demand and other developments, the facility would be constructed in a staged manner as originally proposed.

A description of the other works and infrastructure for which approval is sought is provided in Sections 5.3 to 5.7.

A description of the facilities that would be provided on site is provided in Section 5.2, 5.4 and 5.6. A description of the proposed water supply and treatment infrastructure proposed is provided in Section 5.3 and 5.5.

5.2 Combined cycle gas turbine facility

The following facilities would be provided on site as part of the project:

- Combined cycle equipment:
  - Two heat recovery steam generators (approximate height of 25 metres) would be connected to the gas turbines. The heat recovery steam generators would each have an exhaust stack approximately 40 metres high and 6.7 metres in diameter; and
  - A steam turbine.
- A cooling system including an air cooled condenser (approximate height of 31.1 metres);
- Other facilities:
  - Water treatment plant (to treat the small amount of water to be used as the process water);
  - Piping;
  - Steam generator step-up transformers;
  - Additional electrical equipment in the switchyard; and
  - Water storage tanks – above ground tanks would be used to store sufficient water on site for at least two continuous days of operation.
- A pipeline (approximately 140m in length) to provide the water supply to meet process water requirements.

Figure 5.1 provides a schematic diagram of the operation of the gas power facility as a base load facility in combined cycle configuration.

Figure 5.2 and Figure 5.3 show the proposed conceptual layout of the major components to be provided on site as part of the project.

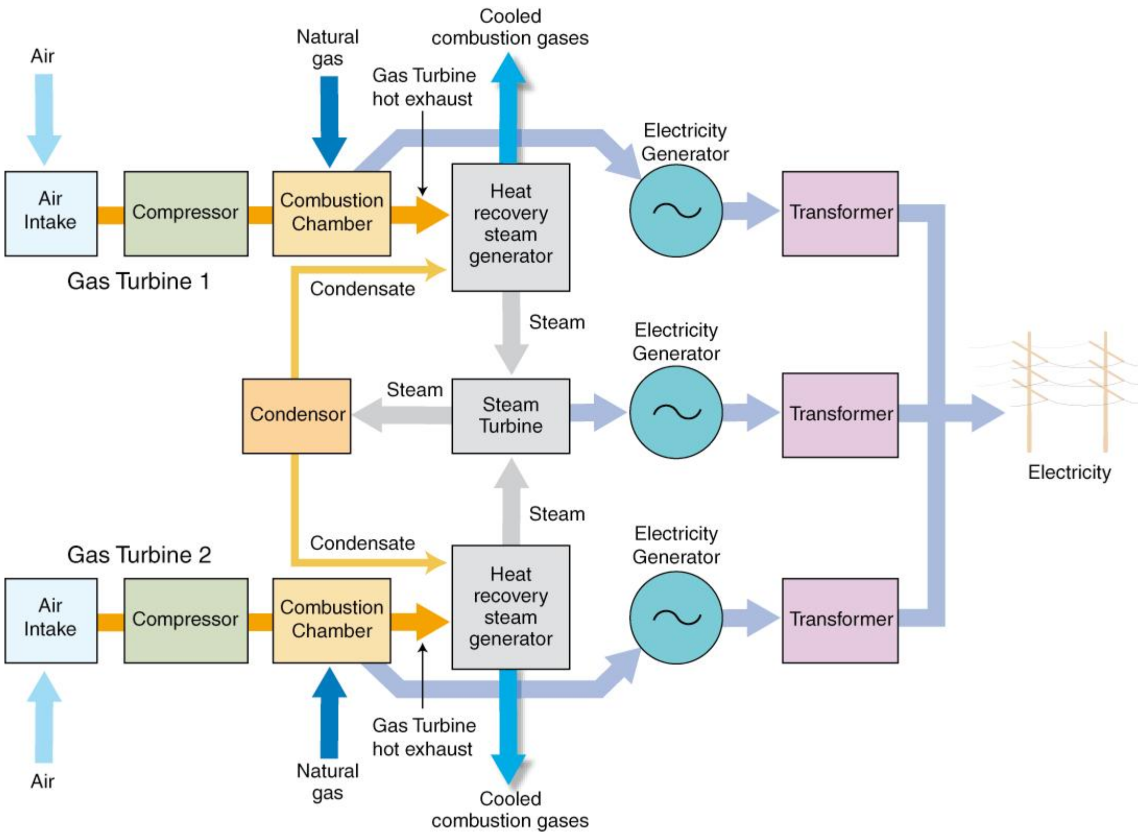


Figure 5.1 Process schematic – base load facility operating in combined cycle configuration (dry cooling)

