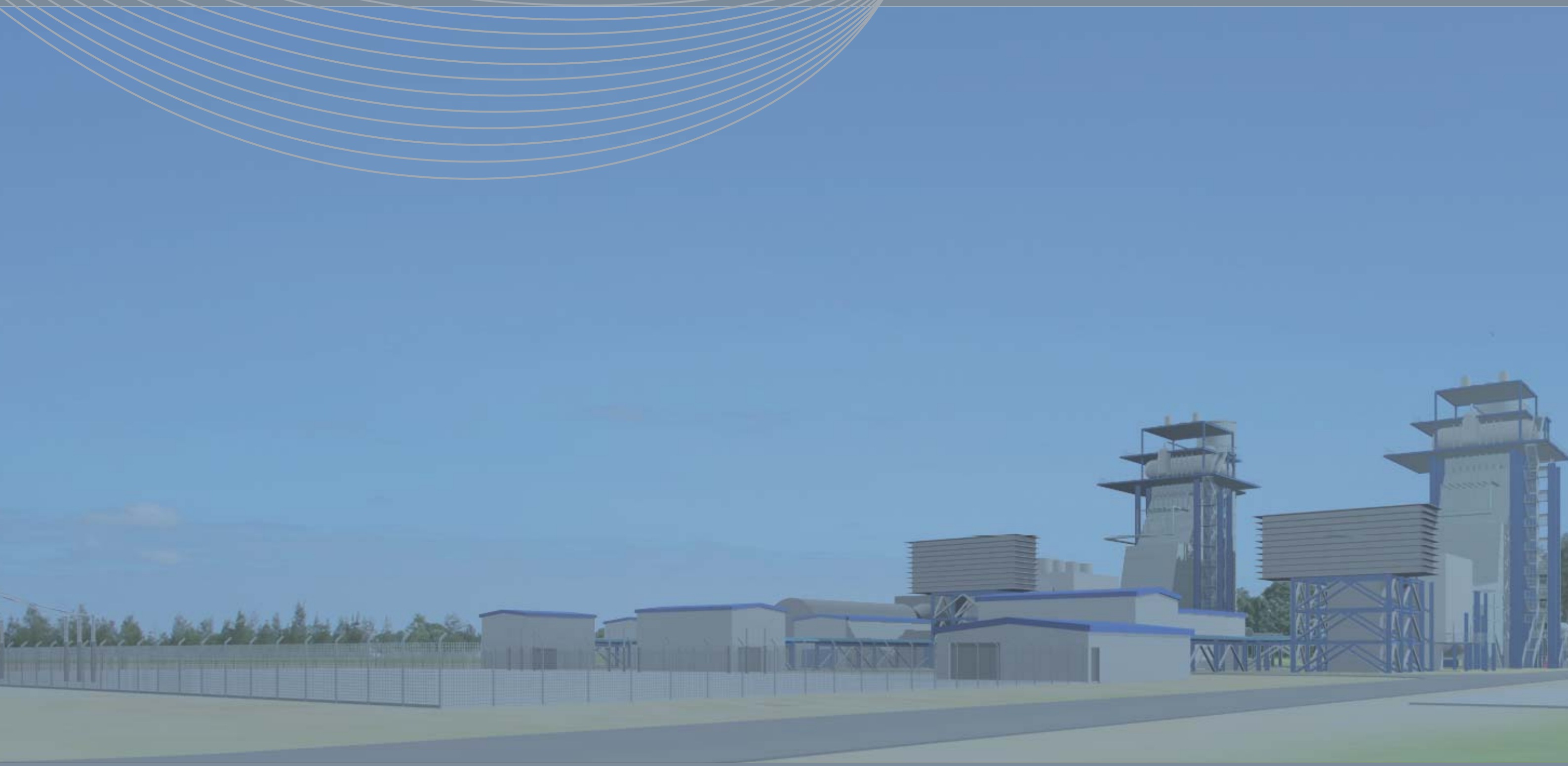


Part B

Information on the proposal

Chapter 5. Strategic justification

5.1 Overview

The strategic context for the proposal is framed by the National Electricity Market (NEM). The National Electricity Market Management Company Limited (NEMMCO) operates the NEM. NEMMCO produces an annual summary of the state of the NEM, including an assessment of predicted supply and demand. The analysis undertaken by NEMMCO indicates that a shortfall in electricity supply is predicted to occur in NSW in the next few years. In response to these predictions, the NSW Government released the Energy Directions Green Paper in December 2004.

The paper recognises that managing and meeting demand for electricity in NSW over the next decade will need to be met through a combination of new and upgraded power facilities and demand management.

A trend is evident towards an increase in peak electricity demands, requiring an increase in supply to meet these demands. Gas power facilities provide an efficient means of meeting peak demands.

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

Further information is provided in the following sections.

5.2 The National Electricity Market

The electricity industry experienced major changes in the 1990s. In 1991, the Industry Commission released a report on Australia's natural gas and electricity sectors. The Industry Commission report recommended a major restructure of the electricity industry. The reforms led to the disaggregation of the vertically integrated government-owned electricity authorities into separate generation, transmission, distribution and retail sales sectors in each State. The goal of the reform process was to increase competition in the industry and provide greater choice for electricity consumers.

A key focus of the reforms was the establishment of the NEM. The NEM is a wholesale market for the supply of electricity in Queensland, NSW, Victoria, South Australia and the ACT. The NEM, which commenced on 13 December 1998, delivers electricity to market customers via an interconnected power system (the 'national grid') stretching more than 4,000 kilometres from Port Douglas in Queensland, to Port Lincoln in South Australia. Retail electricity organisations purchase electricity from the NEM for supply to consumers.

The operation of the NEM is currently based on five interconnected regions that mainly follow State boundaries. Tasmania is expected to become the sixth region of the NEM in 2005.

5.2.1 NEMMCO

Exchange between electricity producers and electricity consumers is facilitated through a pool where the output from all generators is aggregated and scheduled to meet demand. The electricity pool is not a physical location; rather it is a set of procedures managed by the NEMMCO, according to the provisions of National Electricity Law and Statutory Rules and in conjunction with market participants and regulatory agencies.

NEMMCO was established in May 1996 to implement, administer and operate the wholesale NEM. The governments of the ACT, NSW, Queensland, South Australia, Tasmania and Victoria are members of NEMMCO.

NEMMCO has dual roles of market operator and system operator. NEMMCO administers and operates the competitive wholesale electricity market. Approximately 165,000 gigawatt hours of electricity is traded annually. NEMMCO's objectives are to:

» Establish and conduct the electricity market efficiently on a break-even basis;

» Continually improve the NEM's efficiency;

» Maintain the security of the power system; and

» Coordinate planning for the power system.

5.2.2 Operating the NEM

Operating the NEM involves a variety of activities undertaken by NEMMCO to facilitate trade between producers and wholesale consumers of electricity. These activities include forecasting demand levels, receiving offers for supply from generators, scheduling generators, dispatching generators into production, calculating the spot price, measuring electricity use and financially settling the market.

The wholesale electricity market uses the concept of a pool where all electricity output from generators is centrally pooled and scheduled to meet electricity demand. In order to match supply with demand, NEMMCO operates a co-ordinated dispatch process. Dispatch bids, specifying the quantities demanded by market customers, are submitted to NEMMCO. Generators compete by providing dispatch offers (prices for different levels of generation).

Electricity demand and the role of peaking facilities

Demand varies from region to region depending on population, temperature and industrial and commercial needs. It also varies throughout the day, with daily demand peaks (driven by domestic activity) typically occurring between 7 am and 9 am, and between 4 pm and 7 pm. Periods of peak demand occur during high and low temperatures when the use of air conditioners and heaters increase.

Over the past decade, the nature of demand for electricity has changed. There has been a comparative increase in intermediate and peak load demand and a reduction in reserve generating capacity, particularly during periods of peak demand.

The operation of the market and economic factors drive the fact that peaks of demand are best met by a combination of supply and demand side arrangements rather than having excess base-load generation capacity in the system at all times. These arrangements include the need for facilities specifically built to service extreme demand periods (peak generators or 'peaking facilities'), and demand side participation, where consumers voluntarily and temporarily withdraw from the market when the spot price reaches a threshold level.

The mix of generators supplying electricity at any point in time is determined by the bidding and dispatch process of the NEM.

5.2.3 Delta

In the mid 1990s, the NSW Government corporatised the electricity supply industry (with organisations maintained as government-owned entities). Delta, which was formed in March 1996, is one of four government owned electricity generation companies operating in NSW. Delta operates under the *Energy Services Corporations Act 1995* and the *State Owned Corporations Act 1989*. Since it was formed, Delta has operated mainly in the wholesale electricity market selling to energy retailers and in some cases a few very large industrial customers.

Delta currently produces electricity from the four major coal fired power facilities previously mentioned, as well as a number of other facilities using fuels such as coal, water and biomass materials. Delta's facilities produce approximately 12% of the electricity on the NEM. As a wholesale electricity generating company, Delta competes against other generating companies for the supply of electricity into the NEM.

Delta is also responsible for facilitating the development of a range of expanded and/or additional power facilities for NSW. These include gas, renewable energy and coal facilities.

5.3 Need for the proposal – electricity demand

Information on current electricity demands and supply, and the NSW Government's policy response to this information, is provided below.

5.3.1 NSW electricity demands and projected future deficits

Figure 5.1 represents NSW electricity demand during 2004.

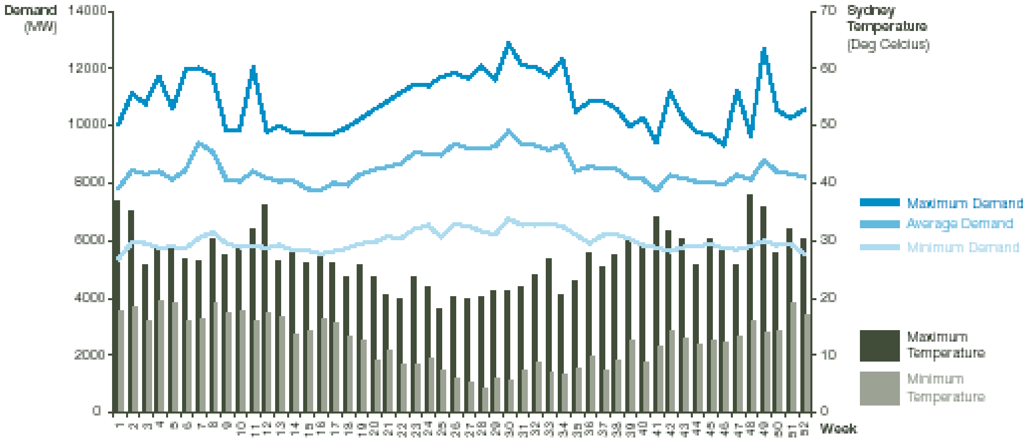


Figure 5.1 NSW electricity demand 2004 (source: esaa 2004)

Average electricity demand in NSW is around 8,500 megawatts. In July 2004, peak demand reached 12,838 megawatts. The trend towards peak electricity demand is evident. Summer peak demand has grown by around 3.8% (500 megawatts) per year in the past five years, compared with a growth in average demand of around 2.8% (Energy Supply Association of Australia (esaa), 2004).

In 2003/04, 10% of NSW's generation and network capacity was used for only 1% of the year (that is, 87 hours). If current trends continue, it is predicted that in 10 years time, around 18% of generation capacity will be used for only 1% of the year (NSW Government, 2004).

The annual NEMMCO Statement of Opportunities provides an overall summary of the state of the NEM. The 'low reserve condition point' refers to the point in time when the reserves are projected to fall below the minimum power system reliability standard requirement. The 'reserve deficit' refers to the amount (measured in megawatts) by which the reserves may be below the minimum requirement. The low reserve condition point for NSW is predicted to occur in 2008/2009 and the reserve deficit will be 372 megawatts (NEMMCO, 2005).

Figure 5.2 shows the projected NSW supply-demand balance.

