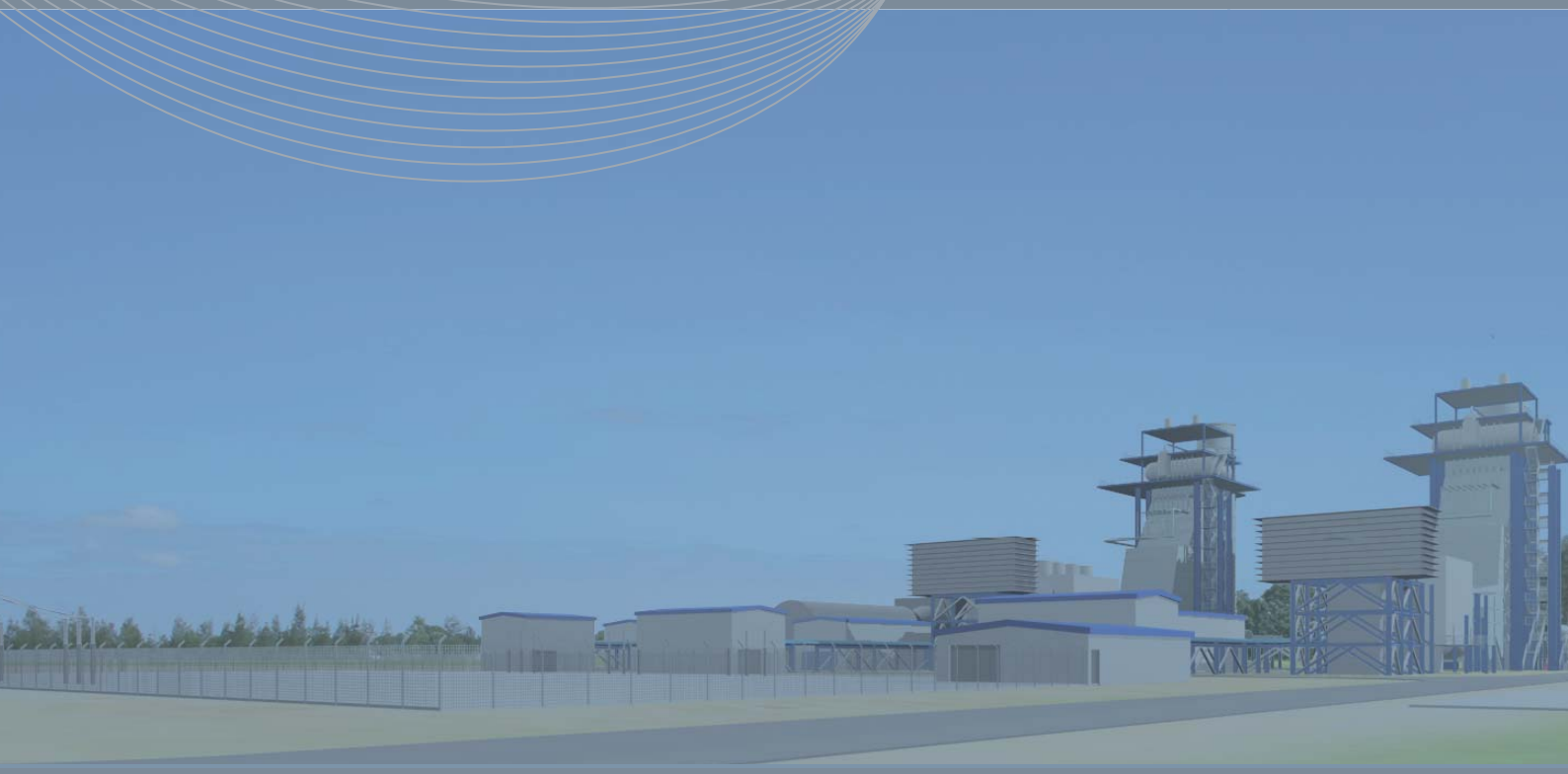
GHD CLIENTS | PEOPLE | PERFORMANCE

Delta electricity



Part C

Environmental assessment

Chapter 8. Key assessment requirements

8.1 Air quality

An air quality impact assessment of the proposal was undertaken by Heggies Australia Pty Ltd (Heggies). The assessment considers the potential direct and indirect impacts of construction and operation of the proposal on local and regional air quality and provides recommended management measures. This section provides a summary of the results of the assessment. The complete report is contained in Appendix D.

8.1.1 Methodology

A computer based dispersion model, The Air Pollution Model (TAPM), version 3.0, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was used to model the potential air quality impacts of the proposal. TAPM was used to develop a model that simulates the local meteorology, and to predict three-dimensional meteorological data and air pollution concentrations, based on terrain, ambient air quality and technical data provided for the proposed gas turbine equipment specifications.

TAPM was selected, in this instance, because it allows for more complex simulations of the chemical transformation of pollutants from stack emissions and the influence of terrain that would not be accounted for using a conventional Gaussian model (such as Ausplume).

Background air quality data for the 2004 period was sourced from the closest representative DEC air quality monitoring stations. Additional data used to develop the TAPM model included local meteorological data collected from the nearest Bureau of Meteorology monitoring site located within the HMAS Albatross base station; a modified terrain data set to allow for actual ground conditions observed during site inspections; and stack emission data determined using technical outputs from software GT PRO, for the selected technology.

Dispersion modelling was conducted for full load operation, and for start up and shut down operations. As there are no plans to use distillate as a fuel source for the proposal, impacts associated with operation on distillate were not considered.

The TAPM dispersion model was also used to establish the potential for generation of photochemical smog.

A plume rise assessment was also undertaken.

8.1.2 Relevant characteristics of the proposal

In stage one, exhaust gases from the turbines would be discharged to atmosphere via the bypass stack on each turbine. The stage one peaking facility would involve frequent start up and shut down operations. The impact of start up and shut down modes has been assessed.

In stage two, heat is recovered from the exhaust gases to generate steam, prior to the discharge of the exhaust to atmosphere via an exhaust stack on each heat recovery generator. The start up and shut down cycles are longer for the stage two configuration, requiring additional time for warm-up of steam cycle components. During stage two, start up and shut down activities are anticipated to be far less frequent than for stage one.

The main potential pollutants from gas turbine engines are oxides of nitrogen (NO_X), formed by the high temperatures generated in the combustor; carbon monoxide (CO); and volatile organic compounds, which are formed predominately by the incomplete combustion of fuel. Particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) and sulphur dioxide (SO_2) are emitted in trace to low amounts from gas turbine operations.

Air emission sources from the proposal include:

» Exhaust gases from bypass stacks in the open cycle mode in stage one and main stacks in the combined cycle mode in stage two; and

» Dust impacts during construction.

Air quality parameters considered in the air quality impact assessment include:

» Particulate matter (PM10) and total suspended particulates;

» Nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x);

» Carbon monoxide (CO);

» Sulphur dioxide (SO_2);

» Unburnt hydrocarbons (UHC); and

» Photochemical smog potential.

8.1.3 Existing environment

Climate

The climate in the region is characterised by mild conditions, with annual average daily air temperatures ranging between 21.3^{o}C (maximum) and 11.3^{o}C (minimum). Given that the site is located approximately 20 kilometres inland, coastal recirculation is not anticipated to play a major role in atmospheric dispersion of pollutants.

Rainfall has a significant effect on the way in which particles behave in the atmosphere, and the way in which pollutants are dispersed. When rainfall occurs, pollutants are flushed out of the atmosphere quickly, thus reducing potential nuisance impacts, as well as those on health and visibility. Rainfall within the area is described as moderate, with the HMAS Albatross base station receiving on average 1,093 millimetres per annum.