5.2.1 Description of major equipment items – stage two

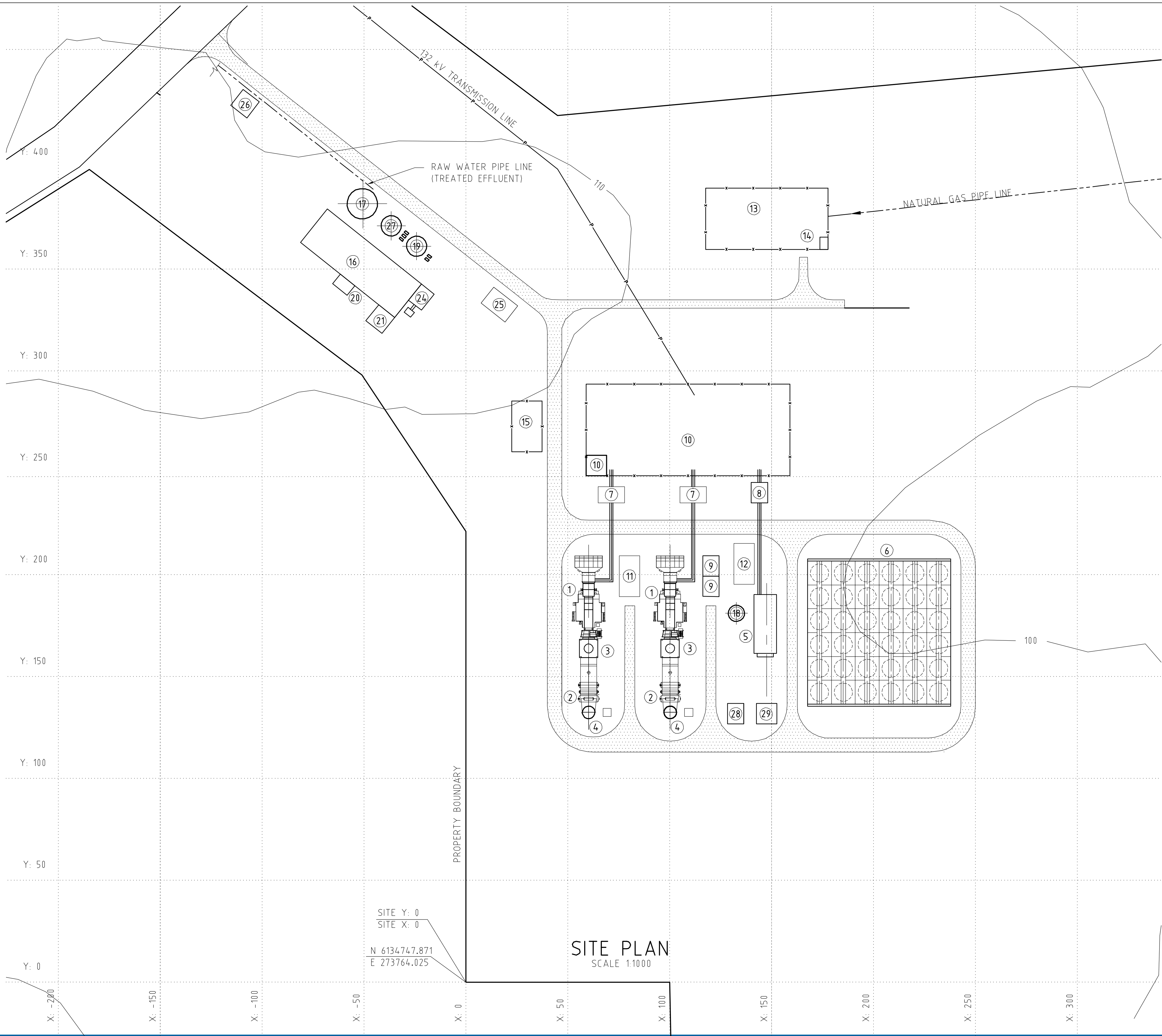
The following major equipment items would be installed on site as part of the development of the project.

Heat recovery steam generators

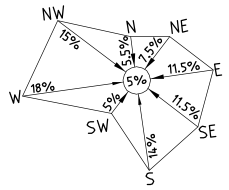
The heat recovery steam generator would be coupled to each gas turbine. The heat recovery steam generators would be natural circulation dual pressure non-reheat units, which are compatible with a steam turbine generator.

Exhaust gas from the gas turbine would be routed to the heat recovery steam generator through insulated ductwork. Heat from the exhaust gas would convert incoming feedwater to steam, which would then be piped to an adjoining steam turbine generator. The exhaust gas would then be discharged to atmosphere through the exhaust stack.

The heat recovery steam generators would be approximately 25 metres high. The heat recovery steam generators would each have an exhaust stack approximately 40 metres high and 6.7 metres in diameter.



SITE PLAN
SCALE 1:1000



AVERAGE WIND DIRECTION
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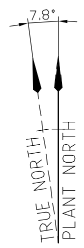