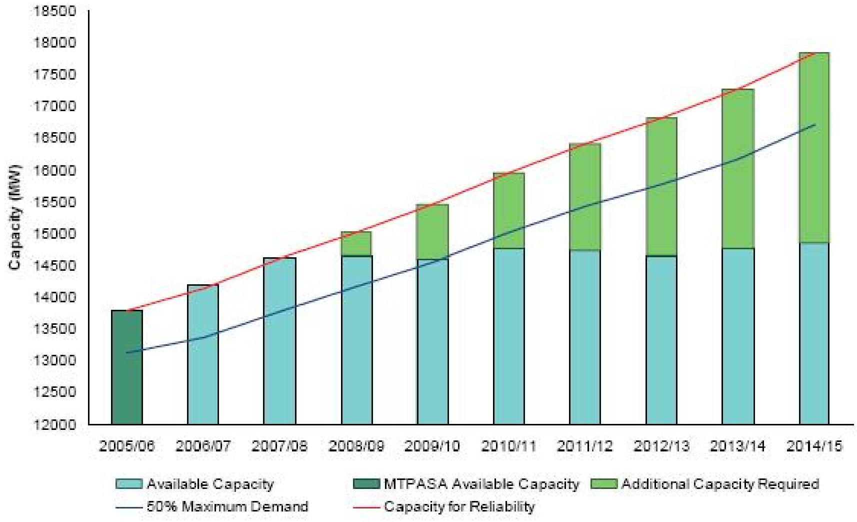


Figure 5.2 NSW summer outlook (source: NEMMCO, 2005)

The results of the supply-demand balance assessment for NSW indicate that without investment in further generating capacity (NEMMCO, 2005):

» NSW will need to rely on imports from interstate to meet minimum requirements from 2005/2006. Reserve capacity support from the Snowy and Queensland regions will provide additional available capacity in 2006/07 and 2007/08.

» In 2008/09, NSW will experience deficits and will not be able to source additional capacity from other sources (which themselves will experience deficits).

5.3.2 Policy response

In response to the above findings, the NSW Government released the Energy Directions Green Paper in December 2004. The paper noted that:

» The level of demand is increasing by an estimated 4% per year, and if this trend continues, there will be shortfalls in electricity supply by the end of the decade.

» The trend towards peak electricity demand influences the types of generating plants required in the future. The use of significant capital resources for small periods is costly. Peak generating plants provide a cost-effective solution.

» New electricity generating capacity will be required in the next few years.

» The next increment of new generation capacity or demand side management capacity is likely to be initially needed to meet demand at peak times only.

» New base-load generation capacity may be required from around 2012/13.

The paper identifies that it is the Government's preference for investment in new generation capacity to be made by the private sector. Government-owned energy businesses (such as Delta) would continue to develop options for new generation capacity. These options would either be sold to other parties, who would further develop and invest in them, or would be further developed through other arrangements (such as joint ventures).

The paper recognises that managing and meeting demand for electricity in NSW over the next decade will need to be met through a combination of:

1. New and/or expanded coal and gas generation facilities;
2. Renewable sources (such as wind, solar and biomass technologies); and
3. Demand side management.

Although the above three options will all continue to play a role in meeting and managing demand in NSW, for the immediate future, the provision of new and/or expanded coal and gas generation facilities is expected to play the most significant role. Renewable energy sources are expected to play an increasing role in future power generation, and a number of projects are currently in the planning phase. For the immediate future, renewable sources will not be able to generate the significant amounts of power required to meet future demands in a cost efficient manner. As a result, new and/or expanded coal and gas generation facilities will continue to be developed in conjunction with renewable sources and demand side management initiatives.

5.3.3 Meeting electricity demands

Open cycle gas facilities are considered to be the preferred option for meeting peak demands, because they can be built for a relatively low capital cost in a short timeframe, and are able to achieve full generation capacity from start up in a relatively short period of time.

For base load generation, combined cycle gas plants are considered to be cheaper and quicker to build than coal-fired plants, and offer comparatively better greenhouse efficiency compared to coal-fired generation. Use of gas by cogeneration systems results in the emission of less than half the greenhouse gas, per unit of energy produced, than the cleanest available thermal power station (Roarty, 1999). However, the fuel costs for gas facilities (as a result of the relatively high cost of gas in NSW) are higher than for coal. It is anticipated that changes in carbon policy will make gas more competitive for base load in the future.

A major attraction of gas is its relative greenhouse efficiency compared to coal fired generation. Combined cycle gas generation emits approximately 0.4 tonnes of CO_2 per megawatt hour of electricity produced. This is less than half the level set for the NSW pool coefficient (0.913 tonnes of CO_2 per megawatt hour of electricity in 2005). Open cycle gas generation emits approximately 0.6 tonnes of CO_2 per megawatt hour.

The disadvantage of open cycle facilities is that they are expensive to run because of their thermal efficiency and the relatively high cost of gas in NSW. As a result, they are only suited for peak supply.

It is anticipated that changes in carbon policy will make gas more competitive for base load electricity supply in the future.

Delta proposes to develop the gas facility in Bamarang in two stages (development of a peaking facility first, with future conversion to a base load facility) to provide a cost effective way of meeting immediate demand requirements, with the option to fast track the facility to base load when required.

5.4 Opportunities for gas power facilities in NSW

5.4.1 Gas power generation

Figure 5.3 shows the sources of electricity generation in the different states. Most electricity in NSW is currently generated from coal facilities. Less than 2% of NSW generation plant capacity is made up of gas facilities. This compares to 18% in Victoria, 8% in Queensland and 75% in SA (ESAA, 2004).

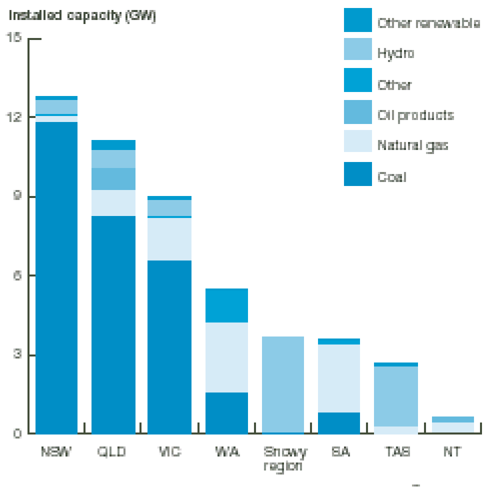


Figure 5.3 Power capacity by fuel types (source: esaa, 2004)

The Smithfield Energy Facility, which has a capacity of 176 megawatts, is the only gas power facility currently operating in NSW.

The following gas facilities have recently received development approval:

» Uranquinty (Wambo Power Ventures Pty Ltd) – approval was granted in June 2005 for a 600 megawatts facility to be developed in two stages.

» Tomago (Macquarie Generation) – approval was granted in November 2003 for a 790 megawatts facility to be developed in three phases.

» Tallawarra (TRUenergy) – approval was granted in 1999 for a 400 megawatts facility.

The above facilities (if all are constructed) would provide for just over three years growth of peak demand. Other opportunities for gas facilities in NSW also need to be considered.

5.4.2 Gas supply

Most of the gas consumed in NSW arrives via pipeline from South Australia or Victoria. There are two pipelines that run through NSW:

- The Moomba to Sydney Gas Pipeline – This pipeline, which services around 85% of NSW's gas consumption, transports gas from the Moomba processing plant in South Australia to Sydney. The pipeline is owned by Australian Pipeline Trust and operated by Agility.
- The Eastern Gas Pipeline (the Longford to Wilton Pipeline) - The 795 kilometre Eastern Gas Pipeline, completed in August 2000, delivers natural gas from Australia's largest natural gas supply region (the Gippsland Basin in Victoria) to Sydney via the east coast. This pipeline currently supplies around 15% of NSW's gas consumption, but has the potential capacity to supply over 100 petajoules per annum. The pipeline is owned and operated by Alinta.

The completion of the Eastern Gas Pipeline in 2000 has opened up opportunities for the development of gas power facilities in NSW. Development of gas power facilities in NSW will provide additional electricity supply opportunities, and will reduce the reliance on coal as the main source of electricity and increase the proportion of electricity generated by gas.

5.4.3 Proposed gas projects

Key locational requirements for gas power facilities are:

- Proximity to one of the main gas supply pipelines described above;
- Proximity to the high voltage (132 kilovolts or above) electricity transmission network; and
- Availability of water.

The location of these facilities with respect to the proposed site is shown in Figure 5.4.

Delta investigated a range of possible sites available for purchase that met the locational requirements. A summary of the sites considered is provided in Section 7.2.

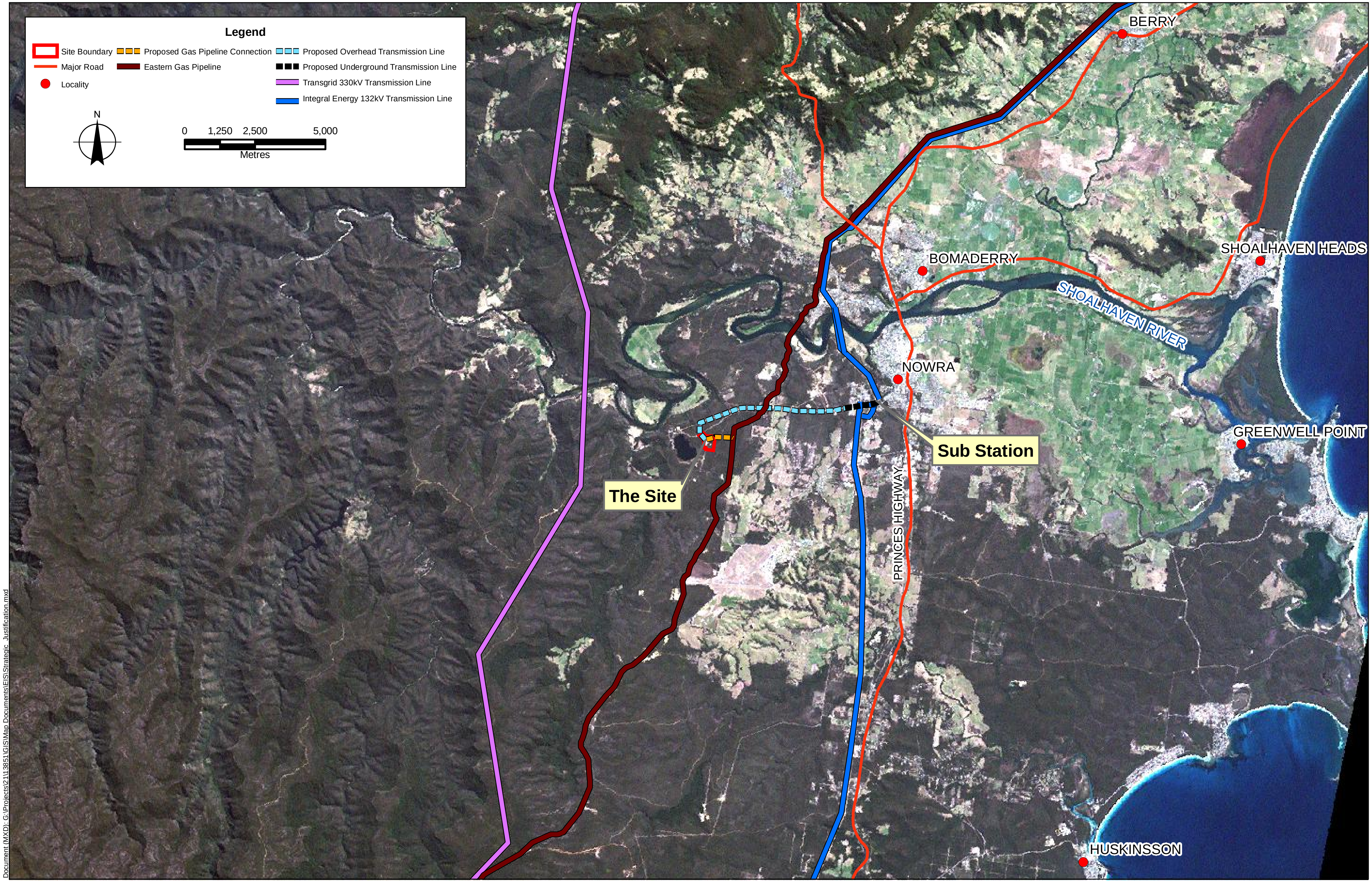


Figure 5.4 Regional Distribution Network

This proposal forms one of three gas power facility proposals currently in the planning phase. On 11 June 2005, the NSW Premier announced that planning had commenced for three gas-fired power stations, to be built in partnership with the private sector, at Munmorah, Bamarang and Marulan.