The relative humidity is described as medium to high, with the mean 9 am and 3 pm relative humidity being 70 percent and 58 percent respectively, with little variation between seasons.

The TAPM model was used to generate a complete 2004 meteorological data set for the site, incorporating the HMAS Albatross base station observations, and background air quality data compiled from DEC monitoring stations.

Seasonal variations in the prevailing wind directions are summarised in Table 8.1 and shown in Figure 8.1. The annual wind rose indicates that the dominant wind direction is from the west-northwest.

Table 8.1 Seasonal variation in prevailing wind directions at the Bamarang site, 2004

Prevailing Wind Direction			
Spring	**Summer**	**Autumn**	**Winter**
W-WNW	S-SSE	W-WNW	W-WNW

Atmospheric stability class describes the tendency of the atmosphere to resist or enhance vertical motion. Atmospheric stability class assessment for the site indicates that conditions can be most frequently described as Class D, or neutral conditions that neither enhance nor inhibit plume dispersion, and to a lesser extent Class F, conditions that provide a low potential for atmospheric dispersion.

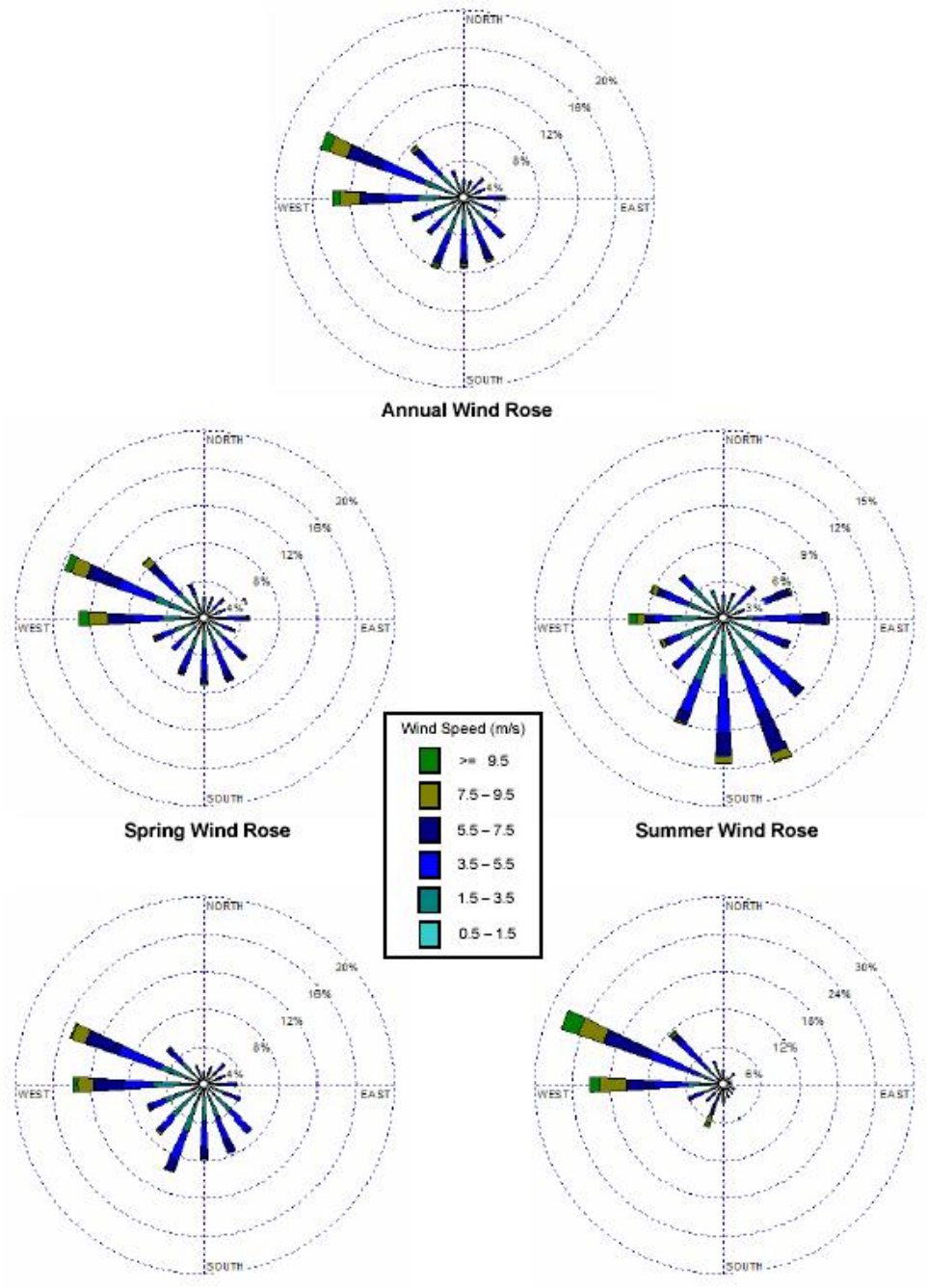


Figure 8.1 TAPM predicted annual/seasonal wind roses (Heggies 2005)

Regional topography

The site is located on relatively flat terrain, with a slight gradient present running from north to the south of the site. The site lies at an elevation of between 100 metres and 110 metres AHD. The preset land cover type used in TAPM was altered to reflect actual land cover observations made during a site inspection and review of regional aerial photographs.

Figure 8.2 shows the topography of the region surrounding the site.

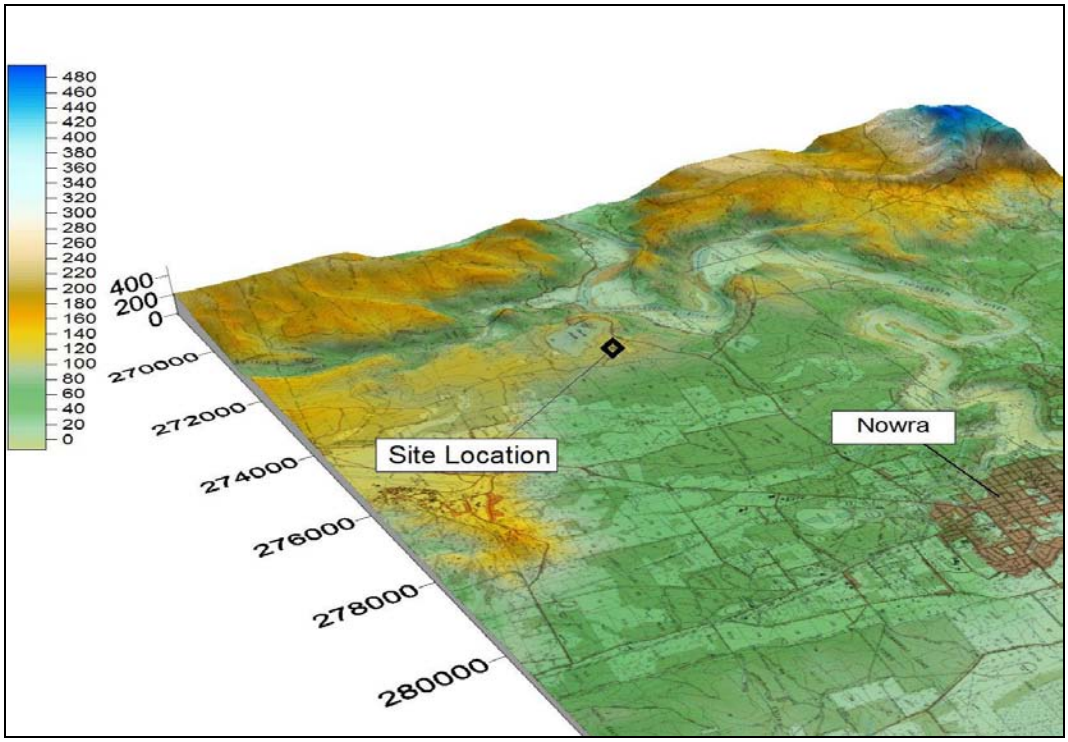


Figure 8.2 Topography of the region, showing the proposed site location (Heggies, 2005)

Nearest sensitive receptors

The DEC document, 'Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW', defines a sensitive receptor as a location where people are likely to work or reside, including dwellings, schools, hospitals, offices or public recreational areas. The nearest potentially affected residential properties for the purposes of the air quality assessment are listed in Table 8.2.