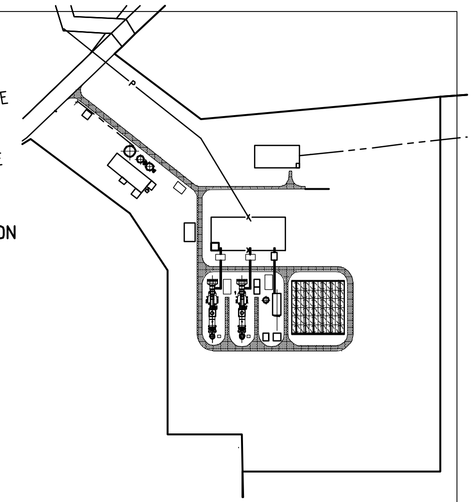

KEY PLAN
SCALE 1:5000

ITEM NUMBER	DESCRIPTION
1	GAS TURBINE GENERATOR
2	HEAT RECOVERY STEAM GENERATOR
3	BYPASS STACK
4	MAIN STACK AND CONTINUOUS EMISSION MONITORING SYSTEM
5	STEAM TURBINE GENERATOR
6	AIR COOLED CONDENSER
7	GAS TURBINE GENERATOR STEP UP TRANSFORMER
8	STEAM TURBINE GENERATOR STEP UP TRANSFORMER
9	UNIT AUXILIARY TRANSFORMER
10	132 kV SWITCHYARD AND SWITCHYARD CONTROL ROOM
11	GAS TURBINE GENERATOR MAIN CONTROL AND ELECTRICAL ROOM
12	STEAM TURBINE GENERATOR MAIN CONTROL AND ELECTRICAL ROOM
13	GAS METERING AND REGULATING STATION
14	GAS METERING STATION CONTROL ROOM / STORE ROOM
15	GAS CONDITIONING SKID
16	WATER TREATMENT PLANT
17	SERVICE WATER TANK
18	CONDENSATE TANK
19	DEMINERALISED WATER TANK AND PUMPS
20	DEMINERALISED PLANT NEUTRALISING PIT
21	ACID/ALKALI TANKS AND PUMPS
22	DELETED
23	DELETED
24	WATER TREATMENT PLANT ELECTRICAL BUILDING
25	ADMINISTRATION BUILDING
26	SECURITY GATE HOUSE
27	FIRE WATER TANK AND PUMPS
28	OIL/WATER SEPARATOR
29	EFFLUENT COLLECTION TANK AND PUMPS

0 50 100 150 200 250m
SCALE IN METRES (1:5000 BEFORE REDUCTION)

0 10 20 30 40 50m
SCALE IN METRES (1:1000 BEFORE REDUCTION)

PRELIMINARY NOT FOR CONSTRUCTION

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

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Date
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Client **DELTA ELECTRICITY**
Project **400 MW COMBINED CYCLE POWER PLANT - BAMARANG**
Title **SITE ARRANGEMENT - STAGE 2 - AIR COOLED CONDENSER OPTION**

Original Size A1 **Drawing No: Figure 5.2** **Rev: A**

Plot Date: 21 August 2007 - 1:47 PM Cad File No: G:\21\1601306\CAD\211601306-SK01.dwg

ITEM NUMBER	DESCRIPTION
1	GAS TURBINE GENERATOR
2	HEAT RECOVERY STEAM GENERATOR
3	BYPASS STACK
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22	DELETED
23	DELETED
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25	ADMINISTRATION BUILDING
26	SECURITY GATE HOUSE
27	FIRE WATER TANK AND PUMPS
28	OIL/WATER SEPARATOR
29	EFFLUENT COLLECTION TANK AND PUMPS