Delta purchased the site at Bamarang in 2004 following investigation of a range of potential sites (refer Section 7.2). Advantages of the proposed site include:

» Proximity to Eastern Gas Pipeline – the pipeline is located approximately 600 metres to the east of the site;
» Proximity to high voltage transmission lines. The 132 kilovolts lines are located approximately 6 kilometres to the east of the site, with an existing substation (providing opportunities for connection) located near the intersection of Albatross and Yalwal Roads 6 kilometres from the site. The 330 kilovolts lines are located four kilometres to the west of the site;
» The gas supply tariff is competitive as the site is located closer to the gas pipeline than other available sites;
» The site was available for purchase. It had been developed for use as an abattoir, and was considered appropriate for the proposed facility;
» With approximately 2.5 hectares already cleared for the abattoir development, the need for large scale clearing was reduced;
» The land use zoning permits the proposed facility; and
» The site is surrounded by bushland, which minimises the visibility of the facility, and the potential for impacts on surrounding land uses.

5.5 Facility scale and scope

5.5.1 Technology

Stage one of the proposed facility would be configured in an open cycle configuration, with the turbines fueled by natural gas. While an open cycle gas turbine facility has a similar overall efficiency to a coal-fired power station, unlike coal fired generation it can be started from cold and generate to full capacity within a few minutes. As a result, open cycle gas turbine facilities are ideal for supplying peak demand loads.

An additional benefit of the initial open cycle configuration is that it can be readily converted to a base load facility by adding a heat recovery steam generator to each gas turbine to create a combined cycle gas turbine configuration.

The combined cycle configuration provides greater conversion efficiencies than traditional generation methods as it harnesses heat that would otherwise be wasted. In addition, carbon dioxide emissions can be substantially reduced. Furthermore, the heat by-product is available for use without the need for the further burning of a primary fuel.

A combined cycle plant takes longer to start-up and shutdown than an open cycle plant. As a result, it is more suited to meeting base load demands.

The gas turbines would be of the stationary type, heavy-duty industrial design, with direct driven generators suitable for use in open cycle and combined cycle. The gas turbine generators would be suitable for operation outdoors.

The reference for this facility has been an E-class machine, as it is proven for peaking plant and combined cycle configurations. Being of a proven type the gas turbine has a high level of reliability and performance. This type of machine achieves thermal efficiency of close to 50%, which is much higher than that of conventional thermal power plants.

However, it is feasible to use other types of machines and configurations, and this would be subject to the final design. F-class machines are an alternative. These are more efficient, but less proven, gas turbine models. These machines give a thermal efficiency, in the combined cycle mode, of at least 55%. These models, which are built by many well-known manufacturers, can be configured to produce a total of 394 megawatts in combined cycle mode. Due to the increasing numbers of these models in operation, and improved reliability and performance, the F-class gas turbines are becoming the technology of choice for large power plants. There are also mid-range F-class machines that can produce 190 megawatts in combined cycle mode.

At the lower output end, highly efficient aero-derivative gas turbines are another alternative for use in a peaking plant. One manufacturer has a machine that can produce an output of 100 megawatts and a simple cycle efficiency of about 45%, nearly exceeding the combined cycle efficiencies of E-class machines. However, aero-derivative machines are usually more expensive to purchase and maintain. They may be considered for cycling duty on base load in smaller unit sizes, because they have high availability, are quicker to build since a boiler and steam turbine generator is not required.

5.5.2 Plant capacity

Through analysis of the NEM and the 2004 NEMMCO Statement of Opportunity it was determined that a base load facility with a capacity exceeding 317 megawatts (2,500 gigawatt hours at 90% capacity factor) was a suitable size for development at the site. Preliminary investigations also confirmed that, for connection to the 132 kilovolts network (refer to Section 7.4 for more information), a maximum capacity of 400 megawatts would be possible.

Project economics dictated that a peaking facility should be developed first to meet immediate demands, and that the facility should be capable of conversion to base load. The proposed staging was taken into account when the configuration of the proposal was developed. The provision of two gas turbines in stage one would improve the reliability of supply and the two machines would be able to operate independently of each other. The transmission constraints imposed by the 132 kilovolts network also dictated use of smaller machines to ensure security of supply into the network.

There are a number of gas turbines available from manufacturers in various configurations to achieve the required output. The two gas turbines proposed would have an output of approximately 140 megawatts each, giving a total output for stage one of 280 megawatts.

To convert the proposed facility to base load in stage two, the addition of a steam generator capable of producing 120 megawatts is proposed, bringing the total generation capacity to 400 megawatts.

5.5.3 Plant configuration and on site layout

The configuration of the proposed facility is driven by the requirement to stage its development and standard configuration requirements for these facilities. The location and onsite layout was driven by the need to maximise use of the existing cleared area; ensure that there is adequate space surrounding the proposed facility for asset protection zones; and to meet technical configuration requirements with respect to the location of key equipment items. This is discussed further below.

Delta's requirement with respect to configuration was that the proposed facility be built in two stages, with an ultimate output of approximately 400 megawatts. To meet these requirements, together with industry reliability and operability requirements, the proposed facility involves two gas turbines (for stage one) and heat recovery steam generators and a steam turbine (in stage two) and other associated equipment and plant items.

This type of equipment is commercially available and commonly used in the configuration proposed. It has a set footprint and relationship with the equipment it connects to. As well as the major equipment (turbines and generators), other equipment is required to complete a working installation. This includes an electrical switchyard to allow the generated electricity to be connected to the grid; a cooling tower for the steam cycle; gas supply equipment; and a water treatment plant.

The proposed layout was developed to take into account the interconnection constraints and the existing cleared area. Other constraints/factors that influenced the layout (and resulted in a need to clear additional vegetation) included:

» The need for partial/total clearing for the bushfire asset protection, involving a 40 metre clearance from any equipment with gas in it, and a 20 metre clearance for other plant items.

» The cooling tower location and orientation (at the northeast of the site) was determined by the prevailing wind direction to avoid cooling tower drift falling onto the switchyard and other electrical equipment. Sufficient free space has been allowed around the cooling tower to minimise restriction to the free flow of air to the tower.

» The electrical switchyard is located to the north of the main plant, as the transmission line corridor is planned along the main entry road, to minimise vegetation clearing and connect to the grid. A 20 metre clearance on either side of the transmission line is required for safety and access reasons.

5.6 Regional connections and transmission constraints

Integral Energy is the distribution network service provider responsible for the electricity network in the Nowra area. The distribution network on the south coast is supplied from TransGrid's (the NSW transmission network service provider) Dapto Supply Point. The main power supply voltage is 132 kilovolts, which is transformed to lower voltages for eventual distribution to electricity consumers in the area.

Integral Energy's main substation in Nowra is the Shoalhaven terminal station (located in Yalwal road near its intersection with Albatross Road). This substation supplies power locally to the Nowra region, as well as functioning as the connection point for power to other areas.

A transmission stability study was undertaken by HMA Consulting (refer Appendix B) to determine whether the proposal would comply with NEMMCO's minimum requirements, which govern connection of power stations to the NEM. The study was undertaken to ensure that:

» The electricity supplies in the network would not be disturbed by normal and abnormal power station operation; and

» The proposal would not be affected by abnormal occurrences in the electricity network.

The transmission stability study concluded that the proposal would exceed NEMMCO's minimum requirements and would not be affected by faults in the network.

5.7 Objectives and benefits of the proposal

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 initial development of a peaking facility would supplement electricity supply during times of peak demand. When demands rise, the facility would operate full time, feeding a constant supply of electricity into the national grid.

An additional objective is to balance the provision of additional electricity supply with the need to minimise the potential for environmental impacts.

Further benefits of the proposal include:

» Adding power to the electricity network at Nowra would help to improve the security of power supplies in the local area.

» Gas facilities provide an effective way of meeting peak demands.

» Opportunities for local employment, particularly during construction and stage two.

» Use of a redundant industrial site and, where possible, existing corridors for electricity supply, minimises the potential for development impacts.

» Combined cycle facilities have lower greenhouse gas emissions than conventional coal fired power stations.

» Removal of the existing 33 kilovolts transmission line between Bamarang and the Shoalhaven Terminal Station.

Chapter 6. Description of the proposal

6.1 Overview

Delta proposes to construct a gas fired electricity generation facility in two stages.

Stage one would involve the development of a peaking facility designed to operate during periods when the demand for electricity peaks. It would also involve development of a gas pipeline and an electricity transmission line. The pipeline would supply the proposed facility with gas from the Eastern Gas Pipeline. The proposed transmission line would transfer the electricity produced to the national electricity network.

The second stage would involve the addition of two heat recovery steam generators and a steam turbine to the facility to 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.

This chapter describes the process of electricity generation in stage one and stage two. It also describes the key elements of the proposal, including the major equipment items and infrastructure requirements for stage one and stage two, details of auxiliary infrastructure and systems, and provides relevant background information for both construction and operation.

Figure 6.1 provides a schematic of the process.

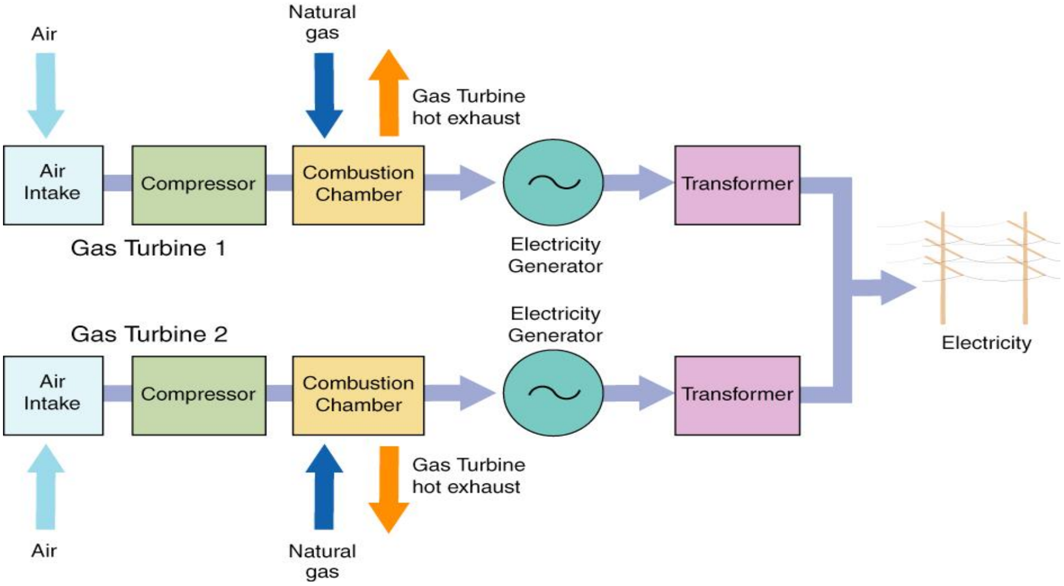
6.1.1 Peaking facility - open cycle configuration

The peaking facility would service peak demands in the electricity supply cycle. The peaking facility would operate in an open cycle configuration, whereby electricity is generated by the combustion of natural gas in gas turbines.