Table 8.2 Nearest potentially sensitive receptors

Property Name	Description	MGA Dwelling Coordinates	
		East (metres)	North (metres)
'Bundanon'	2.6 kilometres north east of proposed site	271728	6136340
Water Treatment Plant	1.3 kilometres west northwest of proposed site	272637	6135903
Bamarang Bush Cabins	1.2 kilometres north northeast of proposed site	273436	6136080
'Katalives'	1.8 kilometres north of proposed site	274343	6136620
'Mundamia' Properties	2.3 kilometres west northwest of proposed site	275993	6135903
'Karingal'	2.7 kilometres south west of proposed site	275042	6132503

Background air quality

The region is subject to ongoing air quality monitoring by DEC. For each of the parameters considered in the air quality assessment report, background air quality was established using historical data from the DEC monitoring stations at Albion Park (the nearest station to the site) and from Wollongong and Warrawong stations, as well as consideration of the Metropolitan Air Quality Study (1997). All results and assessment of DEC monitoring are presented in Appendix D. The background air quality levels adopted for this assessment are summarised in Table 8.3.

Table 8.3 Background air quality levels adopted for the assessment

Air Quality Parameter	Averaging Period	Assumed Background Concentration [1]
PM_{10}	24-Hour	46.8 µg/m^3
	Annual	17 µg/m^3
NO_2	1-Hour	44 ppb (84 µg/m^3)
	Annual	4 ppb (8 µg/m^3)
SO_2	1-Hour	34 ppb (90 µg/m^3)
	24-Hour	1.4 ppb (3.7 µg/m^3)
	Annual	0.8 ppb (2.2 µg/m^3)
Photochemical Oxidants (as O_3)	1-Hour	Variable - Refer Section 7.5 Appendix D
	Annual	20 ppb (39 µg/m^3)
CO	1-Hour	3.1 ppm (3.6 mg/m^3)
	8-Hour	2.1 ppm (2.4 mg/m^3)

Note 1 All gravimetric concentrations derived based on 25 ºC and 1 atmosphere pressure.

8.1.4 Impact assessment

Statutory and policy framework for air quality management

The air quality impact assessment has been conducted in accordance with the publication 'Approved Methods and Guidance for Modelling and Assessment of Air Pollutants in New South Wales' (DEC, 2005).

In establishing the air quality goals for the proposal, consideration has been given to the standards contained in the 'National Environment Protection Measure (NEPM) for Ambient Air Quality'; the recommendations of the National Health and Medical Research Council (NHMRC) regarding total suspended particulate matter; and the requirements of the POEO Act and the *Clean Air (Plant and Equipment) Regulation 1997* (CAPER).

The proposal would need to be licensed under the POEO Act. The CAPER provides the framework for the management of air pollution from licensed premises in NSW by setting the maximum pollutant concentrations permitted in discharges to air. The CAPER is scheduled for staged repeal in September 2005.

Project air quality goals

Project air quality goals are established to assess the potential impacts of the proposal and are selected on the basis of preventing health effects and nuisance impacts associated with the relevant air quality parameters. Criteria for PM_{10} and dust deposition relate to both the construction and operation of the proposal.

The following guidelines were used to establish the air quality goals for this assessment:

» 'Approved Methods and Guidance for Modelling and Assessment of Air Pollutants in New South Wales' (DEC, 2005): ground level air quality criteria for PM_{10}, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3) and carbon monoxide (CO);

» 'NEPM for Ambient Air Quality', noting that the NEPM goals have been developed with the intention of assessing regional air quality and accordingly are not intended as impact assessment criteria; and

» National Health and Medical Research Council (NHMRC) at their 92nd session in October 1981 recommends the annual goal for total suspended particulate matter (or TSP) as 90 $\mu g/m^3$.

In areas where vehicle traffic is not the dominant source of particulate matter, the PM_{10} particle size fraction is typically of the order of 50% of the TSP mass, the goal is consistent with an annual PM_{10} goal of approximately 45 $\mu g/m^3$. Thus, the historical NHMRC goal may be regarded as less stringent than the newer PM_{10} goal of 30 $\mu g/m^3$ expressed as an annual average. The annual TSP goal is considered to be achieved if the annual PM_{10} goal is satisfied, and as such TSP was not been considered further in the report.

The air quality goals adopted for the assessment, which conform to current DEC air quality targets and other relevant air quality criteria, are summarised in Table 8.4.

Table 8.4 Project air quality goals

Pollutant	Averaging Time	Maximum Concentration		Reference
		Gravimetric	Volumetric	
PM_{10}	24 hours Annual	50 µg/m^3 30 µg/m^3	N/A	DEC/NEPM
Nitrogen dioxide (NO_2)	1 hour Annual	246 µg/m^3 62 µg/m^3	120 ppb 30 ppb	DEC
Sulphur Dioxide (SO_2)	10 minutes 1 hour 24 hours Annual	712 µg/m^3 570 µg/m^3 228 µg/m^3 60 µg/m^3	250 ppb 200 ppb 80 ppb 20 ppb	DEC
Photochemical oxidants (as ozone - O_3)	1 hour 4 hours	214 µg/m^3 171 µg/m^3	100 ppb 80 ppb	DEC
Carbon Monoxide (CO)	15 minutes 1 hour 8 hours	100 mg/m^3 30 mg/m^3 10 mg/m^3	87 ppm 25 ppm 9 ppm	DEC
Dust Deposition	Annual	4 g/m^2/month [1]	N/A	DEC

Note: 1 Assumes background dust deposition of the order of 2 g/m^2/month.

In addition to the ground level concentration criteria above, the proposal must meet the CAPER emission limits for a gas turbine (used in connection with an electricity system with a capacity of 10 megawatts or more) outlined in Table 8.5.

Table 8.5 CAPER pollutant emission limits

Pollutant	Emission Limit	Applicable to
NO_2	0.07 g/m^3	Gas Turbines > 10 megawatts using gaseous fuels
Particulate (PM_{10})	0.10 g/m^3	Boilers or incinerators emitting solid particles
Opacity	20% opacity	All fuel burning plant

There is currently no CAPER emission limit for CO, and none planned under the draft amendment. There is also no CAPER emission limit for SO_2, except for sulphuric acid plants. Stack emission limits for both these compounds have been derived through dispersion modelling to ensure that the ground level concentrations outlined in Table 8.4 are met.

Emissions from the proposal

For the purposes of this assessment, the emission levels have been assessed for the proposal in full load, start up and shut down modes, for both stages one and two.

The primary source of air emissions from the proposal would be from exhaust stacks on the two gas turbine generators. Emission levels have been estimated from technical design and equipment specification requirements. Equipment specifications are performance based and nominate particular

upper limits on concentrations of airborne contaminants, such as unburnt hydrocarbons, NO_x and particulates. The gas turbines selected for this proposal would be of the dry low NOx type, which are now commonly used in the power generation industry.

Full load stack exit parameters are provided in Table 8.6.