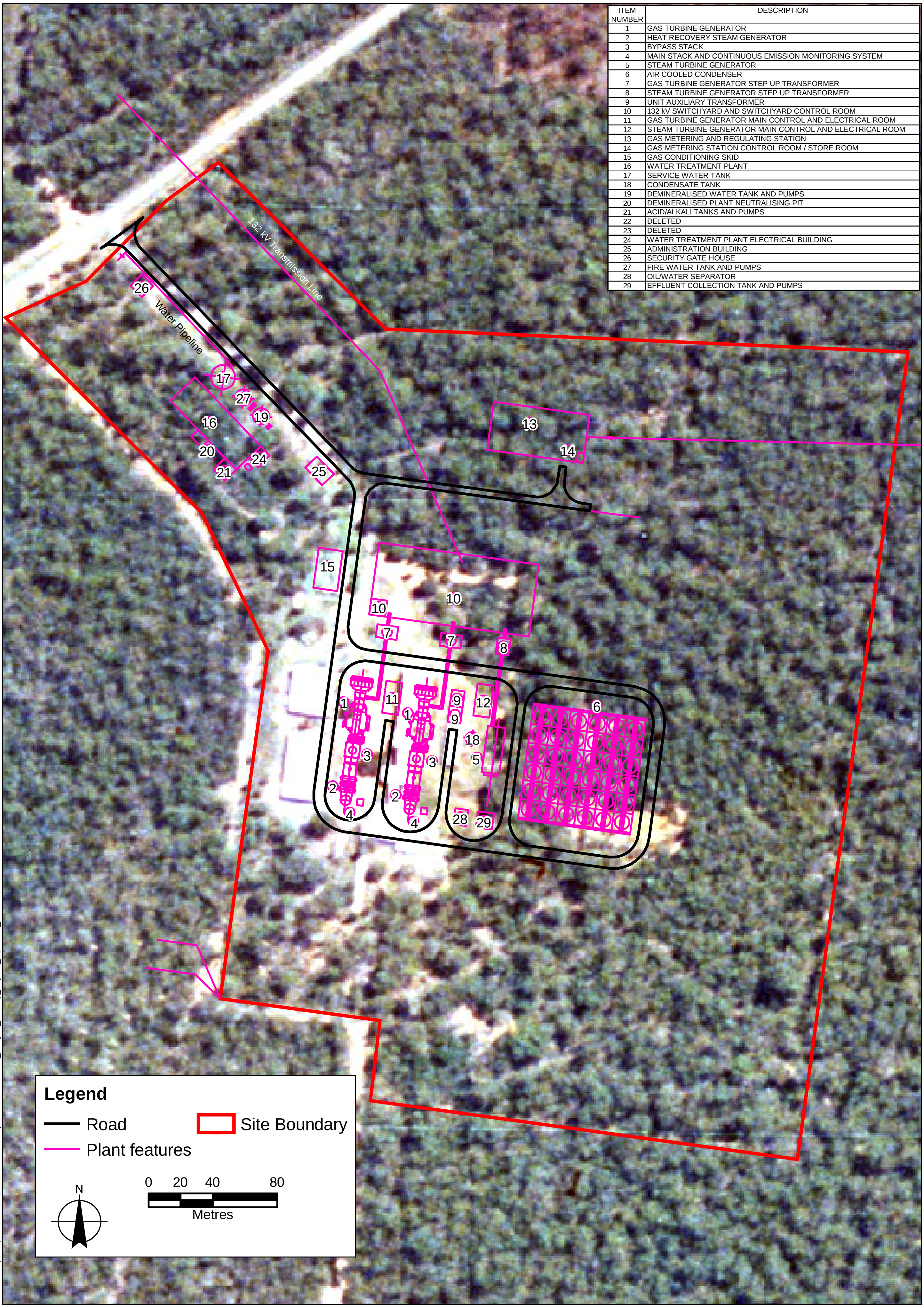

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Figure 5.3 Stage Two - Site Layout

Steam turbine

The steam turbine proposed would be of the stationary type, heavy-duty industrial design, with a direct driven generator. The steam turbine would be capable of producing approximately 120 megawatts.

Waste steam would be exhausted to the air cooled condenser (connected to the steam turbine).

Cooling system

The air cooled condenser is used to condense steam from the turbine exhaust. The air cooled condenser does not consume water for cooling.

Typically, an air cooled condenser would include:

- A-frame or V-frame supporting structure;
- Finned tube bundles;
- Fans, motors and drives;
- Fan cells and deck;
- Air flow control system;
- Air removal system/equipment;
- Air removal piping and drain piping;
- Steam pipes/ducts and expansion joints;
- Steam bypass system for cold ambient conditions;
- Condensate storage tank and pumps; and
- Pressure relief devices.

The air cooled condenser would be one of the largest structures in the plant, and requires a large footprint to complement its height. The air cooled condenser is required to be located closer to the steam turbine building to minimise the steam duct length. The proposed air cooled condenser has a footprint of approximately 70m x 70m, and a height of approximately 31.1m.

Some of the key advantages of a dry cooling system are that it eliminates the need for a cooling tower, cooling tower make up water (more than 90% of a wet cooled plant's consumptive water requirement), circulating water pumps and piping, cooling water treatment and blowdown treatment/disposal. Given the issues associated with securing adequate water for wet cooling, it is considered to be an appropriate solution.

However, there are disadvantages also associated with dry cooling system. The turbine backpressure is generally higher, resulting in increased heat rate or decreased cycle efficiency. In this regard, the proposed gas power facility using the air cooled condenser is estimated to result in approximately 1% less efficiency, compared to a wet cooling system operating under similar conditions (e.g. around 4MW less net output based on a 400 megawatt plant when the same amount of gas is consumed).

An air cooled system also requires a larger footprint and has a higher capital cost as compared to a wet system of similar heat duty.

Water treatment plant

The process water used during stage two needs to be of high quality, to minimise corrosion and potential build-up of scale. An on-site water treatment plant would be provided to meet this requirement.

Externally sourced water would be stored in an on-site service water tank. Water from the service water tank would then pass to the on-site water treatment system, which involves a micro filtration plant and reverse osmosis (RO) plant. The membrane reject wastewater from the micro filtration plant is treated in a clarifier/settling tank and the supernatant is returned to the service water tank. The membrane reject wastewater from the RO plant is passed through a brine concentrator and the distillate is returned to the service water tank. The RO treated water also passes through a demineralising water treatment system, and then is used in the heat recovery steam generator.

5.3 Water supply

As outlined in Chapter 4, process water and domestic water would be sourced from the DN600 Hobas rising main, which runs along the western boundary of the Delta site.

The infrastructure and construction works required for connection include:

- Connection point to water main, including:
  - Water meter;
  - Required valving and RPZD to protect against contamination of potable water;
- Pipeline (as shown in Figure 4.3);
  - Preliminary pipe sizing indicates that a DN 100 pipe would be sufficient to supply the 0.5 ML/d to the site. There is sufficient sizing in the pipe for the 0.5 ML/d to be extracted over 12 hours;
  - A trench that is approximately 600 mm wide and 1200 mm deep will be needed to construct the pipe; and
- Onsite buffer tank.

5.4 On site water treatment

Although the water received on site for process water requirements would be treated and potable (of drinking water quality), it would need to undergo further treatment prior to entering the heat recovery steam generators.

While detailed analysis is yet to be conducted on this water source and its reliability for stage two process requirements, the treatment process is likely to involve microfiltration and reverse osmosis.

The microfiltration/reverse osmosis plant adopts membrane based desalination technologies, which use exclusion membranes to separate fresh water (containing low salt levels) from saline waters. In brief, the process relies on the following treatment processes in series:

- Microfiltration is a pre-treatment step undertaken to remove solids, thus providing very low turbidity water, remove pathogens and prolong reverse osmosis membrane life. Backwash from the microfiltration unit would be treated and returned to the service water tank.
- Reverse osmosis, which occurs where a solution is placed under pressure causing water to pass through a semi permeable membrane while the solute is retained. The brine from the reverse osmosis would be concentrated prior to passing to a holding tank for offsite disposal.

The microfiltration/reverse osmosis plant would be sized to handle flows of around 0.5 megalitres per day.