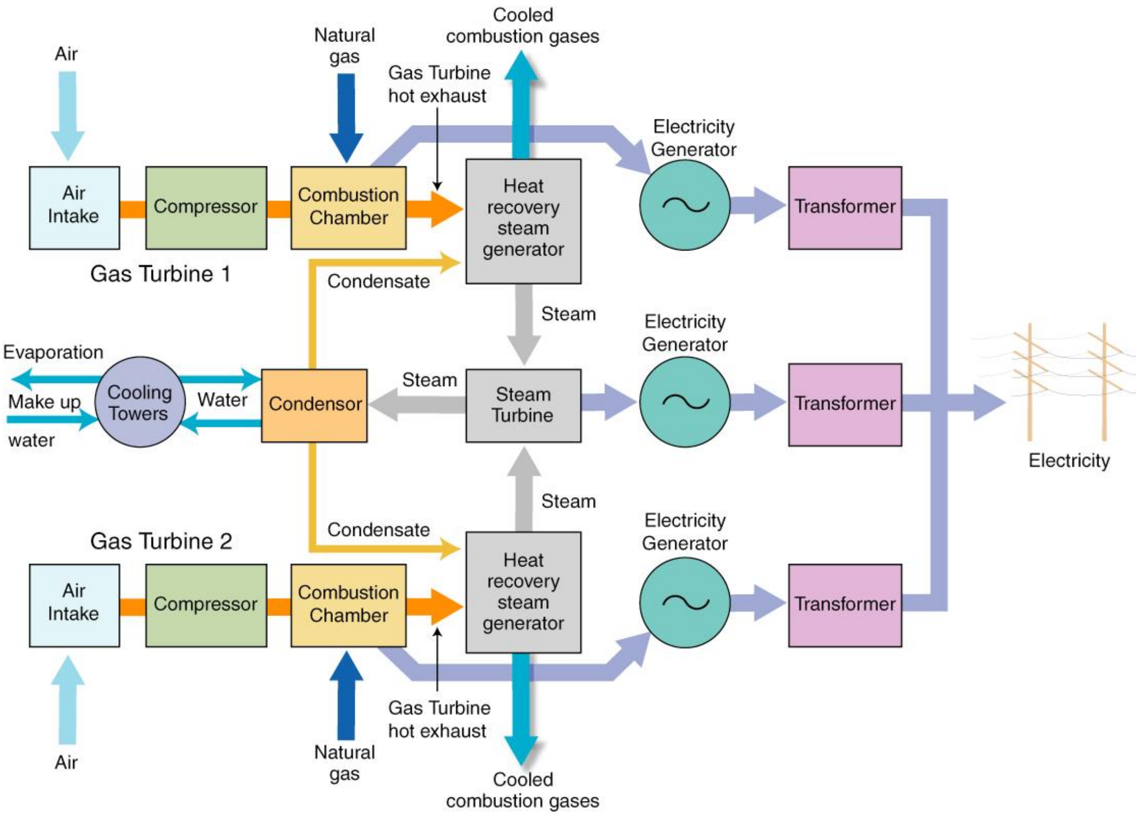
The gas turbine unit consists of a compressor, combustion chamber, turbine and generator. Air is compressed to a high pressure before being admitted into the combustion chamber. Fuel (natural gas) is injected into the combustion chamber where combustion occurs at very high temperature. The resulting mixture of hot gas is admitted into the gas turbine where the hot gases expand. The expansion of the hot gases converts heat energy into power by causing the turbine to turn. In the open cycle configuration, hot exhaust gas is vented directly to atmosphere through the exhaust stack, without heat recovery.

Typically about 50 percent of the power produced by the turbine is used to drive the compressor, with the rest converted into electricity by the generator coupled to the gas turbine.

The generators produce electricity at around 14 kilovolts and this would be stepped up to 132 kilovolts through a generator step-up transformer. The electricity would then travel off site to the Shoalhaven Terminal Station via the proposed transmission line (see section 6.2.4), where it would enter the regional electricity distribution system.



Stage one peaking facility, open cycle configuration



Stage two base load facility – combined cycle configuration

Figure 6.1 Process schematics

6.1.2 Base load facility – combined cycle configuration

Open cycle gas turbines produce heat, in the form of hot exhaust gases, as well as electricity. In combined cycle facilities, the hot exhaust gases (typically in the range of 540-550 degrees Celsius) are used in the heat recovery steam generator to produce steam. This steam is then used to drive a steam turbine generator to generate additional electricity. Combined cycle facilities have higher thermal efficiency (typically 50 % or more) due to the recovery of heat energy in the exhaust of a gas turbine.

Waste steam from the steam turbines would be directed to a cooling system where it would be condensed by transfer of heat to a cooling medium.

6.2 Stage one – peaking facility

Stage one involves the installation of two gas turbines in an open cycle configuration, and construction of associated infrastructure, including facilities required on site and the proposed pipeline and proposed transmission line.

6.2.1 On site facilities

For stage one, the following facilities would be installed on site:

» Two gas turbines, each with a capacity of approximately 140 megawatts – the turbines have a height of approximately 18 metres each, and include exhaust stacks (up to 40 metres in height each);

» Step-up transformers to convert the generator output to 132 kilovolts for transmission to the Integral Energy network;

» 132 kilovolts switchyard containing electrical equipment for connection to the Integral Energy transmission lines;

» Installation of a fuel gas supply system, incorporating gas metering and regulating station, piping to deliver fuel gas to the turbines, and emergency shutdown systems;

» Electrical and control building used to monitor the operation of the facility;

» A single storey administration building, including staff offices, meeting room, lunchroom and toilets; and

» Civil works such as roads, car parking area and site drainage.

In addition to these facilities, stage one involves the construction of the proposed pipeline and transmission line.

Figures 6.2 and 6.3 show the proposed conceptual layout of the major components to be provided as part of stage one.

6.2.2 Description of major equipment items – stage one

The following major equipment items would be installed during the development of stage one.

Open cycle gas turbine units

The gas turbines would be of the stationary type, heavy-duty industrial design, with direct driven generators suitable for use in both open and combined cycles. The unit and auxiliary equipment would be supplied with a freestanding noise enclosure and acoustic silencers. The gas turbine generators would be located outdoors. The gas turbine generator includes the following major components:

- Air intake silencing and filters;
- Compressor;
- Turbine;
- Generator;
- Fuel gas system (not the gas pipeline);
- Low NOx combustion system;
- Fire protection and detection system;
- Bypass stack/exhaust; and
- Unit acoustic enclosure/s.

Step-up transformers

Step-up transformers would be located between the generators and the switchyard. These provide the means to step up the generator terminal voltage to the substation voltage for power transmission. Dedicated transformers would be provided for each gas turbine and the steam turbine (during stage two). Each transformer would be set on a concrete pad. Oil containment would be provided. Drainage would be routed to an oil/water separator before release to the stormwater system.

Electrical switchyard

A 132 kilovolts outdoor switchyard would be located on site. The switchyard would connect the facility to the existing 132 kilovolts distribution network via the proposed transmission line. The switchyard would have electrical equipment such as circuit breakers and associated equipment such as voltage and current transformers, isolators and earthing switches installed. Each piece of equipment would be installed on concrete footings. The switchyard would be covered with crushed rock such as blue metal and securely fenced to prevent unauthorised access.

It is noted that Delta intends to subdivide the land occupied by the switchyard from the site, to enable it to be owned by Integral Energy.

Fuel gas system

The fuel gas system would be sized based on the maximum continuous gas consumption of the facility. The estimated fuel gas usage is 3,500 gigajoules per hour of operation.

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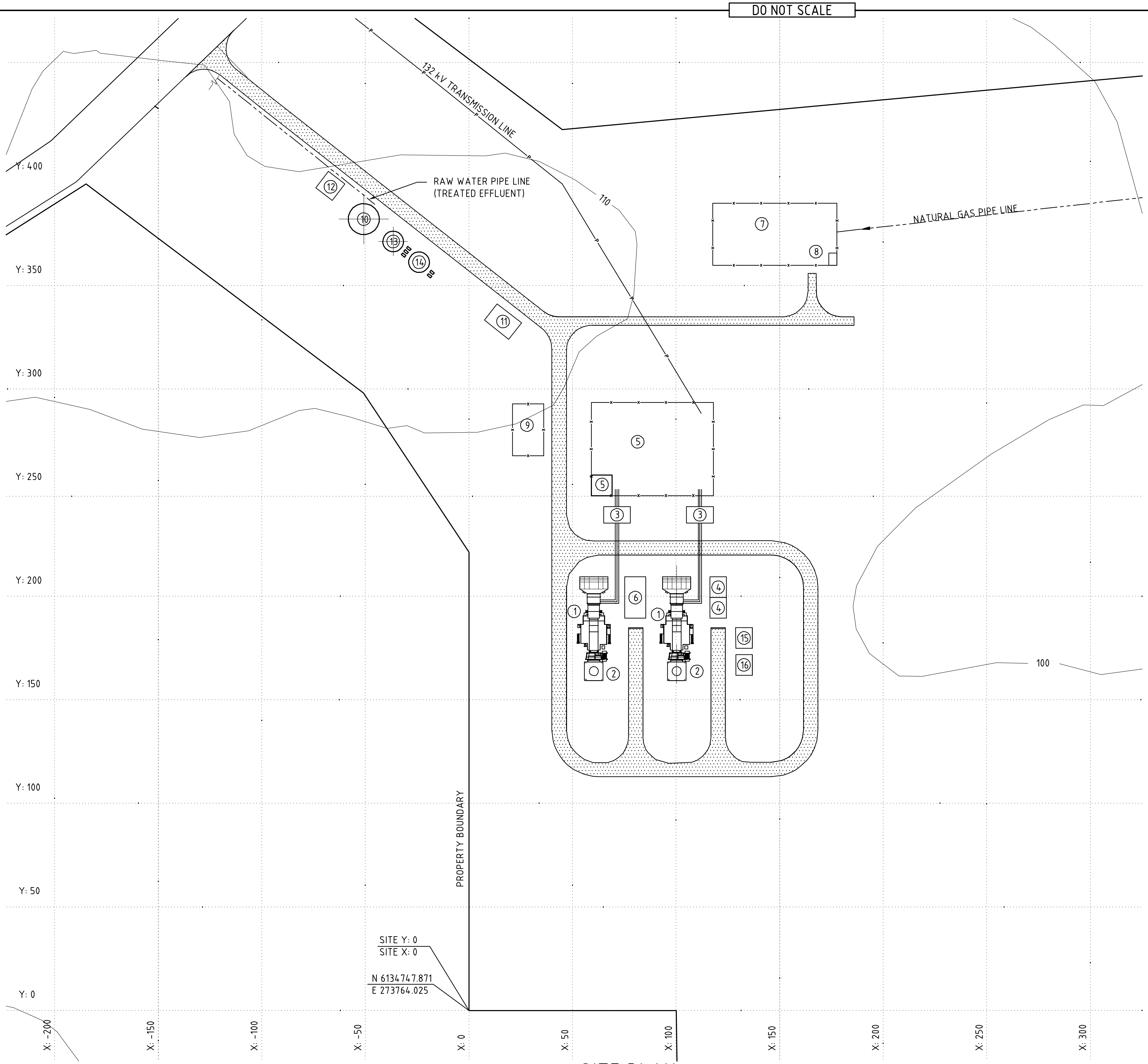

SITE PLAN
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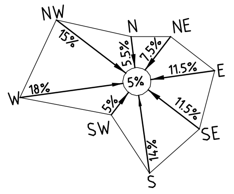
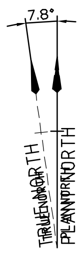
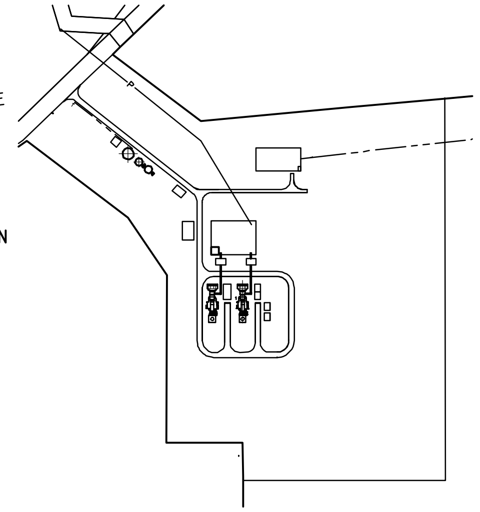


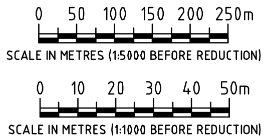
AVERAGE WIND DIRECTION
(ANNUAL)





KEY PLAN
SCALE 1:5000

ITEM NUMBER	DESCRIPTION
1	GAS TURBINE GENERATOR
2	BYPASS STACK
3	GAS TURBINE GENERATOR STEP UP TRANSFORMER
4	UNIT AUXILIARY TRANSFORMER
5	132 kV SWITCHYARD AND SWITCHYARD CONTROL ROOM
6	GAS TURBINE GENERATOR MAIN CONTROL AND ELECTRICAL ROOM
7	GAS METERING AND REGULATING STATION
8	GAS METERING STATION CONTROL ROOM / STORE ROOM
9	GAS CONDITIONING SKID
10	SERVICE WATER TANK
11	ADMINISTRATION BUILDING
12	SECURITY GATE HOUSE
13	FIRE WATER TANK AND PUMPS
14	DEMINERALISED WATER TANK AND PUMPS
15	EFFLUENT COLLECTION TANK AND PUMPS (TO BE RELOCATED IN STAGE 2)
16	OIL/WATER SEPARATOR (TO BE RELOCATED IN STAGE 2)