Table 8.6 Full load stack exit parameters

Stack parameter	**Stack identification**							
	East and west open cycle gas turbine exhaust stacks				**East and west heat recovery steam generator exhaust stacks**			
Project stage	Stage one				Stage two			
Description	Exhaust stacks servicing the turbines, operating in open cycle mode				Exhaust stack servicing the turbines, operating in combined cycle mode. Combustion gases passed through the heat recovery steam generator prior to exhaust			
Location (easting, northing)	273816	6134906	273856	6134900	273812	6134875	273851	6134869
Height (metres)	40		40		40		40	
Diameter (metres)	5.6		5.6		5.6		5.6	
Area (m2)	24.63		24.63		24.63		24.63	
	Ambient temperature				**Ambient temperature**			
	273	**288**	**298**	**313**	**273**	**288**	**298**	**313**
Exit temperature (K)	763	774	781	793	398	422	416	406
Flow rate (Nm3/s)	392	371	359	337	392	372	360	339
Flow rate (Am3/s)	1096	1053	1027	980	572	575	548	503
Exit velocity (metres/s)	44.0	43.0	42.0	40.0	23.0	23.0	22.0	20.0

The effect of ambient temperature on stack emissions was assessed over the range 0 to 40^{o}C. The assessment identified that stack emission rates were predicted to be greater at the lower temperature, and as such, stack exit parameters at 0^{o}C have been used in the dispersion modelling to provide the most conservative scenario.

The TAPM model was run in chemistry mode to account for the photochemistry that would drive the formation or destruction of oxides of nitrogen.

No buildings of sufficient influence to generate building wake effects are located in the immediate vicinity of the stack discharge points. As such, building wake effects have not been considered in the evaluation of plume dispersion.

Due to the close proximity of the two stacks, located approximately 40 metres apart, the impact of plume merging and subsequent buoyancy enhancement was assessed in the evaluation of plume dispersion. The results of dispersion modelling for the operation of both stages the proposal have been summarised against the project air quality goals in Table 8.7. Full results of modelling for each pollutant and contour diagrams can be found in Appendix D.

Due to the limited impact on air quality parameters, stage one and two operations have been considered simultaneously for each relevant pollutant. Results are summarised below.

Particulate Matter (PM_{10})

Particulate matter emissions would result from the combustion of natural gas. The predicted increase in ground level concentrations arising from the proposal is predicted to be negligible. Dispersion modelling predicts that the incremental increase of PM_{10} for stage one operations would be of the order of 0.2 to 0.4 $\mu g/m^3$ and for stage two operations would be of the order of 0.6 to 1.6 $\mu g/m^3$.

The assessment has been conducted using the maximum 24 hour average background level of 46.8 $\mu g/m^3$, the highest reading recorded during 2004, which occurred on one day only. The annual average 24 hour average background level was 17.0 $\mu g/m^3$ for the 2004, and it is anticipated that the proposal would satisfy the NSW 24 hour goal of 50 $\mu g/m^3$. Additionally, the project air quality goal for PM_{10} is considered to be more stringent that the NHMRC guideline criteria for total suspended particulate in areas where vehicle emissions are not the primary source of particulate emissions. Therefore, the proposal is anticipated to satisfy the NHMRC guideline criteria for total suspended particulate.

Nitrous Oxide (NO_2)

Nitrous oxide emissions would result from the combustion of natural gas. Background levels for the region did not exceed the NSW goal of 120 ppb (246 $\mu g/m^3$) at any time during the 2004 period. Dispersion modelling predicts the incremental increase of nitrogen oxide for stage one operations at the nearest sensitive receptors to be between 0 and 7 ppb, and for stage two operations ranges between 4 and 14 ppb. The assessment has been conducted using the maximum 1-hour average for the 2004 period for the background level, and the proposal is expected to meet the project air quality goal of 120 ppb for the 1-hour average.

Additionally, the impacts of the proposal were assessed against the annual average NO_2 concentrations and it is anticipated that the proposal would satisfy the project air quality goal of 30 ppb for annual average NO_2 concentration at all sensitive receptors.

Carbon Monoxide (CO)

Carbon monoxide emissions would result from the combustion of natural gas. The incremental increase of carbon monoxide arising from the proposal is predicted to be less that 0.01ppm for both stages of the proposal. The impact of the proposal on carbon monoxide background levels would be insignificant.

During start up and shut down operations, the levels of CO are predicted to be 4500 ppm, some 450 times greater than during full load operations. Start up and shut down operations would be more frequent during stage one operations, when the proposal would operate as a peaking station only. Even in view of this, ground level concentrations are anticipated to be satisfied during these periods.

Table 8.7 Ground level concentrations of air quality parameters for stages one and two

Receptor	PM_{10} (maximum 24-hr average, $\mu g/m^3$)	NO_2 (1-hr average, ppb)	CO (1-hr average, ppm)	CO (1-hr average, ppm)	SO_2 (1-hr average, ppm)	SO_2 (24-hr average, ppm)	SO_2 (annual average, ppm)
Stage one – open cycle							
Bamarang Bush Cabins	47.0	46.0	3.1	2.1	34.4	1.5	0.8
'Bundanon'	47.0	44.0	3.1	2.1	34.5	1.5	0.8
'Katalives'	47.2	51.0	3.1	2.1	34.4	1.5	0.8
'Karingal'	47.0	47.0	3.1	2.1	34.4	1.5	0.8
'Mundamia' Properties	47.0	49.0	3.1	2.1	34.4	1.5	0.8
Water Treatment Plant	47.0	44.0	3.1	2.1	34.5	1.5	0.8
Stage two – combined cycle							
Bamarang Bush Cabins	48.0	58.0	3.1	2.1	34.4	1.5	0.8
'Bundanon'	47.4	48.0	3.1	2.1	34.5	1.5	0.8
'Katalives'	48.0	58.0	3.1	2.1	34.4	1.5	0.8
'Karingal'	47.5	54.0	3.1	2.1	34.4	1.5	0.8
'Mundamia' Properties	48.4	57.0	3.1	2.1	34.4	1.5	0.8
Water Treatment Plant	47.7	51.0	3.1	2.1	34.5	1.5	0.8
Project Air Quality Goal	50	120	25	9	200	80	20

Sulphur Dioxide (SO_2)

Sulphur dioxide emissions would result from the combustion of natural gas. The incremental increase of sulphur dioxide arising from the proposal is predicted to be between 0.0 and 0.5 ppm at the nearest sensitive receptors for all SO_2 project air quality goals. No significant impact of the proposal on background levels of sulphur dioxide is predicted.

Unburnt Hydrocarbons (UHC)

Unburnt hydrocarbon emission would be predominantly methane and derived from the fuel source. During full load operation, emission of unburnt hydrocarbons is predicted to be negligible. During start up and shut down mode, emissions of unburnt hydrocarbon are predicted to be 6500 ppm. There is currently no ground level air quality goal, however, methane emissions from the proposal are considered in the greenhouse gas assessment in Section 8.2.

Photochemical smog potential

Photochemical smog arises when chemical reactions occur with oxides of nitrogen, hydrocarbons and atmospheric oxygen in the presence of ultraviolet radiation. Ozone is a product of these reactions and is classed as a secondary pollutant. Dispersion modelling concluded that there are less than 30 hours per year with suitable ambient air conditions for ozone generation to proceed within the plume discharge. As such, it is not anticipated that emissions from the proposal would have a significant impact on the ability of the receiving air shed to generate photochemical reactions that result in photochemical smog pollution.

Additionally, assessment of inter-regional transport of photochemical precursors was assessed and it was found that the high level of atmospheric dispersion during inter-regional transport to the north would not justify any further assessment of the potential impact of the proposal on air quality impacts on the Sydney air shed.

Stack concentration limits

Predicted stack concentrations satisfy the CAPER emission-based limits.