Some process water (from the microfiltration/reverse osmosis plant) would pass to the steam plant via a demineralised water treatment system. Demineralised water would be produced on site for the steam cycle and other miscellaneous uses. Demineralised water would be produced via an ion exchange process. The ion exchange could be conventional, using acid and caustic chemicals for regeneration or by electrodialysis, requiring less chemicals.

5.5 Wastewater quantities, treatment and disposal

5.5.1 Domestic wastewater

From the facility, due to the limited number of staff, only a small amount of domestic wastewater would be generated (approximately 1 kL/day).

Sewage would be directed to an on-site septic system or pump out storage facility for removal to the Nowra wastewater treatment plant (WWTP). The system would comply with local council requirements.

Wastewater at the WWTP is currently treated and discharged to both a receiving waterway and a reuse (irrigation) area. As a result of the small volume and quality of the wastewater generated by the Delta Electricity facility, no impacts are expected. The relative proportion of wastewater from the proposed facility would be expected to be less than 0.02% of the total flow received at the Nowra WWTP.

5.5.2 Process wastewater disposal

Of the process water that is consumed, the majority is lost through general process losses (e.g. boiler blowdown). Around 6% of the process water is discharged as sludge water and liquid waste from the brine concentrator and ion exchange units.

For the Bamarang facility using dry cooling, this means that up to 30kL/day of concentrated wastewater could be generated. This is considerably less than would have been generated using wet cooling.

Concentrated wastewater from the reverse osmosis process (brine) would be pumped to a holding tank prior to offsite disposal during stage two. Offsite disposal is likely to be via an ocean outfall, potentially in conjunction with effluent outfall from a sewage treatment plant (to assist in dilution and dispersion). In the event that such an option is not available, then disposal via onsite evaporation or brine crystallisation would need to be investigated. If evaporation pans only were used, then areas of up to 2.5 ha may be required and hence it is more likely that brine crystallisers (or other mechanical equipment), which occupy a significantly smaller area, would be used. Crystallisers can be skid mounted and hence are likely to fit within the existing process area. This would be addressed as part of the detailed design process.

5.6 Other infrastructure required for the project

Other facilities, including waste management, emergency and security systems were described in the 2006 environmental assessment.

5.7 Construction

The construction activities as outlined in the 2006 environmental assessment would remain the same.

It should be noted, however, that the facilities described as part of stage one and two in the 2006 environmental assessment may not be staged in the manner originally proposed.

The 2006 environmental assessment indicated that the proposed gas power facility would be constructed in a staged manner, with stage one being constructed first and the facility operating in open cycle configuration, producing electricity during peak periods only. Stage two was expected to be constructed at a later time, with the facility then operating in combined cycle configuration, producing constant (base load) electricity.

However, the recent Owen Inquiry into Electricity Supply in NSW found that new base load electricity generation is required in order to avoid potential energy shortfalls. As such, it is possible that the proposed gas power facility may not be staged in the manner originally proposed.

As the base load power generation may be required sooner, stages one and two may be constructed concurrently. In this regard, the infrastructure required for both stages would be constructed at the same time, and the facility would operate as a base load facility from the commencement of operation.

5.7.1 Construction activities – on site

Construction specific to the project would involve:

» Vegetation clearing – With the change in layout of the facility as a result of the air cooled condenser, there has been an increase in the amount of vegetation to be cleared. As described in the 2006 environmental assessment, stage two (wet cooled) would require 6 hectares of total clearing, and 4.7 hectares of partial clearing for hazard reduction in the bushfire asset protection zone. The new layout of stage two (dry cooled) would require approximately 6.5 hectares of total clearing, and 3.9 hectares of partial clearing for hazard reduction in the bushfire asset protection zone.

- Bulk earthworks – minimal site grading would be required to establish building platforms, roads, car parks and associated facilities. Suitable material would be reused as engineering fill on site.
- Establishing and preparing foundations – foundations for major plant items and buildings would be established on concrete foundations. The type of foundations would be determined following a geotechnical survey undertaken as part of the detailed design process.
- Construction of pipeline from DN600 Hobas rising main – a trench that is approximately 600 mm wide and 1200 mm deep will be needed to construct the pipeline.
- Construction of buildings and facility components – prefabricated components would be imported and erected onsite.

5.7.2 Construction activities – off site

As Delta's preferred option for water supply is to connect to the DN600 Hobas Rising Main through the site along the shortest route to the onsite buffer tank, no off-site construction activities (in addition to those already approved as part of stage one) are proposed.

5.7.3 Construction equipment

Major construction equipment types, purpose and estimated numbers are summarised in Table 5.1.

Table 5.1 Likely construction equipment

Equipment Type	Purpose	Quantity
Bulldozers	Clearing vegetation, removal of topsoil, development of internal roads and drains	1
Backhoe and excavators	Excavation for drainage, site levelling and pipeline trenching	2
Graders	Site levelling and pipeline easement clearing	2
Compactors	Soil compaction for the base of infrastructure items	4
Cranes	Assembling prefabricated building items and positioning equipment	1 (150 Tonne) 1 (40 Tonne) 2 (25 Tonne) 3 (20 Tonne) 2 (10 Tonne)
Trucks	For equipment haulage, dust suppression on exposed surfaces, materials and equipment delivery	10

5.7.4 Construction times and duration

Construction hours would be limited to daylight hours during weekdays (7am to 6 pm) and Saturday mornings (7 am to 1 pm).