PRELIMINARY
NOT FOR CONSTRUCTION

No.	Drg.No.	REFERENCE	No.	REVISION	DRN.	CHK.	APP.	DATE
			A	ISSUED FOR CLIENT REVIEW				

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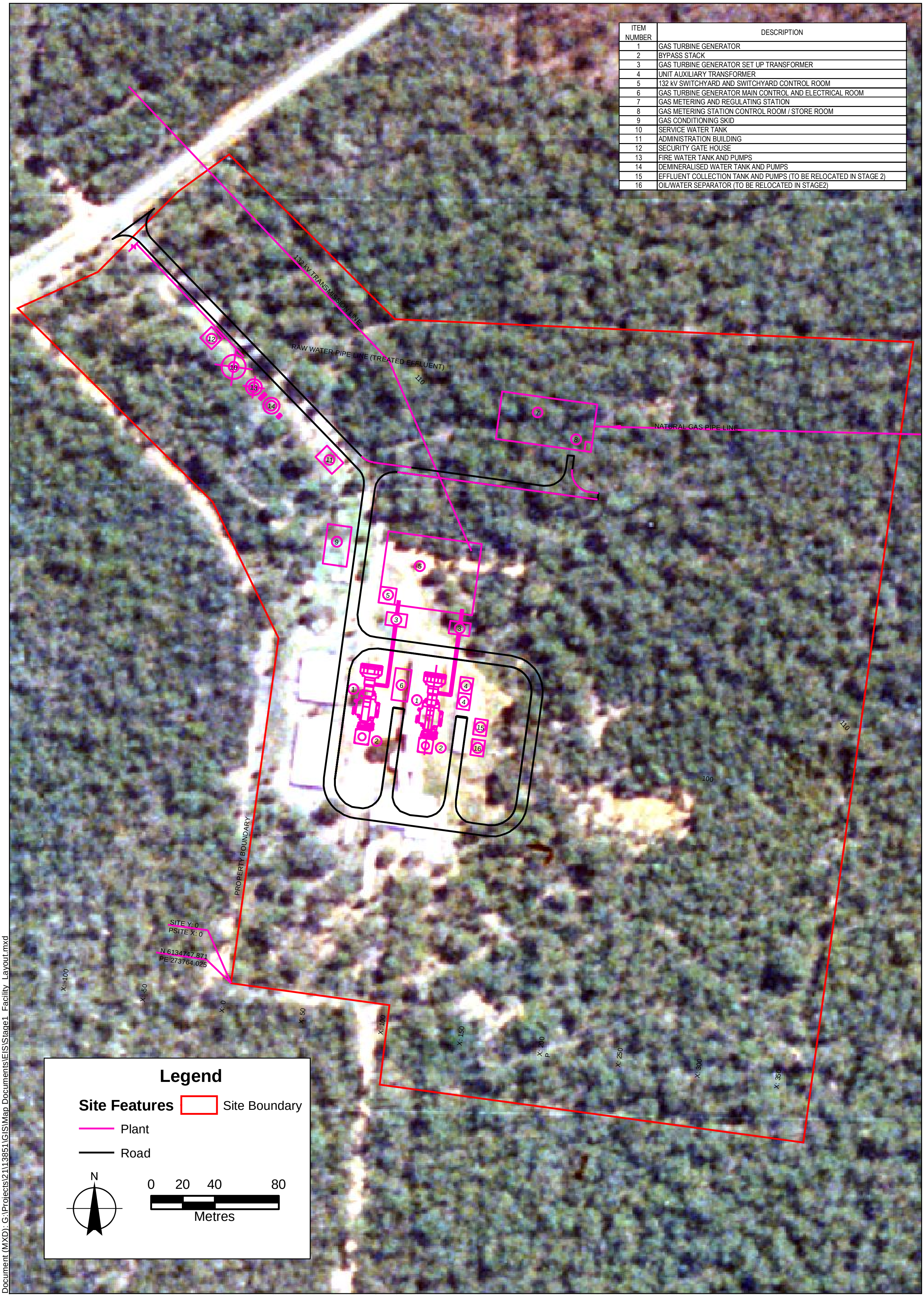
Drawn: M.PENDLEBURY | Designed: S. MADHUSUDANAN
Drafting Check | Design Approved
Customer Approved | Date

This Drawing must not be used for Construction unless signed as Approved

Drawing Title
DELTA ELECTRICITY
400 MW COMBINED CYCLE POWER PLANT - BAMARANG
FACILITIES LAYOUT - STAGE 1

Scale: AS SHOWN | Drg. No. FIGURE 6.2 | Sheet Size A1



ITEM NUMBER	DESCRIPTION
1	GAS TURBINE GENERATOR
2	BYPASS STACK
3	GAS TURBINE GENERATOR SET UP TRANSFORMER
4	UNIT AUXILIARY TRANSFORMER
5	132 kV SWITCHYARD AND SWITCHYARD CONTROL ROOM
6	GAS TURBINE GENERATOR MAIN CONTROL AND ELECTRICAL ROOM
7	GAS METERING AND REGULATING STATION
8	GAS METERING STATION CONTROL ROOM / STORE ROOM
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16	OIL/WATER SEPARATOR (TO BE RELOCATED IN STAGE2)

Document (MXD): G:\Projects\21\13851\GIS\Map Documents\EIS\Stage1_Facility_Layout.mxd

Figure 6.3 Stage One - Site Layout

The system would incorporate pressure metering and a regulating station for the management of gas supply to the turbines. Gas supplied to the site would enter the fuel gas system at the regulating station. On entering this station, natural gas would flow through a gas conditioner where it would be filtered and separated to remove particulates and liquids, preheated, and then pressure regulated to the supply pressure required for operation of the gas turbines.

An emergency shutdown valve would be installed in the gas compound to shut off the fuel supply in the event of an emergency.

The natural gas supply installed for stage one would not need augmentation for stage two, as the two gas turbines installed as part of stage one would remain, and the additional equipment installed as part of stage two relates to the generation of additional electricity using steam.

Equipment selection

For both stage one and two, major equipment items would be selected following a competitive tendering process during the detailed design phase. It is expected that the items selected would be 'off the shelf' units, provided by dedicated manufacturers.

Equipment items would be evaluated and selected on the basis of proven efficiency and reliability, and demonstrated conformance with the specifications. The specifications provided to prospective equipment suppliers would dictate the technical and environmental performance that the equipment items would be required to meet, based on Delta's operational requirements and the conditions of consent for the proposal.

6.2.3 Proposed pipeline

Stage one also involves construction of a new 150 millimetre diameter underground high-pressure pipeline connected to the Eastern Gas Pipeline. The preferred option for connection to the Eastern Gas Pipeline would be a new hot tap connection on the main pipeline at the closest point to the site (approximately 600 metres east).

The pipeline is proposed to be located in a 10 metre wide easement to be acquired over the land in which it would be located (owned by Council). It would be buried for most of its length to a depth varying between 0.75 to 1.2 metres, except at the entry and exit points.

On the site, the pipeline would terminate and connect the fuel gas system at the pressure regulation and metering station.

Approximately 0.9 hectares of existing vegetation would need to be cleared to construct the pipeline – approximately 0.3 hectares within the site, and 0.6 hectares along the new easement.

The Eastern Gas Pipeline is owned and operated by Alinta. A copy of correspondence received from Alinta is provided in Appendix C.

6.2.4 Proposed transmission line

Electricity generated at the site would be delivered to the national electricity grid via the proposed 132 kilovolts electricity transmission line. The proposed transmission line would connect to the site at the high voltage electricity switchyard. The line would run above ground until east of Flat Rock Creek, where it would then run underground to the Shoalhaven Terminal Station.

The overhead lines would be constructed to current Integral Energy requirements. The lines would be installed on concrete poles (refer Figure 9.2), which would include standoff polymer insulators and aluminium conductors.

It is estimated that a maximum of approximately 2.8 hectares would need to be cleared for the proposed transmission line. The total amount would be determined as an outcome of the detailed design process. The actual location of the poles and their height depends on terrain features and orientation. Typically, the poles would be approximately 20 metres high, and located approximately 100 metres apart. If the poles are located closer together the width of the corridor could be reduced and this would be determined during the detailed design process by Integral Energy.

Two circuits would be required to export the power produced. It is proposed to place both circuits on the one line, that is, a single pole double circuit line (lines located on both sides of the pole).

Proposed route

Key features of the proposed route are summarised in Table 6.1.

The proposed route would extend north from the site across Yalwal Road and through Crown land (and a small section of private land) to meet the existing cleared transmission route located in the Bamarang Nature Reserve. The transmission lines would then continue along this existing corridor (located to the north of, and parallel to, Yalwal Road) through the Bamarang Nature Reserve. This route is considered to be preferable to a route running along Yalwal Road, as it would make use of the existing cleared corridor, minimising the amount of additional clearing that would be required. The corridor finishes near the intersection of Flat Rock and Yalwal Roads. The lines would travel along the south side of Yalwal Road (an easement, within the existing road easement, would be acquired) until east of Flat Rock Creek.

From east of Flat Rock Creek, the lines would run underground to the Shoalhaven terminal station. The underground lines would be located at least 900 millimetres below the surface in the road reserve. Some vegetation clearance would be required for the above ground sections of the route (refer Table 6.1).

The proposed transmission route follows the existing 11 kilovolts and 33 kilovolts lines. No formal survey of the Yalwal Road corridor exists. There is agreement between Shoalhaven City Council and the National Parks and Wildlife Service that the road corridor extends 20m either side of the centreline of the existing road pavement. It is proposed that the transmission line alignment along Yalwal Road would be located 10m to the south of the centreline of the road pavement from Flat Rock Creek to Cabbage Tree Lane. This would keep the transmission corridor wholly within the road reserve, avoiding easement requirements over Nature Reserves and crown land, and move the transmission line away from the existing road, improving road safety. The existing 11 kilovolts lines and poles would be removed and new 11 kilovolts lines would be provided on the proposed transmission 132 kilovolts line. The existing 33 kilovolts lines (connecting to the site) would be removed and a new 33 kilovolts line would be provided from the site to reconnect to the 33 kilovolts line that currently supplies Burrier from Nowra.

A formal connection enquiry under the National Electricity Code has been made by Delta to Integral Energy for the connection of proposed facility to the electricity grid. Integral Energy has written to Delta (refer Appendix C) to advise that connection is acceptable in principle, and to outline the next steps in the process. This involves Integral Energy and NEMMCO carrying out further studies to allow formalising of connection applications and operating procedures.

6.3 Stage two – base load facility

Stage two involves the conversion of the open cycle facility developed in stage one, to a combined cycle facility. In stage two, steam turbine generators would be fitted to the existing gas turbine generators to increase the efficiency of electricity generation for constant (base load) generation.

The capital cost of the combined cycle facility is higher than that of an open cycle facility. However, due to the energy recovery and the higher efficiencies, the operating cost per unit of electricity produced is lower.

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 turbines;
- Steam piping;
- Steam generator step-up transformers;
- 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 currently proposed as the preferred cooling medium; and
- Associated civil works.

Stage two would not involve any further offsite development.

Figures 6.4 and 6.5 show the proposed conceptual layout of the major components to be provided as part of stage two.