Potential construction impacts

During construction, potential air quality impacts relate mainly to dust generation associated with construction activities, including:

» Earthworks associated with the installation of the natural gas pipeline;

» Demolition of existing buildings and structures;

» Exposure of surfaces resulting from vegetation removal; and

» Wheel generated dust (by machinery and transport vehicles.

Dust impacts during construction can be managed through mitigation measures implemented as part of a construction environmental management plan. Mitigation measures have been provided for the construction phase.

Ambient PM_{10} concentrations in the region were well below the NSW 24 hour goal of 50 $\mu g/m^3$ during the 2004 period, with the annual average concentration being 17 $\mu g/m^3$. The results of the assessment indicate no significant impact of dust on the nearest sensitive receptors during construction, however a comprehensive dust control strategy is recommended.

Particulate emissions are not expected to result in significant impact on sensitive receptors, given the distance between the receptors and the site and the implementation of dust generation controls described below. Dust may, however, impact on site personnel.

Standard health and safety procedures for construction employees would be implemented at the construction site, including requirements for protective equipment (masks) where dust generation in unavoidable. Dust emissions during construction are not anticipated to result in significant air quality impacts if the recommendations listed below are implemented.

Plume rise assessment

The proposed facility will have two exhaust stacks, both of which are estimated to have a height of approximately 40 metres above ground level. The Defence (Areas Control) Regulations controls the height of structures, and the purpose for which they may be used, within a 15 kilometre radius of an aerodrome. Although the stacks proposed are located within this 15 kilometre radius, the structure of the stacks will not infringe on the Obstruction Clearance Surface (OCS) for the Albatross facility.

According to the Civil Aviation Safety Authority's Advisory Circular titled 'Guidelines for Conducting Plume Rise Assessments' (June, 2004) exhaust plumes with a vertical velocity in excess of 4.3 m/s may cause damage to an aircraft airframe, or upset an aircraft when flying at low levels.

The proposed gas turbine power facility at Bamarang is located within the Conical Surface OCS for the Royal Australian Navy Naval Air Station Nowra. Through correspondence with the Department of Defence it is understood that the plume velocity from the two stacks should not exceed 4.3 m/s at the height of the Conical Surface OCS. The Conical Surface OCS at the site of the Bamarang stacks has been determined as 167 metres AHD.

The Bamarang site lies at an elevation of approximately 107 m AHD. Accordingly, the OCS used for this assessment is 60 metres AGL.

Heggies undertook a Plume Rise Assessment as part of the air quality assessment

The Air Pollution Model (TAPM) was used in plume rise mode to analyse plume behaviour from the stacks for meteorological conditions predicted for the site over a modelling period of 5 years (2000-2005).

The plume rise from a single stack was modelled, and a plume rise enhancement factor was applied to the vertical velocity and plume radius outputs to conservatively account for the impact of enhanced buoyancy as a result of the two plumes merging.

The potential impacts of the stack exhaust plume from the proposed power facility on regional aviation safety have been assessed in Appendix D. The results indicate that the probability of an exceedance of the critical vertical velocity (4.3 m/s) decreases significantly with altitude, particularly between 50 metres and 100 metres above ground level (AGL). Approximately 96% of all predicted exceedances of the critical vertical velocity occur between 50 metres and 90 metres AGL, (10 metres and 50 metres above stack height respectively).

At a height of 200 metres AGL (160 metres above stack height), it is predicted that the frequency of exceedance of the critical vertical velocity will be 0%. Under prevailing wind conditions, such a plume would travel of the order of 350 metres to the northwest, and would have a maximum plume radius of 29 metres.

In view of this, it is anticipated that the combined probability of an aircraft being exposed to a vertical velocity (attributable to the gas turbine power facility stacks) in excess of 4.3 m/s will be acceptable in terms of CASA risk criteria.

The combined probability of this event may be calculated subject to quantification of the probability of aircraft traversing within the plume influence area.

The results of the plume assessment were sent to the Department of Defence for their review. Comments received have been incorporated in the assessment included in Appendix D.

8.1.5 Recommended mitigation and management measures

Construction

A dust control plan detailing control measures, responsibilities for implementing dust control measures and monitoring and reporting requirements would be prepared as part of the construction environmental management plan for the proposal. Mitigation measures to minimise the generation of dust would target dust generation by vehicle movements and construction activities. Typical mitigation measures are described below.

- Minimising the extent of exposed surfaces and the timeframe surfaces are exposed;
- Progressively stabilise disturbed areas to ensure that no areas remain unstable for any extended length of time;
- Covering stockpiles;
- Truck movements would be controlled by restricting movements to designated roadways;
- Rehabilitation of disturbed areas at the soonest practicable time;
- Watering of disturbed areas during unavoidable periods of exposure;
- Minimising drop heights front end loader buckets and trucks carrying excavated materials;
- Brushing down surfaces of vehicles (truck trays etc) prior to transport;
- Ensuring that loads are covered during transport;
- The use of wind barriers in potential dust generating areas would be considered during site establishment design;
- Use of water sprays along unsealed access ways;
- Inspections of haulage roads conducted during days on which construction activities were occurring and dust generation would be monitored visually during operations; and
- Limiting or preventing high dust generating activities during adverse wind conditions, for example strong prevailing winds blowing towards nearest sensitive receptors.

These mitigation measures would be implemented and monitored through a detailed construction audit schedule.

Operation

The specifications provided to prospective equipment suppliers would dictate the technical and environmental performance the units would be expected to meet, based on Delta's operational requirements and the conditions of consent for the proposal.

Mitigation of air quality impacts for the proposal would largely be achieved through the application of (dry) low NO_x design of the gas turbine combustors. Dry low NO_X combustors represent the best practicable option for emission control as when used with natural gas, they do not need any fluid injection to maintain emissions at acceptable levels over a wide operational range.

The initial cost of low NO_x combustors is model-specific, and is reported as being from 15% to 100% more expensive than a conventional equivalent, with maintenance costs being about 40% higher than gas turbines not fitted with low NO_x combustors (PAE, 2005).

Given the results of atmospheric dispersion modelling, it is anticipated that no additional post-combustion mitigation measures from an air quality perspective (such as selective catalytic reduction) would be required.

Air quality monitoring

Delta would establish pollutant concentrations and emissions parameters to be monitored in accordance with the requirements specified in 'Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales' (DEC, 2005). This would include location of the sampling points on the discharge stacks in accordance with the requirements set out in test method TM-1. Monitoring would be undertaken annually or in accordance with frequency and requirements otherwise specified in the conditions of approval. Proposed monitoring measures are summarised in Table 8.8.

Table 8.8 Periodic pollutant and parameter monitoring (air)

Pollutant/Parameter	Units of Measure	Method	Frequency
Nitrogen dioxide (NO_2) or nitrous oxide (NO) or both as NO_2	mgm^3	CEM-2	Continuous
Velocity	ms^1	TM-2	Within 90 days of commissioning and annually
Volumetric flow rate	m^3s^1	TM-2	
Temperature	^oC	TM-2	
Moisture	%	TM-22	
Dry gas density	kgm^3	TM-23	
Molecular weight of stack gas	$g.gmol^1$	TM-23	
Carbon dioxide	%	TM-24	
Oxygen	%	TM-25	

8.2 Greenhouse gas assessment

The air quality impact assessment of the proposal undertaken by Heggies (refer Appendix D) included an assessment of the greenhouse gas emissions associated with the proposal. The results of this assessment have been incorporated into the following section.

8.2.1 Methodology

The annual emissions of carbon dioxide (CO_2) and other greenhouse gases from the proposal have been estimated using the Australian Greenhouse Office (AGO) document 'Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2002 – Energy (Stationary Sources)'.