The estimated construction duration for the combined cycle gas power facility is 17 months for staged construction (i.e. conversion from stage one open cycle to stage two combined cycle) or 24 months for concurrent construction (i.e. construction of stages one and two at the same time).

5.7.5 Workforce

The maximum construction workforce would be approximately 300 people. The maximum workforce is only likely to be required during intensive construction activity, which would usually be less than two months duration. The average workforce is likely to be approximately 200.

Available positions would consist of a small portion of highly skilled personnel (between 15 to 25 individuals) and the remainder made up of skilled and unskilled labour. Some of the highly skilled personnel may need to be sourced from outside Australia.

5.8 Operation

5.8.1 Operating hours

The facility would operate to a maximum of 24 hours a day, 365 days a year.

5.8.2 Employment

The total employment for the facility operating in combined cycle configuration would be approximately 18 full time staff, comprising technical operators and administration staff. Most of these staff would be located on site.

Additional staff may be required from time to time and would be employed on a contract basis.

5.8.3 Major maintenance

Scheduled maintenance would be undertaken during periods when electricity demand is not expected to be high. In addition to operational staff, up to 20 to 50 contractors would be required on site during such periods.

It is expected that the gas turbines would undergo inspections every 2-3 years with more extensive maintenance at 5 and 10 years. It is expected that inspection and maintenance of the heat recovery steam generators would be required every 3 years. Gas turbine and steam turbine maintenance would coincide with these inspection periods.

5.9 Energy statement

Indicative values for the expected annual net energy consumption and electricity generation are presented in Table 5.2.

Table 5.2 Estimated net energy consumption and electricity production

Operational mode	Project operating in combined cycle configuration
Approximate power plant nominal output (megawatts)	400
Estimated total operating time factor per annum (%)	90% (8,300 hours)
Fuel consumption per annum (petajoules) (gross heating volume)	24
Annual generation (gigawatts per hour, per annum)	3,300
Efficiency, %, (electrical to fuel gross heating volume)	50%

Chapter 6. Consistency assessment

6.1 Overview

Condition 2.2b of the Minister for Planning's Concept Approval requires *'a demonstration that the project is consistent with the requirements of this approval and generally consistent with the scope and intent of the concept outlined in the documents under condition 1.1 of this approval.'*

The following sections demonstrate how the delivery system is consistent with condition 2.2b of the Concept Approval.

6.2 Consistency with the Concept Approval

On 27 February 2007, the Minister for Planning approved *'the concept plan referred to in Schedule 1, subject to the modifications in Schedule 2.'*

Schedule 1 describes the proposal as 'Bamarang Gas Turbine Facility'.

Schedule 2 includes the following descriptions relevant to the project:

» Open cycle gas turbine facility project – construction and operation of an open cycle gas turbine facility, including the construction and operation of a transmission line, gas supply, metering and compression infrastructure.

» Combined cycle gas turbine facility project – the construction and operation of a combined cycle gas turbine facility and all water supply infrastructure.

» Stage one – Open cycle gas turbine facility project, including gas supply and electricity transmission infrastructure.

» Stage two – Combined cycle gas turbine facility project, including water supply infrastructure.

The Concept Approval specifies assessment requirements for the project. Table 2.1 details these requirements and refers to the section of the environmental assessment where they are addressed.

The project assessed in this environmental assessment is consistent with the concept defined by the Concept Approval above as it would involve conversion of the approved open cycle gas turbine facility (stage one) project to a combined cycle gas turbine facility, and the construction of water supply infrastructure.

The project is consistent with the Concept Approval as:

» It is consistent with the scope and intent of the concept for which Concept Approval was granted; and

» The assessment requirements specified are addressed in this environmental assessment.

There are a number of other Conditions of Approval that relate to:

» Administrative conditions (Condition 1);

» Compliance monitoring and tracking (Condition 3); and

» Community information, consultation and involvement (Condition 4).

These conditions do not contain any other requirements relating to the design or assessment of the project. Where relevant, these conditions have been incorporated into the Statement of Commitments in Chapter 8 to ensure consistency with the Concept Approval.

6.3 Consistency with the concept outlined in the documents specified in the Concept Approval

Condition 2.2b requires that the project is generally consistent with the scope and intent of the concept outlined in the documents under condition 1.1 of the approval.

Condition 1.1 lists the following documents:

a) Major Projects Application 06_0029;

b) Proposed Gas Power Facility at Bamarang, Environmental Assessment, prepared by GHD Pty Ltd and dated May 2006;

c) Delta Electricity, Proposed Gas Power Facility at Bamarang, Submissions Report, prepared by GHD Pty Ltd and dated August 2006;

d) Delta Electricity, Proposed gas power facility at Bamarang near Nowra – Options to reduce plume rise impacts, prepared by GHD Pty Ltd and dated December 2006;

e) Gas Fired Power Facility, Bamarang, NSW Revised Stack Operations – Air Quality Impact Assessment NSW Department of Environment and Conservation Submission, prepared by Heggies Pty Ltd for GHD Pty Ltd (Report 10-4044R1) dated 18 December 2006; and

f) The conditions of this approval.

The consistency with the documents referenced as a to e is discussed below. Section 6.2 discusses consistency with the conditions of approval.