Table 6.1 Key features of the proposed electricity transmission line

Section (corridor width/length)	Location characteristics	Existing transmission line status	Land ownership	Corridor/acquisition characteristics	Estimate of total clearing required (hectares) and approx dimension
Site to Yalwal Road	Located on site	11 kilovolts line would be retained for construction and removed for operation.	Delta	Corridor would be 25 metres wide, 250 metres long; acquisition required.	0.5 (20 x 250 metres)
Yalwal Road to the existing corridor through Crown Land	Follows existing roadway	11 kilovolts line would be retained for construction and removed for operation	Crown land	Acquisition of an easement of 28 metres wide and 400 metres long would be required.	0.5 (13 x 400 metres)
Along existing corridor to the intersection of Flat Rock/Yalwal Roads	Along existing transmission line and water line corridor through (predominantly) Bamarang Nature Reserve	33 kilovolts line would be removed	Private land, NPWS land, Aboriginal owned land and Crown Land	Acquisition from landowners required. The existing cleared corridor is approximately 28 metres wide and 2.3 kilometres and no further clearing is planned.	Nil
Flatrock/Yalwal Road intersection to Cabbage Tree Lane	Travels along the south side of the road within the cleared road corridor.	11 kilovolts line would be relocated to the 132 kilovolts line	Council road corridor and private land	Within existing easement (approximately 10 metres wide) within private property.	0.1 (10 x 125 metres)
Cabbage Tree Lane to George Evans Road (university access)	Travels along the south side of the road adjacent to Crown Land	11 kilovolts line would be relocated to the 132 kilovolts line	Council road corridor	Council is proposing to widen the road corridor to 40 metres. Within this corridor, a section 8 metres wide for a distance of 1.4 kilometres would need to be cleared. No easement is required within the road corridor.	1.1 (8 metres x 1.4 kilometres)
George Evans Road to east of Flat Rock Creek	Travels along south side of the road adjacent to Triplarina Nature Reserve	11 kilovolts line would be relocated to the 132 kilovolts line.	Council road corridor	A section 8 metres wide for a distance of 0.7 kilometres would need to be cleared. No easement is required within the road corridor.	0.6 (8 metres x 0.7 kilometres)

Section (corridor width/length)	Location characteristics	Existing transmission line status	Land ownership	Corridor/acquisition characteristics	Estimate of total clearing required (hectares) and approx dimension
East of Flat Rock Creek to substation	Underground	-	Within Council road corridor	No easement required within the road corridor.	Nil
TOTAL					2.8

6.3.1 Description of major equipment items – stage two

The following major equipment items would be installed during the development of stage two.

Combined cycle gas turbine units

The major additional components of a combined cycle plant are:

- Heat recovery steam generators;
- Steam turbines;
- Cooling system (water cooled condenser); and
- Water treatment plant.

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 discharged to atmosphere through the exhaust stack.

Steam turbines

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 cooling system (a condenser).

Cooling system

A water-cooled condenser is proposed for the facility at Bamarang. Warm water from the condenser would be cooled using a mechanical induced draft wet evaporative type cooling tower, which exhausts the heat directly to the atmosphere. The loss of water due to evaporation, drift and blowdown would be replenished with make-up water. The location and orientation of the cooling tower has been chosen taking into consideration the prevailing wind direction to avoid cooling tower drift falling onto the switchyard and other electrical equipment. Sufficient free space has been allowed around the cooling tower to minimise restriction to the free flow of air to the tower.

Condensate would be pumped from the condenser back to the heat recovery steam generator.

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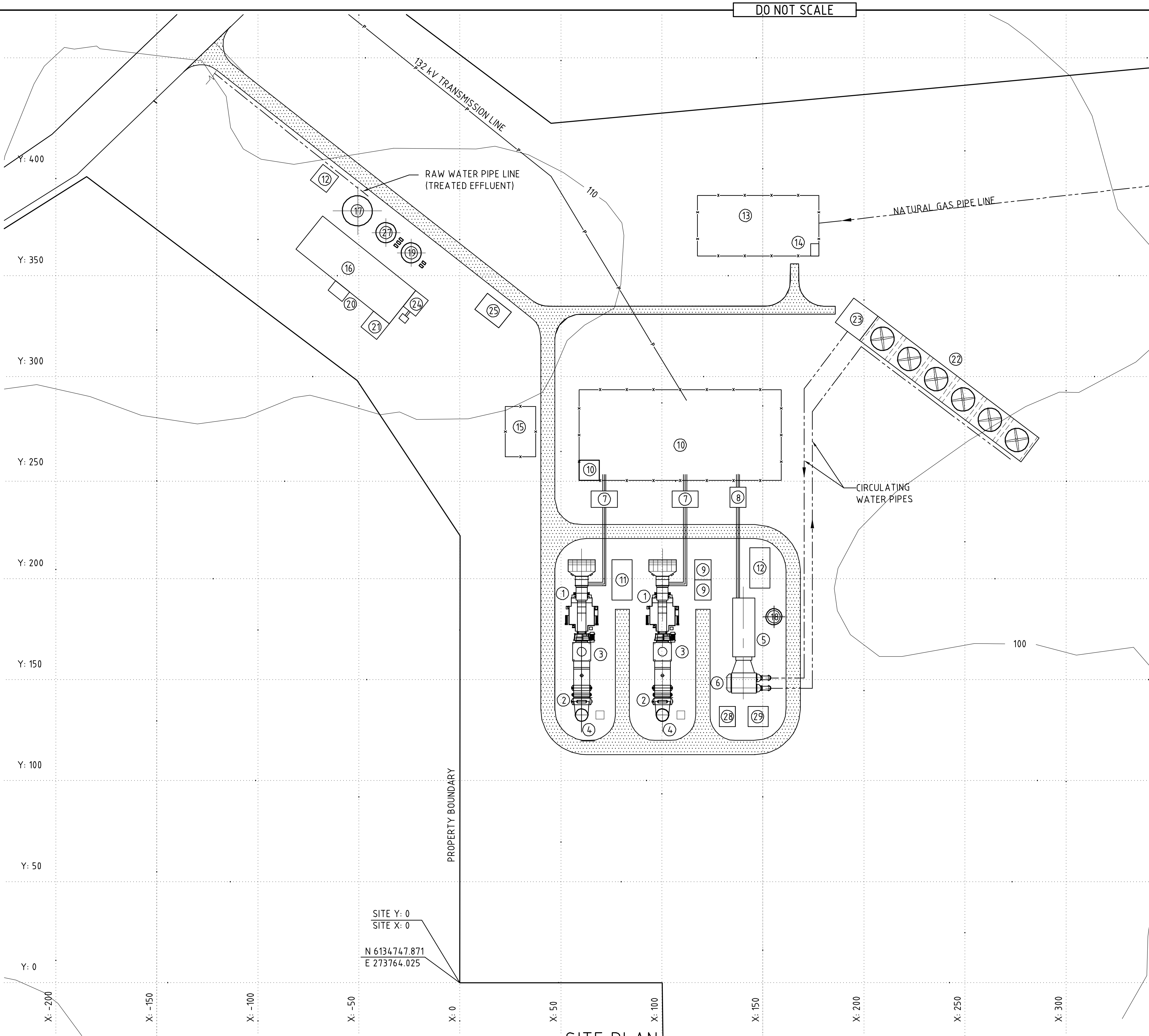

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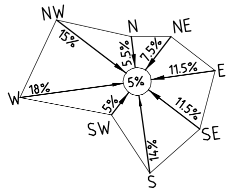

AVERAGE WIND DIRECTION
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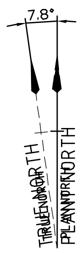

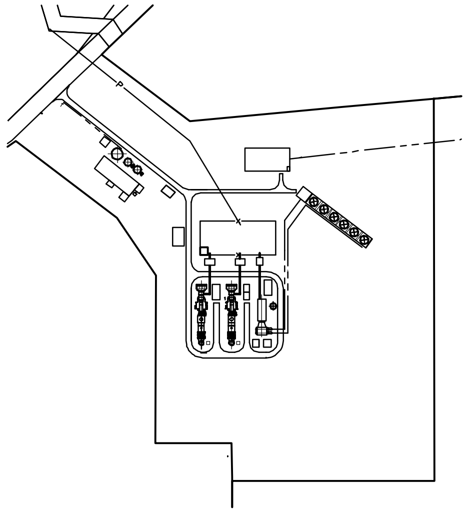

KEY PLAN
SCALE 1:5000

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	WATER 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	INDUCED DRAUGHT COOLING TOWER
23	CIRCULATING WATER PUMPS
24	COOLING TOWER AND 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

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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.	Drg.No.	REFERENCE	No.	REVISION	DRN.	CHK.	APP.	DATE
			A	ISSUED FOR CLIENT REVIEW				

GHD - BLACK & VEATCH PTY LTD
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Project Number

Drawn: M.PENDLEBURY
Designed: S. MADHUSUDANAN
Drafting Check
Design Approved
Customer Approved
Date

This Drawing must not be used for Construction unless signed as Approved

Drawing Title
DELTA ELECTRICITY
400 MW COMBINED CYCLE POWER PLANT - BAMARANG
FACILITIES LAYOUT - STAGE 2

Scale: AS SHOWN
Drg. No.: FIGURE 6.4
Sheet Size: A1

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

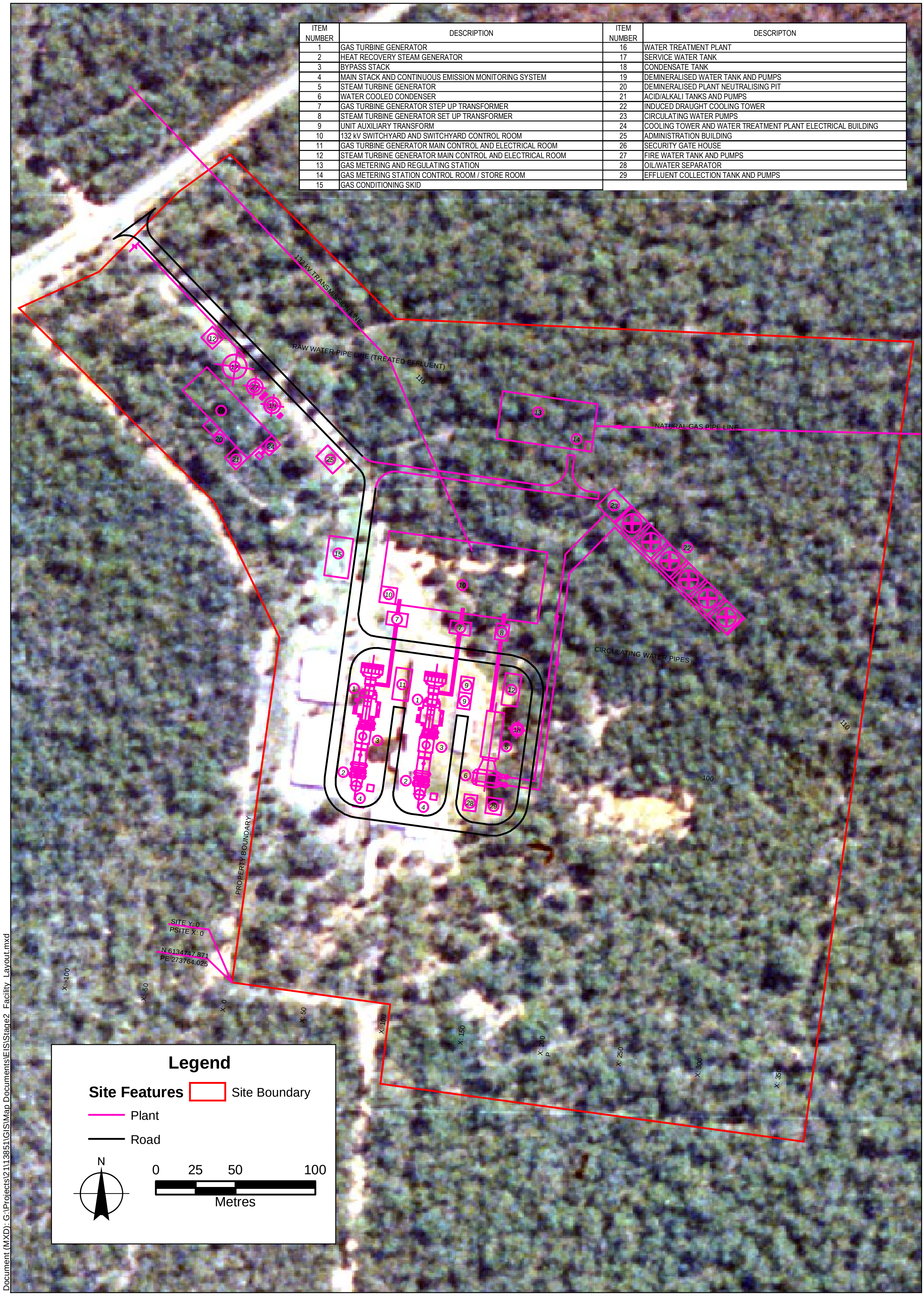

Figure 6.5 Stage Two - Site Layout

Water treatment plant

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. A reverse osmosis treatment plant is proposed. Pre filtration would be employed upstream of the treatment plant.