For comparative purposes, non-CO_2 greenhouse gases are awarded a 'CO_2 equivalence' based on their contribution to the enhancement of the greenhouse effect. The CO_2 equivalence of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO_2 greenhouse gases are contained within the Intergovernmental Panel on Climate Change (IPCC) document 'Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories'. The GWPs of relevance to this assessment are:

» Methane: GWP of 21 (21 times more effective as a greenhouse gas than CO_2); and

» Nitrous Oxide: GWP of 310 (310 times more effective as a greenhouse gas than CO_2).

The short-lived gases such as CO, NO_2, and non-methane volatile organic compounds (NMVOCs) vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

The annual emissions of greenhouse gases, expressed as CO_2 equivalent (tonnes/year), have been determined on the basis of the planned operation anticipated to have an annual gas demand of 1.3 PJ over 440 hours of operation (stage one operations) and an annual gas demand of 24.0 PJ over 8,300 hours for stage two.

8.2.2 Relevant characteristics of the proposal

Direct greenhouse gases would be produced by the proposal, with the primary source being emissions from the exhaust stacks on the two gas turbines during electricity generation operations.

CO_2 is produced during fuel combustion as a result of the oxidation of the fuel carbon content. CO_2 is likely to make the largest contribution to greenhouse gas emissions from fuel combustion as approximately 99.5% of natural gas fuel is oxidised during the combustion process (Australian Greenhouse Office, 2002).

Other greenhouse gases emitted as a result of the proposal may include CO, CH_4, NO_X and NMVOCs. These are produced by incomplete fuel combustion, reactions between air and fuel constituents during fuel combustion, and post-combustion reactions. Fugitive emissions of NMVOCs may also be expected due to fuel evaporation.

Indirect greenhouse gas emissions are also associated with electricity consumption for operational facilities at the site including:

» Electricity consumption for operation of the proposed reverse osmosis treatment plant of waste water

» Electricity consumption for the operation of administration buildings, control room and lighting; and

» Fuel consumption associated with personnel and materials transport to and from the site during construction and operation.

For the purposes of this assessment, the greenhouse gases associated with indirect emissions of greenhouse gases estimated to be less than 2% of the direct greenhouse gas emissions, and are not considered significant. Therefore, this greenhouse gas assessment is limited to direct emissions only.

8.2.3 Greenhouse gas assessment

Greenhouse gas emissions have been assessed for stage one and stage two operations. Emissions of greenhouse gases associated with construction activities are not considered to be significant compared to the operational emission over the life of the project.

Operation – stage one

A summary of the predicted net increase in emissions from stage one is provided in Table 8.9. The CO_2 equivalent emissions are also detailed as a percentage of the total emissions from electricity generation operations in Australia at 1990 and 2002 (129 and 182 mega tonnes per year respectively, (AGO, 2004)).

Table 8.9 Stage one - predicted emissions of greenhouse gases natural gas-fired turbine engines

Compound	CO_2	NO_2	CH_4	Total Emissions
Predicted Emissions (tonnes/year)	67,210	0.13	10.4	67,220.5
CO2-Equivalent (tonnes/year)	67,210	40.3	218.4	67,468.7
% of CO2 emissions of Australian electricity generation, 1990	0.052%	0.00003%	0.00017%	0.052%
% of CO2 emissions of Australian electricity generation, 2002	0.037%	0.00002%	0.00012%	0.037%

Operation – stage two

A summary of the predicted net increase in emissions from stage two is provided in Table 8.10. The CO_2 equivalent emissions are also detailed as a percentage of the total emissions from electricity generation operations in Australia at 1990 and 2002 (129 and 182 mega tonnes per year respectively, (AGO, 2002).

Table 8.10 Stage two - predicted emissions of greenhouse gases natural gas-fired turbine engines

Compound	CO_2	NO_2	CH_4	Total emissions
Predicted emissions (tonnes/year)	1,240,800	2.4	192	1,240,995
CO_2-equivalent (tonnes/year)	1,240,800	744	4032	1,245,546
% of CO_2 emissions of Australian electricity generation, 1990	0.96%	0.00058%	0.00313%	0.97%
% of CO_2 emissions of Australian electricity generation, 2002	0.68%	0.00041%	0.00222%	0.68%

8.2.4 Greenhouse gas abatement strategies

As the second largest electricity generator in Australia, Delta recognises its responsibility to continue to meet increasing energy demands, the need to deliver this energy in the most sustainable form practicable, and to meet the increasing concerns of the global community regarding global warming.

Delta manages greenhouse gas abatement at a whole-of-organisational level, through participation in the Australian Government's Greenhouse Challenge (Plus) Program and the Generator Efficiency Standards Program. These programs are established by the AGO, Commonwealth Department of Environment and Heritage. The AGO provides a range of programs and initiatives designed to assist Australian business and industry to meet Australia's Kyoto target.

The approach to greenhouse gas abatement adopted by Delta includes:

» Minimising impacts of existing coal-fired plants;

» Investigating transitional, combined technologies; and

» Developing new renewable energy technologies for the future.

While natural gas is a non-renewable fuel source, the proposal provides increased energy efficiency over traditional coal fired power stations.

Through its commitment to the Generator Efficiency Standards and the Greenhouse Challenge Program, Delta has implemented a range of greenhouse gas emissions abatement measures including:

» Technology upgrades and replacement for older stations;

» Installation of control systems;

» Introducing co-firing of renewable fuels (biomass) as a fuel feed at coal fire power stations; and

» Installation of a number of mini-hydro power stations and sugar mill cogeneration projects to increase the production of electricity from renewable sources.

In the 2002/2003 period, Delta achieved abatement of 304,000 tonnes of CO_2 equivalent from projects implemented under the Generator Efficiency Standards and Greenhouse Challenge programs. Development of co-generation plants with sugar mills in NSW are expected to achieve some 400,000 tonnes of greenhouse gas abatement each year.

Delta would continue to identify opportunities to achieve greenhouse gas abatement throughout its operation, research, and investment programs.

8.3 Flora and fauna

An ecological assessment of the proposal was undertaken by GHD. The assessment considers the potential direct and indirect impacts of construction and operation of the proposal on threatened species and endangered ecological communities within the study area, and recommends measures to mitigate identified impacts. This section provides a summary of the results of the assessment. The complete report is contained in Appendix E.

8.3.1 Methodology

The study area for the purposes of the ecological assessment included the site, approximately 20 metres either side of Yalwal road and existing transmission line corridors, and along the proposed gas pipeline corridor.

Literature review

Available literature and database records regarding the environmental features of the study area and locality (10 kilometre radius) were reviewed, including database searches for threatened species and matters of national environmental significance listed under the EPBC Act. A full description of the literature and databases reviewed is provided in Appendix E.

Field surveys

Consultation with DEC was undertaken prior to the surveys, and the survey methodology was designed to meet the requirements of the DEC '*Draft Threatened Biodiversity Survey and Assessment Guidelines*' (2005). Surveys for threatened species were undertaken by two ecologists over a five day period from 8 to 12 August 2005.

Flora

Field surveys included mapping of vegetation communities within the study area, establishment of 20 x 20 metres vegetation quadrats focussing on areas that had not been previously surveyed, and targeted surveys for two threatened flora species with potential to occur in the study area – Nowra Heath-myrtle (*Triplarina nowraensis*) and Illawarra Greenhood Orchid (*Pterostylis gibbosa*).

Fauna

A general fauna habitat assessment was undertaken to identify areas of potential habitat within the study area. Specific resources such as shelter, basking, roosting, nesting and foraging sites for amphibians, birds, bats, arboreal mammals, ground-dwelling mammals and reptiles were noted. Animal scats found during the surveys were collected and sent for analysis and identification. In addition, any indirect evidence of fauna (i.e. feathers, fur, tracks, dens, nests, scratches, chew marks and owl wash) was recorded.