6.3.1 General consistency with the Major Projects Application

The Major Projects Application form was submitted in January 2006 with a copy of the draft environmental assessment.

The proposal was described by the application as: *'Proposed gas power facility at Bamarang near Nowra. The proposed facility would be developed in two stages. Stage one would involve development of a peaking facility. Stage one also involves development of a gas pipeline and an electricity transmission line. Stage two involves conversion to a base load facility.'*

The project presented in this environmental assessment is consistent with this definition as it involves conversion of the stage one facility to a base load facility, by converting the open cycle gas turbine facility proposed as part of stage one to a combined cycle facility as described by the environmental assessment.

A more detailed description of the project was included in the draft environmental assessment provided with the major projects application form. This description was also included in the 2006 environmental assessment. The consistency of the project with this description is considered in Section 6.3.2.

6.3.2 General consistency with the 2006 environmental assessment

Section 1.1 of the 2006 environmental assessment explained that stage two would involve 'converting the proposed facility to a combined cycle configuration by adding two heat recovery steam generators and a steam turbine. This would increase the amount of energy recovered from the gas and therefore the amount of electricity produced. The stage two facility would provide a constant supply of electricity and is referred to as a base load facility.'

Project description – development on site

The consistency of the existing project with the key features of stage two summarised in Table 1.1 of the 2006 environmental assessment are summarised in Table 6.1.

Table 6.1 Estimated net energy consumption and electricity production

	Stage two (as described in the 2006 environmental assessment)	**Stage two as currently proposed**
Gas power facility	Two heat recovery steam generators connected to the gas turbine generators Steam turbine with an electrical output of approximately 100 megawatts Steam generator step-up transformer	Two heat recovery steam generators connected to the gas turbine generators Steam turbine with an electrical output of approximately 100 megawatts Steam generator step-up transformer
Ancillary on-site infrastructure	Cooling tower (water) Water storage and treatment plant	Air cooled condenser (dry cooling) Water storage and treatment plant
Gas supply	-	-
Electricity transmission connections	-	-
Electricity generated	Approximately 400 megawatts	Approximately 400 megawatts
Employment (estimate maximum)	Construction – 200-300 employees Operation – 18 employees	Construction – 200-300 employees Operation – 18 employees
Water Supply	Water supply for stage two is subject to further investigations. Proposed sources/estimates are as follows: » Domestic water – Nowra potable supply (0.4 megalitres per year) » Process water – industrial effluent (8.4 megalitres per day)	Treated (potable) water from the Nowra reticulated water supply. Proposed sources/estimates are as follows: » Domestic water – Nowra potable supply (0.4 megalitres per year) » Process water – Nowra potable supply (0.5 megalitres per day) Water pipeline of approximately 140m to be constructed in the site from the adjacent DN600 Hobas Rising Main, which runs along the site's western boundary.

A more detailed description of the stage two base load facility was provided in section 6.3 of the 2006 environmental assessment. This section identified that the following facilities would be provided on site as part of stage two:

» Two heat recovery steam generators connected to the gas turbines (each with an exhaust stack approximately 40 metres high);

» Steam turbine;

» Steam piping;

» Steam generator step-up transformer;

» Additional electrical equipment in the switchyard;

» Water treatment plant (to treat the water to be used for cooling);

» Water cooled condenser;

» Cooling tower (approximate height of 11 metres) with water as the preferred cooling medium; and

» Associated civil works.

It is now proposed to replace the water cooled condenser and the cooling tower with an air cooled condenser (which is described in Section 5.1 of this environmental assessment). However, this proposed change does not change the fundamental nature of the proposal. That is, although there are some changes to individual facilities/plant items, the project is still consistent with the overall concept of stage two being the conversion of a open cycle (peaking) facility to a combined cycle (base load) facility.

Prior to receiving the approvals described in Section 1.2.2, changes to the design of the stacks were proposed to respond to issues raised by the Department of Defence. The report described in Section 6.3.4 modified the design of the facility described in the 2006 environmental assessment.

Other infrastructure to be developed as part of stage two

Water supply

The assessment of infrastructure associated with the supply of water to the stage two facility did not form part of the scope of the 2006 environmental assessment. Section 3.2.1 of the 2006 environmental assessment noted that one of the reasons Delta sought concept approval for stage two of the proposal was because it was not possible to confirm the water supply option for stage two at the time of making the application for approval:

> 'The proposed facility is a staged project and there is uncertainty regarding timing of the second stage, which requires large volumes of water to be supplied. As a result, it is not possible at this time to confirm and secure the water resource (from either current wastewater streams or the existing fresh water supply network) and determine a water pipeline route. If water were not available, Delta would have to revert to dry cooling for the stage two operations, which is more costly and less efficient. Prior to commencing stage two, Delta would need to further investigate and confirm the availability of water.'

The 2006 environmental assessment noted that in stage two, water would be required for the process (approximately 8.4 ML per day), including:

- Cooling (to replace blowdown and evaporative losses);
- Water losses in the water treatment process (reverse osmosis concentrator, demineralised water treatment); and
- Fire water requirements.

Options for the supply of water were outlined (in Section 8.5.2 and Appendix G of the 2006 environmental assessment), and the environmental assessment noted that the preferred source of water for these process uses is industrial effluent.