Output from the treatment plant would be fed into an ion exchange plant and the resultant demineralised water would be used as feedwater for the steam cycle and miscellaneous other uses such as inlet air evaporative coolers. A brine concentrator and dewatering facility would be included to recover water.

The precise means of water treatment would be finalised during the detailed design process, and would be determined by the condenser and cooling tower manufacturer's requirements.

Aboveground tanks would be used to store sufficient water on site for at least two continuous days of operation.

6.4 Auxiliary facilities

6.4.1 Water

Usage requirements and proposed water infrastructure

A water cycle assessment was conducted for the proposal (refer to Appendix G). The results of the assessment are discussed in Section 8.5. A brief overview of key facilities proposed is provided below.

In stage one, water would be required for domestic uses, such as building amenities and grounds maintenance. Approximately 0.2 meglitres per annum would be required. In stage one the plant and equipment requires only minimal water for use in the inlet air evaporative cooler. The total annual usage is estimated to be approximately 2 megalitres per annum. It is proposed that this water would be sourced from the Nowra potable water supply, originating at the treatment plant at Bamarang Reservoir. Approval for the construction of the water supply pipeline would need to be sought separately.

In stage two, water would be required for the process (approximately 8.4 megalitres 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.

The preferred source of water for these process uses is industrial effluent.

Non-process water requirements would include domestic uses, similar to stage one. The total demand of domestic water for stage two is expected to be double that for stage one, approximately 0.4 megalitres per annum.

As a wet cooling process has been identified as the preferred technology for cooling, there would be a high net water demand for stage two, with an estimated daily demand of approximately 8.4 megalitres per day. The water (industrial effluent) received at the proposed facility would undergo minor treatment prior to entering the service water tank. This would likely involve a filtration process (with some chemical dosing) such as sand filters or dual media filters.

The two industrial sources of effluent identified for possible use include a treated effluent stream from Australian Paper (approximately 6 megalitres per day available) and a clear condensate stream of approximately 3 megalitres per day from Manildra Starches. It is noted that it is not intended to use the other wastewater stream (wash down water) from Manildra Starches as this stream would require more extensive treatment than the condensate stream.

While these streams are yet to be assessed in detail some pre-treatment of the Manildra Starches condensate may be required to reduce the chemical oxygen demand and grease and oil content, to avoid potential impacts on the water cycle of the facility or environmental impacts such as odours. The Australian Paper effluent is understood to be of a very high quality (BOD<7mg/L, TSS<15mg/L) and hence no additional treatment (beyond that noted above for all industrial effluent received at the plant) is likely to be required.

The process water for 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. A reverse osmosis treatment plant is proposed. Pre-filtration would be employed upstream of the treatment plant. Output from the treatment plant would be fed into an ion exchange plant and the resultant demineralised water would be used as feedwater for the steam cycle and miscellaneous other uses such as inlet air evaporative coolers. A brine concentrator and dewatering facility would be included to recover water.

The means of water treatment would be finalised prior to commencement of stage two, and would be determined by the condenser and cooling tower manufacturer's requirements. Approval requirements for any pipelines required would need to be determined at that time.

Aboveground tanks would be used to store sufficient water on site for at least two continuous days of operation.

Further information on water, including a water balance for the facility, is provided in Section 8.5.

Process wastewater

Water management at the site has been designed for minimal discharge and hence recycling of water would be undertaken.

No process wastewater would be generated in stage one. In stage two, process wastewater would be generated from:

» The demineralisation plant regeneration effluent (neutralised);

» Oil water separator output; and

» Brine concentrator rejects.

A total of approximately 50 m^3 per day of wastewater is likely to be generated during stage two. The process wastewater would initially be pumped to a holding tank prior to offsite disposal. 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).

Sewage

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

Surface water management

The on site drainage system would be segregated so that potentially contaminated surface run-off water would be separated from clean rainwater runoff.

Clean rainwater draining from roofs, paved areas and areas within the facility footprint where contamination is unlikely to occur would be directed to a water collection basin where suspended solids would settle out. A portion of the water would be diverted to storage tanks for re-use as part of the process.

Clean rainwater draining from undisturbed areas of the site would be diverted around the facility footprint.

Segregated drains would direct potentially contaminated water through oil and grit traps and a 'first flush' pit designed to remove any oil and minimise suspended solids to an acceptable level prior to discharge offsite.

Total offsite discharge of surface water (both clean and treated water) would be equivalent to current runoff volumes (that is, 48 megalitres per year). Any volumes above this (48 megalitres per year estimated) would be captured and stored for onsite reuse.

A full description of the surface water management system is provided in Section 8.5.

6.4.2 Power supply

Power required to operate the facility would be obtained from power generated at site. This would be achieved by changing the generated voltages to appropriate levels. When the facility is not operating a small amount of power would be required to maintain essential services. This would be obtained from a 33 kilovolts supply that would be installed to the site.

During construction, power would be supplied by the existing 11 kilovolts connection.

6.4.3 Chemicals

A list of chemicals likely to be used on site is provided in Table 6.2.

Chemicals would be stored in designated and secure bunded chemical storage compounds, designed and constructed in accordance with:

- Relevant Australian Standards:
  - AS 1940 (1993): The Storage and Handling of Flammable and Combustible Liquids;
  - AS 4452 (1997): The Storage and Handling of Toxic Substances;
  - AS 3780 (1994): The Storage and Handling of Corrosive Substances; and
- *Dangerous Goods Act 1975* and the Regulations.

Table 6.2 Chemicals list

Chemical	Quantity	Use	Where used?	Which stage?
Acetone	100 litres	Cleaning solvent	Throughout the facility	1&2
Ammonia (NH_3)	As required	Boiler water treatment	Steam turbine	2
Antiscalant (phosphonate based)	2000 litres	Water treatment	Water treatment plant/brine concentrator	2
Calcium Sulphate Seed	1000 kilograms	Brine concentrator	Brine concentrator	2
Caustic (eg NaOH)	20,000 litres	Demineraliser resin regeneration and neutralisation / reverse osmosis membrane cleaning	Water treatment plant	2
CO_2 / Inergen / FM200	As required	Fire protection	Throughout the site	1&2
EDTA 10% Solution	2000 litres	Reverse osmosis membrane cleaning	Water treatment plant	2
Ethylene Glycol	1000 litres	Cooling system - freeze protection	Cooling system	2
Hydrazine (N_2H_4)	200 litres	Boiler water treatment / O2 scavenger	Steam turbine	2
Hydrogen	As required	Cooling of gas and steam turbine generator units	Gas turbine & steam turbine building	1&2
Insulating oil	1000 litres	Transformers	Bulk oil storage	1&2
Miscellaneous oils and lubricants	1000 litres	Lubrication of caustic and acid pumps, fire water pump, transformer pumps.	Water treatment plant, fire water pump station and switchyard	1&2
Morpholine	200 litres	Condensate treatment	Steam turbine building	2
Reagents for chemical laboratory	50 kilograms	Chemicals used in water testing laboratory	Laboratory	2
SAE W 40	600 litres	Diesel fire pump lubricant	Chemical store	1&2
Sodium Hypochlorite (12.5% available Chlorine)	3000 litres	Reverse osmosis cleaning, cooling systems	Water treatment and cooling system	2
Sulfuric Acid (H_2SO_4)	20,000 litres	Demineraliser resin regeneration and neutralisation / reverse osmosis membrane cleaning	Water treatment plant	2
Trisodium Phosphate (Na_3PO_4)	100 kilograms – bulk chemical	Boiler water treatment and pH control	Steam turbine building	2

Chemical	Quantity	Use	Where used?	Which stage?
	storage			
Turbine oils	1000 litres – bulk chemical storage	Lubrication of turbines and pumps	Turbine building	1&2

6.4.4 Waste management

General approach to waste management

The general approach to managing wastes generated onsite from construction and operation of the proposal would be based on the waste management hierarchy:

Avoid à Reuse à Recycle à Dispose

Wastes that are difficult to manage would be avoided where possible. Also, where practicable materials would be reused onsite, suitable surplus materials would be recycled and residuals disposed in an environmentally responsible and safe manner.

All waste would be classified and managed/disposed of in accordance with the EPA's (1999) *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes.*

Construction

During the construction phases, a range of solid wastes is likely to be generated, including:

- Demolition waste from the removal of the existing abattoir building – concrete, metals and other construction materials.
- Vegetation and surplus soils from preparatory clearing.
- Soils from the bulk earthworks – from site grading.
- Packaging waste – wooden pallets, cardboard and plastics.
- Scrap metals from construction and plant assembly activities.
- General waste from construction personnel – cans, paper, plastics and food scraps.

Demolition wastes would be segregated and appropriate material would be retained and reused onsite, any surplus recyclable demolition waste would be sent to a local construction and demolition receival facility. Suitable facilities would be selected from the Resource NSW (2003) *Construction & Demolition Recycling Directory - Illawarra/Shoalhaven Edition*. Several facilities in the local area or further north in the Illawarra/Wollongong region would be suitable.

Furthermore, appropriate scrap metal recyclers are located further north in Wollongong, however local Council waste and recycling depots are also suitable. Scrap metal generated from the construction works would be sent to one of these facilities.

Any surplus soil with suitable properties from earthwork activities would be reused as engineering fill on site or, where unsuitable for this purpose, would be retained for landscaping.

Wood waste and green waste from clearing of vegetation would be reused on site where practicable (for landscaping mulch) and surplus would be disposed of at one of the Shoalhaven Council operated waste depots (that accept green waste) such as the West Nowra waste and recycling depot or other suitable sites such as the Soilco Nowra which accepts large quantities of wood and green waste for a fee. The majority of the wood and green waste is expected to be generated during stage one of construction, as more vegetation would need to be cleared in this stage.

Other recyclable materials and non-recyclable materials would be sent for disposal at a local Council operated waste receival facilities such as the West Nowra waste and recycling depot.

Operation

The main solid wastes generated would include:

» Normal domestic and commercial waste from site personnel – paper, plastics, cans, food scraps.

» Waste from maintenance activities – oily rags, packaging materials, dust/rust particles, cleaning cloths and materials etc.

General waste generated from the normal operation and maintenance procedures at the site is not expected to exceed approximately 10 tonnes per annum.

Garbage and recycling bins would be placed around the site, particularly in locations where site personnel are expected to frequent.

Recyclable food and beverage containers such as aluminium, plastic and glass and recyclable packaging and other materials would be segregated from non-recyclable wastes where practicable and stored short-term on site. These wastes would be periodically removed by a local licensed contractor for either recycling or disposal (depending on suitability) at one of the Shoalhaven's licensed waste or recycling facilities – most likely the waste and recycling facility in West Nowra.

Other wastes

As noted in Section 6.4.1, a total of approximately 50 m^3 per day of wastewater would need to be disposed of during stage two.

6.4.5 Emergency systems

Fire protection

The fire and explosion protection system provides fixed water suppression systems, standpipes and hose stations, hydrants, monitors, clean agent systems, escape means, passive protection fire extinguishers, fire and gas leak detection systems and fixed carbon dioxide suppression systems to protect the plant buildings, equipment, and personnel in the unlikely event of fire or explosion. The gas turbines would be fitted with fire detection and suppression systems.

Emergency response plan

An emergency response plan would be prepared for the facility to address construction and operational stages.

The plan would detail the measures for both site and local evacuation procedures. A copy of the plan would be provided to the local State Emergency Service and the fire brigade. All personnel would attend an induction before commencing work and be involved in routine emergency training exercise.

6.4.6 Security

The purpose of the security systems is to preserve personnel, process, equipment, and facilities and prevent interference with operations by implementing a set of integrated systems that permit:

- Early detection of any incident or intent of incident;
- Delay the incident or intent of incident as much as possible; and
- Supply measures and support to the security personnel to counteract the incident or intent of incident and neutralise the risk.

These three aspects are of equal importance and interdependent. Commercially available security systems would be put in place to cover these aspects. Security operations would include:

- Site lighting designed to ensure that light overspill to areas outside the boundaries of the facility is minimised;
- Fencing around the entire site;
- Locked gates at the entrance to the site;
- CCTV monitored from the control room; and
- Additional fencing and security around individual components, such as the switchyard and chemical storage.

6.5 Construction

The construction and operational timetable for the proposal would be dependent on growth in the electricity demand and economic factors. Stage one and stage two would be constructed in time to meet demand, subject to economic factors including fuel and equipment price, labour costs and the exchange rate.