Avifauna surveys were conducted in the early morning or late afternoon with all species heard or sighted being recorded and the location of any threatened species mapped. Feeding habitat for the Glossy Black Cockatoo, a species listed as vulnerable under the TSC Act, was mapped using a global positioning system and aerial photography, and evidence of feeding (chewed cones) recorded.

Spotlighting was conducted in addition to the fauna habitat assessment to detect the presence of any nocturnal arboreal mammals, some of which are listed as threatened under the TSC Act and EPBC

Act. Spotlighting was conducted along the length of the proposed and current powerline easements and across the proposed gas fired power facility site.

Hollow-bearing trees were surveyed along 10 x 100 metres transects in the study area recording the number of hollow-bearing trees, tree species, number of hollows, hollow height and average hollow diameter.

Impact assessment

The potential impacts of the proposal on threatened species were assessed in accordance with the DEC '*Draft Threatened Biodiversity Survey and Assessment Guidelines* (2005). Recommendations for avoidance and mitigation of impacts were developed based on the results of the literature review, field surveys and impact assessment.

8.3.2 Existing environment

Flora

Much of the vegetation on the western side of the site was cleared during the construction phase for the original abattoir development. However, scattered native trees remain and the groundcover comprises mainly native grasses. A fire trail approximately 4 metres wide has been maintained around the perimeter of the site and informal tracks are also evident through some of the site.

The transmission line easements are regularly slashed and vegetation is maintained as a grassy cover. Road reserves along Yalwal Road are also regularly slashed.

Weed invasion was limited throughout the study area with the only major occurrences recorded along Cabbage Tree Creek on the southern side of Yalwal Road and within pasture areas.

Ten ecological communities were recorded within the study area as shown in Figure 8.3. One of these communities, River-flat Eucalypt Forest, is listed as an endangered ecological community under the TSC Act. A modified remnant characteristic of this community was recorded north of Yalwal Road along Cabbage Tree Creek but would not be directly impacted by the proposal.

Threatened flora that have been recorded in the locality, or are likely to occur within the locality, together with their conservation status and likelihood of occurring at the site (DEC, DEH and Royal Botanical Gardens) are shown in Table 8.11.

In addition, a number of threatened and/or rare or threatened Australian plants (RoTAP), and endangered or regionally significant ecological communities, were identified within the study area during a study by Parsons Brinckerhoff (2005). These included:

Ecological Communities

» River-flat Eucalypt Forest (Endangered under the TSC Act); and

» Northern Foothills Spotted Gum – Blackbutt Moist Shrub Forest (regionally significant).

Flora

» Nowra Heath-myrtle (Endangered under the TSC Act);

» *Leptospermum epacridoideum* (RoTAP); and

» *Grevillea linearifolia - parviflora* intergrade (known but unresolved taxon).

No RoTAP species were recorded during the surveys. However, *Leptospermum epacridoideum* was recorded within the study area in the past along the current transmission line corridor. *Grevillea linearifolia - parviflora* intergrades were recorded in a number of locations across the site.

Fauna

Potential habitat for a variety of fauna was present within the study area due to the extensive areas of intact vegetation and presence of mature, hollow-bearing trees. Habitat was present for most bird species due to the dense and heathy understorey providing potential shelter and nesting habitat for small birds, and large hollow-bearing trees scattered across the study area providing potential roosting habitat for larger birds such as owls and the Glossy Black Cockatoo (*Calyptorhynchus lathami*).

Flat Rock Creek and the associated instream vegetation provide known habitat for the Black Bittern (*Ixobrychus flavicollis*) which has been recorded in the past along Flat Rock Creek (DEC 2005). However, all other creeks and drainage lines within the study do not support suitable habitat for bitterns. A complete list of birds species recorded during the surveys is included in Appendix E.

The sandy soils and heathy vegetation provide potential habitat for ground-dwelling mammals such as bandicoots and the threatened Eastern Pygmy Possum (*Cercartetus nanus*). The hollow-bearing trees, extensive areas of Red Bloodwood and intact and connected vegetation also provide habitat for arboreal mammals such as gliders. Two Greater Gliders (*Petauroides volans*) were recorded north of Yalwal Road during the surveys and one Common Brushtail Possum (*Trichosurus vulpecula*) to the south of Yalwal Road. Yellow-bellied Gliders (*Petaurus australis*) were not recorded during the current surveys but have been recorded within the study area in the past and potential habitat was present for this species throughout much of the study area.

The numerous drainage lines across the study area provide potential habitat for a variety of common frog species as well as the threatened Giant Burrowing Frog (*Heleioporus australiacus*). Limited habitat was also present for the Green and Golden Bell Frog along Flat Rock Creek and the adjacent drainage line that supported *Eleocharis sphacelata*. However given that the majority of the riparian vegetation along Flat Rock Creek supported a heath rather than grassy understorey, this is considered marginal habitat for the Green and Golden Bell Frog.

Potential habitat for reptiles has been reduced across the site due to recent fires. However, small rocky areas on the plateau are likely to provide habitat for small lizards and snakes. Vegetation along the proposed corridors supported abundant leaf litter, rocky areas and fallen logs and is therefore likely to provide good habitat for common reptiles.

Table 8.11 Threatened flora recorded or with the potential to occur in the study area

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurring in study area
Acacia bynoeana	Bynoe's Wattle	E	V	Potential habitat present throughout majority of study area.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Potential habitat present in areas supporting moist heath and open areas within the eucalypt forests.
Cynanchum elegans	White-flowered Wax Plant	E	E	Limited potential habitat for this species within River-flat Eucalypt Forest area.
Eucalyptus langleyi	Albatross Mallee	V	V	Unlikely. No suitable habitat.
Eucalyptus sturgissiana	Ettrema Mallee	V		Potential habitat present within study area but not recorded during the surveys therefore unlikely to occur.
Genoplesium baueri	Brittle Midge Orchid	V		Potential habitat present in areas supporting open forest and within the mossy areas over sandstone on the western side of Flat Rock Creek
Melaleuca deanei	Deane's Melaleuca	V	V	Potential habitat present within heath vegetation adjacent to Flat Rock Creek.
Pterostylis gibbosa	Illawarra Greenhood	E	E	Targeted searches undertaken in suitable habitat but not recorded within study area.
Pterostylis pulchella	Waterfall Greenhood	V	V	Unlikely. No suitable habitat within study area.
Solanum celatum	Violet Nightshade	E		Limited potential habitat north of Yalwal Road along Cabbage Tree Creek.
Thesium australe	Austral Toadflax	E	V	Unlikely. No suitable habitat.
Triplarina nowraensis	Nowra Heath-myrtle	E	E	Recorded along creeks and drainage lines at the site.
Zieria baeuerlenii	Bomaderry Creek Zieria	E	E	Unlikely. No suitable habitat present.