The studies undertaken to identify a secure water supply, as outlined in Chapter 4, found that there was insufficient volume of water available to supply the required process water for wet cooling (even when using a combination of options). As such, Delta has decided to use dry cooling rather than wet cooling. Dry cooling uses considerably less water than wet cooling, and reduces the process water requirement from 8.4 ML per day to approximately 0.5 ML per day. Shoalhaven Water has confirmed that they can readily provide this volume of water from either a raw or potable water source.

The project presented in this environmental assessment is consistent with the above in that options for the supply of water were considered, and the project for which approval is sought includes a description of the preferred means of cooling (now dry cooling) and the source of the small amount of water required (refer Chapter 4).

Process wastewater

The 2006 environmental assessment noted in Section 8.5.4 that (in relation to stage two):

> 'Concentrated wastewater from the reverse osmosis process (brine) together with wastes from the demineralisation process and separated oil/water mixes would be pumped to a holding tank prior to offsite disposal during stage two (little or no wastes would be generated during stage one). Offsite disposal is likely to be via an ocean outfall, potentially in conjunction with effluent outfall from a sewage treatment plant (to assist in dilution and dispersion). In the event that such an option is not available, then disposal via onsite evaporation or brine crystallisation would need to be investigated. This issue requires further consideration as part of the design process for stage two.'

Although, dry cooling would result in significantly less amounts of wastewater, it is consistent with the above in that options for the disposal of wastewater were considered prior to seeking approval for stage two, and the project for which approval is sought includes a description of the preferred means of wastewater disposal (Section 5.6).

Timing of development

Section 1.5 of the 2006 environmental assessment noted that:

> 'The key objective of the proposal is to provide additional electricity supply in NSW to address the predicted shortfalls likely to occur within the next few years. The development of a peaking facility (stage one) would supplement electricity supply during times of peak demand, such as on hot summer days. When the overall level of demand increases further, the facility would be converted to a combined cycle facility (stage two), allowing it to operate efficiently full time, producing a constant supply of electricity.

> Delta has determined that developing the proposal in two stages would provide a cost effective way of meeting short-term demand requirements, whilst providing the option to fast track development of a base load facility when required.'

As noted in Section 1.2.1 of this environmental assessment, the NSW Government has identified that the level of electricity demand is such that suppliers need to focus on securing future base load supply of electricity now. Consistent with the need for increased base load power generation capacity in NSW, Delta has decided to progress with seeking a project approval for the works that formed part of what was described as stage two in the 2006 environmental assessment, so that, if required, the facility at Bamarang can operate as a base load facility from commencement.

6.3.3 General consistency with the Submissions Report

No changes to the design of the project were proposed by the submissions report. Additional information was provided in relation to the potential plume rise impacts, noise mitigation measures and ecological impacts.

The submissions report confirmed that when the need for stage two of the facility is confirmed, Delta would undertake a detailed study of water supply options and an environmental impact assessment of the preferred option and/or any modification to the proposal. Subsequent to confirming the need for stage two, a detailed study of water supply options was undertaken (refer Chapter 4 and Appendix B) and this document provides the impact assessment of the preferred option.

6.3.4 General consistency with the report on options to reduce plume rise impacts

The report on options to reduce plume rise impacts, in response to issues raised by the Department of Defence (GHD Pty Ltd, 2006c), proposed changes to the design of the exhaust stacks. The design parameters of the exhaust stacks have not changed from that outlined in this report.

The air quality assessment contained in Section 7.5 and Appendix C has assessed the plume rise impacts of the revised dry cooling option. The results of the revised modelling showed that exhaust plumes retained virtually the same results as the previous modelling (with regards to height of maximum vertical velocity exceedance of 4.3m/s and frequency of exceedance with height in particular), while the air cooled condenser showed a low level of critical velocity exceedance (<0.3% of the 5 year modelling period). This would suggest that the volume of air released from the air cooled condenser has the potential for plume growth to the Obstruction Clearance Surface and beyond. Analysis of the plume merging heights and enhancement factors showed a conservative average merging height at a minimum of 80m and at a maximum plume enhancement of 1.23.

These results would therefore suggest that the potential for plume enhancement of the exhaust stack plumes from interaction with the air cooled condenser plumes does exist. However, based on the conservative approach returning a relatively high minimum average height of plume merging and relatively low maximum average plume rise enhancement factor, it is not expected that this enhancement will significantly alter the results predicted for the exhaust stack plumes, which were similar between both this assessment and the previous plume rise modelling. Consequently, the installation of the air cooled condenser system is not predicted to significantly impact upon the plume rise of the facility.

As such, the proposed is considered to be generally consistent with the report (GHD Pty Ltd, 2006c) on options to reduce plume rise impacts.

6.3.5 General consistency with the air quality impact assessment of the revised stack operations report

The air quality impact assessment of the revised stack operations report assessed the air quality impacts of the changes to the design parameters of the exhaust stacks (Heggies Pty Ltd, 2006). The design parameters of the exhaust stacks have not changed from that outlined in this report.

The air quality assessment contained in Section 7.5 and Appendix C has assessed the air quality impacts of the revised dry cooling option, including the emissions from both the exhaust stack and the air cooled condenser. The results of the assessment indicate that ground level concentrations of all pollutants would not exceed their respective criteria at sensitive receptors. The existing air environment in the Bamarang area is consistent with a rural environment, and the proposal is not expected to impact significantly on the existing air quality environment.

These results are consistent with the findings of the air quality impact assessment of the revised stack operations report.