6.5.1 Construction activities

Construction activities would include:

- Clearing – some expansion of the existing cleared area on site would be required for components associated with the operation of the proposal and the asset protection zones (refer Section 8.4). For the pipeline and power transmission line construction some clearing is required along the proposed routes as described above.
- 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 buildings and facility components – prefabricated components would be imported and erected onsite.
- Gas pipeline construction – excavation works would be undertaken to install the gas pipeline during stage one. Construction would involve clearing the easement, trenching, stringing and

welding the pipe, lowering the pipeline into the trench, and backfilling the trench. Once installed the pipeline would be pressure tested for leaks by filling it with clean water.

» Transmission lines – existing lines and poles would be removed. Pre fabricated concrete poles would be installed along the transmission route in accordance with Integral Energy requirements. The transmission lines would be strung along the poles. The underground section would be installed by means of trench excavation and directional drilling.

6.5.2 Construction equipment

Major construction equipment types, purpose and estimated numbers are summarised in Table 6.3.

Table 6.3 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
Roller	Access road surface compaction	1

6.5.3 Construction duration and timing

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

The estimated duration of construction for stages one and two is 14 and 17 months respectively.

6.5.4 Workforce

The maximum construction workforce would for stage one and two would be approximately 150 and 300 respectively. 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 approximately 100 and 200 respectively.

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

6.6 Operation

6.6.1 Operating hours

For stage one, operating times and duration would depend on the requirements of the national electricity market. Operating hours to a maximum of 440 hours a year (approximately 55 days a year, for up to 8 hours a day) have been assumed for the purposes of the environmental assessment.

During stage two, operation would increase to a maximum of 24 hours a day, 365 days a year.

6.6.2 Employment

Operations during stage one would require approximately eight full time staff, most of which would be located off site.

The total employment for stage two would increase to 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.

6.6.3 Major maintenance

Scheduled maintenance would be undertaken during periods when electricity demand in the region 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.

During stage one, it is expected that the gas turbines would undergo inspections every 2-3 years with more extensive maintenance at 5 and 10 years. During stage two, 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.

6.7 Energy statement

Indicative values for the expected annual net energy consumption and electricity generation of are presented in Table 6.4.

Table 6.4 Estimated net energy consumption and electricity production

Operational mode	Stage one	Stage two
Power plant nominal output (megawatts)	280	400
Estimated total operating time factor per annum (%)	5% (440 hours)	90% (8,300 hours)
Fuel consumption per annum (petajoules) (gross heating volume)	1.3	24
Annual generation (gigawatts per hour, per annum)	120	3,300
Efficiency, %, (electrical to fuel gross heating volume)	33%	50%

Chapter 7. Alternatives to the proposal

7.1 Overview

Alternatives considered during development of the proposal included:

- » Sites for the location of gas power facilities;
- » Options for electrical connection;
- » Routes for the gas pipeline and electricity transmission; and
- » Alternative technologies to be employed as part of the proposal.

Further information on the alternatives considered is provided in the following sections.

7.2 Alternative sites

A range of possible sites for the location of a new gas turbine power facility was considered by Delta. The key selection criteria used to identify potential sites were:

- » Proximity to the high voltage electricity distribution system;
- » Proximity to the gas supply; and
- » Availability of water.

Other characteristics considered to be desirable included:

- » Availability of existing easements/corridors for electricity transmission;
- » Distance from built up areas;
- » Existing land use zoning permits the use for a power facility;
- » Development would not require significant amounts of large scale clearing (for on site uses or transmission); and
- » The size of the site permits the facility to be adequately buffered from surrounding land uses.

Nine sites were considered. A summary of the findings of the study, with comments on the sites considered, is provided in Table 7.1.

Table 7.1 Alternative sites

Site	Comments
Bamarang	Selected as one of three suitable sites and purchased in 2004. The reasons for selection are listed in Section 5.4.3.
Tomerong	Tomerong is a site owned by Transgrid for the location of a future substation connecting the 330 kilovolts network to the South Coast 132 kilovolts feeders. This substation would be required between 2010 and 2020 as load growth continues on the South Coast and the limitations of the 132 kilovolts systems are reached. Delta investigated this site for co-location of a gas power facility, however it is located in undisturbed bushland surrounded by National Parks.
Goulburn/Marulan Hill	This region has good access to the 330 kilovolts transmission infrastructure. A site was purchased in 2005 to be developed as an alternative gas turbine facility site pending gas price negotiations.
Tallawarra	Pacific Power sold the site at Tallawarra by a public tender process. Delta was unable to purchase rights to the site. This site was benchmarked due to its clear potential for gas-fired generation. The disadvantage of the Tallawarra site is a higher gas transportation tariff of $0.21/GJ than the Bamarang site. Approval was granted in 1999 for a 400 megawatts 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. It is in the same tariff zone as Bamarang but is far removed from any potential sources of water.
Wagga Wagga	The site at the Bomen industrial park did have prospects, as the 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 megawatts 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 kilovolts transmission substation, there are no immediate plans for a gas pipeline to be built. 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. Disadvantages of the site include the high cost of supplying gas to this location and the availability of sufficient gas for base load generation. A peaking facility is currently proposed for development 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 local council indicated that there would be concerns with adjacent land uses. Pacific Power used to own the site but disposed of it following disaggregation.

7.3 Options for electrical connection

Two options for connection to the high voltage electricity distribution network were considered:

- The 132 kilovolts lines located approximately 6 kilometres to the east of the site, with an existing substation providing opportunities for connection; and
- The 330 kilovolts lines located four kilometres to the west of the site.

Previous studies carried out by Delta indicated that connection to the 330 kilovolts lines (owned by TransGrid) would require the addition of a switching station near the 330 kilovolts lines or diversion of the 330 kilovolts lines to a switching station at the site. The report concluded that the transmission line construction would be technically possible but would be difficult as the terrain is very steep, with deep gullies and escarpments to cross. The line would also need to pass near the crest of a high hill where it would be visible for some distance.

The other option considered was connection to Integral Energy’s 132 kilovolts network. Advantages of this option included:

- Location of an existing substation providing connection opportunities; and
- Location of existing transmission corridors between the site and the substation, minimising the potential impacts of transmission construction.

Preliminary studies indicated that there was a constraint on the amount of power that could be connected to the network at this substation. The amount was expected to be approximately 400 megawatts, subject to confirmation by a stability study. The study commissioned by GHD (refer Appendix B) concluded that it was technically feasible to connect a 400 megawatts power facility to the 132 kilovolts network in this location. As a result, connection to the 132 kilovolts network was considered to be the preferred option.

Delta is a member of the esaa and adopts the esaa’s Policy Statement on Electric and Magnetic Fields. This includes a commitment to the ongoing monitoring of engineering and scientific research, including overseas policy developments and a commitment to the policy of prudent avoidance as endorsed by the esaa with regard to the location of assets and electric and magnetic fields.

7.4 Route options

7.4.1 Gas supply

Three options were considered for development of a pipeline to connect the proposed facility to the Eastern Gas Pipeline. The preferred option would be a new hot tap connection on the main pipeline at the closest point to the site (approximately 600 metres east).

The alternative option would involve connecting the pipeline to the existing gas sales tap within the Nowra main line valve station (approximately 1.5 kilometres north of the proposed hot tap connection). For this option, the pipeline would travel south from the main line valve station, along the existing pipeline easement (it would be constructed underground next to the existing pipeline), it would then travel west to meet the site in the same location as the preferred option. This option would be more expensive as a result of the additional length of pipeline that would need to be constructed. As a result, the hot tap connection is the preferred option.

Another option considered was to run the pipeline north from the site, and then east next to Yalwal Road. This option was rejected because it would require a larger amount of clearing.

7.4.2 Electricity transmission

Two options were considered for the location of the transmission lines between the site and the Shoalhaven terminal station. The preferred option, which forms part of the proposal, is described in Section 6.2.4.

The alternative option would travel along Yalwal Road between the site and the intersection of Flat Rock and Yalwal Roads, rather than along the existing corridor through Bamarang Nature Reserve.

Both routes are similar in length and are both are technically feasible to build. However, the section along Yalwal Road (between the site and the intersection of Flat Rock and Yalwal Roads) would require clearance of significantly more vegetation from the Bamarang Nature Reserve, as there is currently no cleared easement located along the road.

Another option would be to place the lines underground for the entire route. This option was not considered further as a result of the significantly higher costs involved (approximately 10 times the cost of overhead construction).

Placement of the transmission lines underground for the whole route is not proposed for the following reasons:

- Increased capital cost of approximately $12M;
- Increased maintenance costs due to limited access;
- Increased breakdown maintenance times due to limited access. Faults may take days rather than hours to clear impacting security of supply to the region;
- Directional drilling would be required underneath Flat Rock Creek Dam, Sandy Creek, Cabbage Tree Creek and the Eastern Gas Pipeline increasing costs and maintenance risks further;
- The transmission line uses existing easements along the edge of future urban expansion areas and would not limit urban development;
- The majority of the transmission easement borders nature reserves and crown land; and
- The life cycle of underground infrastructure is 15 years less than overhead transmission lines.

7.5 Alternative technologies

7.5.1 Configuration

Two options for the configuration of the 400 megawatts combined cycle facility were considered:

» A single 250 megawatts gas turbine with a single heat recovery steam generator and steam turbine; and

» Two gas turbines (with a capacity of 140 megawatts each) with two heat recovery steam generators and one or two steam turbines.

For the operation of the stage one (peaking) facility, the use of two smaller turbines rather than one larger one was preferred for the following reasons:

» The provision of two gas turbines would improve the reliability of supply;

» Integral Energy requires two turbines for network stability;

» The two machines would be able to operate independently of each other, started and run individually as demand dictates;

» The configuration is well proven for peaking facilities; and

» Although the two smaller turbines have a lower efficiency than a single large turbine, the part load efficiency can be higher. For example, if the demand is only 100 megawatts, then a single 140 turbine would operate more efficiently than the larger 250 megawatts turbine.

7.5.2 Cooling options

The stage two combined cycle configuration requires a cooling system to convert the exhaust steam to condensate for recycling through the heat recovery steam generator. There are three cooling options:

» A once through system in which water is drawn from a large water body such as ocean, river, lake etc and circulated through the condenser and returned to the source.

» A recirculating system with a water cooled condenser in conjunction with a wet mechanical draft cooling tower or natural draft cooling tower.

» An air cooled condenser (dry cooling)

A once through system was not considered as there is no large water body that would be available. The heat of the return water for once through systems also has the potential for environmental impacts on the receiving water body.

Disadvantages of dry cooling include:

» Large footprint required for the cooling tower, with more clearing required;

» Reductions in overall plant efficiency – uses more energy;

» Higher greenhouse gas generation;

» Longer construction time; and

- Dry cooling systems generate more noise than wet cooling.

Water cooling was chosen as the preferred option for cooling for this assessment.

A mechanical draft tower was preferred over a natural draft tower since a mechanical draft tower has smaller footprint, lower capital cost and shorter construction time than a natural draught tower. A natural draft cooling tower would also need to be over 100 metres tall, which would not be acceptable.

7.5.3 NOx control measures

There are three main options for controlling gas turbine emissions:

- Injection of a diluting substance such as water or steam into the burning zone of a conventional (diffusion flame) combustor;
- Catalytic clean-up of NOx and CO from the gas turbine exhaust; and
- Design of the combustor to limit the formation of pollutants in the burning zone by using 'lean-premixed' combustion technology or dry low NOx technology.

Injection of water would reduce the flame temperature and, in turn, would reduce NOx formation. This option would also increase gas turbine output. However, this option requires large amounts of water, and demineralised water must be used to prevent corrosive deposits in the turbine. The increase in power output is offset by a decrease in thermal efficiency. Steam injection operates on the same principle, and steam is generally fed from the heat recovery steam generator. However, the injection of steam is not feasible during open cycle operation unless separate arrangements for external steam supply are made.

Catalytic clean-up or selective catalytic reduction system could be introduced in the turbine exhaust. This system has higher capital costs and operating costs.

The third option was considered to be the preferred option for the proposal. Dry low NOx burners have become the standard for new gas turbines, which operate on lean premixed and staged combustion mode. It would not affect efficiency or output of the turbine. Multi-stage combustion ensures thorough mixing of air and fuel and minimises the amount of air required. Dry low NOx burners do not require demineralised water or steam injection.