E = Endangered, V = Vulnerable

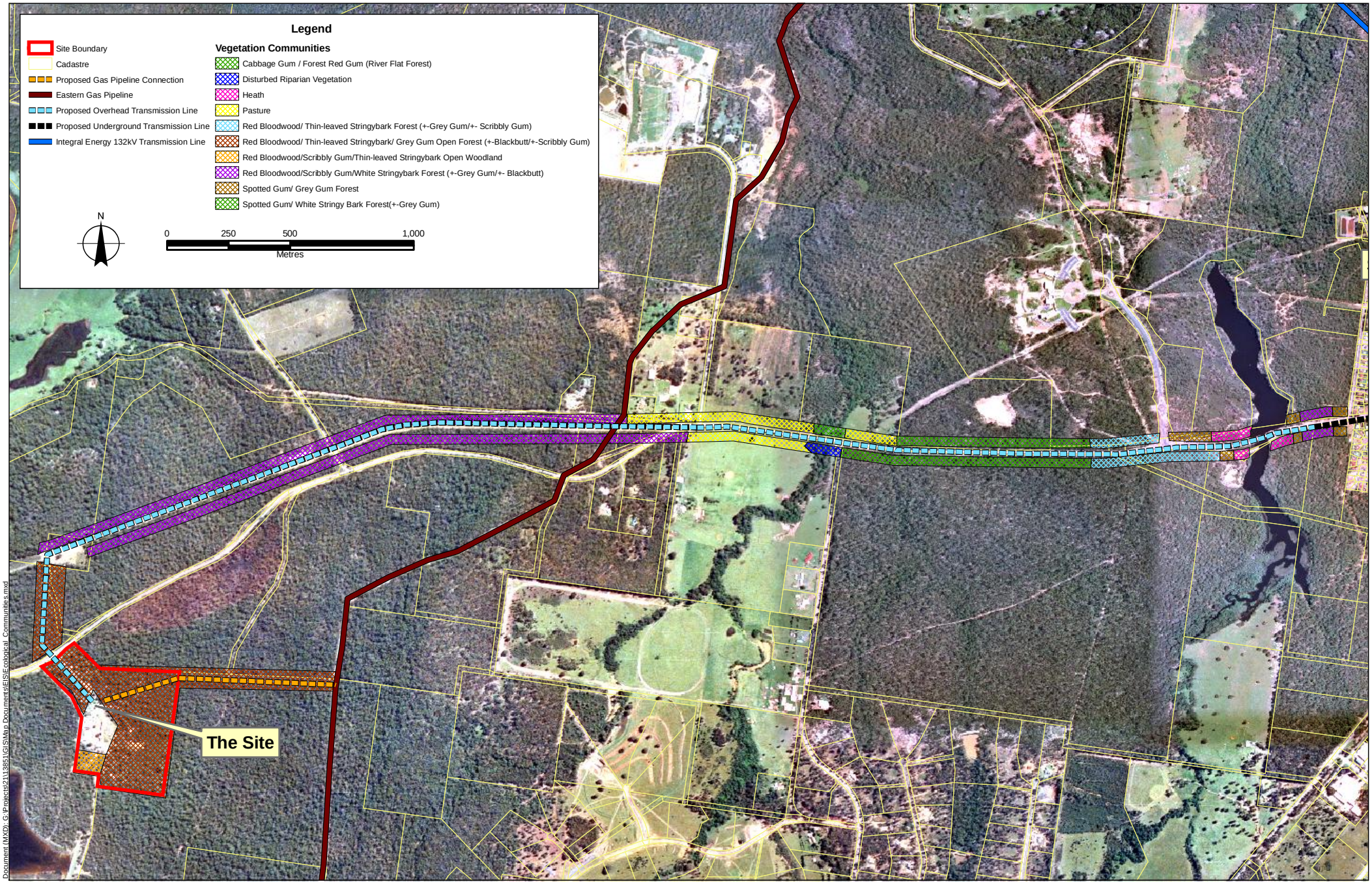


Figure 8.3 Vegetation Communities within the Study Area

Threatened fauna that have been recorded in the locality, or are likely to occur within the locality, together with their conservation status and likelihood of occurring at the site (DEC, DEH and Royal Botanical Gardens) are shown in Table 8.12. Potential habitat is present within the study area for the majority of these species.

Potential habitat is present in the study area for the Bush-stone Curlew, Eastern Pygmy Possum, the Southern Brown Bandicoot, Long-nosed Potoroo and White-footed Dunnart. The study area also provides extensive habitat for a number of threatened bats and owls (Barking Owl, Masked Owl and Powerful Owl), although no owls, owl wash or pellets were noted during the survey. Extensive areas of potential feeding habitat for the Glossy Black Cockatoo were recorded within the study area and proposed site.

An extensive area of potential habitat occurred at the proposed gas fired power facility site for the Eastern Pygmy Possum. The disused abattoir could potentially provide roosting habitat for a number of microchiropteran bats, although a visual inspection of the interior of the abattoir failed to detect any bat colonies or bat guano, which would indicate present and/or past usage by bats.

State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44) applies within the Shoalhaven LGA. Potential habitat for the Koala is present across the study area with Koala feed trees present in areas mapped as supporting Grey Gum (*Eucalyptus punctata*) and Forest Red Gum (*Eucalyptus tereticornis)*. Although detailed surveys were not undertaken to assess areas supporting Core Koala habitat, it is likely that Vegetation Community 6 (Red Bloodwood/Thin-leaved Stringybark/Grey Gum Forest (±Blackbutt, ±Scribbly Gum) would represent potential Koala habitat as Grey Gum was one of the dominant canopy species and was likely to constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

However, the area investigated supporting Forest Red Gum was unlikely to represent potential Koala habitat as it would not constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

Considering most recent record 1986 (DEC 2005) and the amount of survey effort that has been undertaken in that area in the recent past and the current farmland areas, it is considered unlikely that Koalas would inhabit the site and it would not represent Core Koala habitat. Given that no Core Koala habitat was identified at the site. No further assessments or provisions under SEPP 44 need to be considered.

Hollow-bearing trees were present across the majority of the study area. Hollows were most commonly recorded in Scribbly Gums with hollows also present in Grey Gum, Red Bloodwood and stags. The area surrounding the existing transmission corridor through Bamarang Nature Reserve supported the highest densities of hollow-bearing trees. As only approximately one metre of vegetation clearance either side of the existing corridor maybe required, it is unlikely that many of these would be cleared.

Table 8.12 Threatened fauna recorded within the locality (DEC 2005)

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurring in the study area
Burhinus grallarius	Bush Stone-curlew	E		Potential habitat present within proposed easement areas.
Callocephalon fimbriatum	Gang Gang Cockatoo	V		Potential habitat present throughout forest and woodland areas.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Recorded at site during inspection and potential foraging and breeding habitat present throughout study area.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Potential foraging habitat present throughout study area.
Dasyurus maculatus	Spotted-tailed Quoll	V		Potential habitat present within study area along Yalwal Road and the current transmission line easement.
Heleioporus australiacus	Giant Burrowing Frog	V	V	Potential habitat present throughout the majority of the study area except for pasture areas.
Hoplocephalus bungaroides	Broad-headed Snake	E	V	Unlikely. No suitable habitat present within study area.
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E	E	Potential habitat present throughout study area particularly in heath and open forest areas.
Ixobrychus flavicollis	Black Bittern	V		Previously recorded within the study area along Flat Rock Creek. Not recorded during current surveys.
Litoria aurea	Green and Golden Bell Frog	E	V	Limited potential habitat in small drainage line adjacent to Flat Rock Creek. However, considered unlikely to occur.
Lophoictinia isura	Square-tailed Kite	V		Potential habitat present within forest and woodland areas and has been recorded in close proximity to study area. This species is likely to forage across study area.
Macropus parma	Parma Wallaby	V		Unlikely. No suitable habitat.
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	V	Potential foraging habitat present across study area and potential roosting habitat within old abattoir building.
Mixophyes balbus	Stuttering Frog	E		Unlikely. No suitable habitat within study area.
Mormopterus norfolkensis	Eastern Freetail-bat	V		Potential foraging habitat across study area.
Myotis adversus	Large-footed Myotis	V		Potential foraging habitat across study area especially along drainage lines.
Neophema pulchella	Turquoise Parrot	V		Limited potential foraging habitat within study area but considered unlikely to occur.

Scientific name	Common name	TSC Act status	EPBC Act status	Likelihood of occurring in the study area
Ninox connivens	Barking Owl	V		Potential foraging and roosting habitat within study area.
Ninox strenua	Powerful Owl	V		Potential foraging and roosting habitat within study area.
Petaurus australis	Yellow-bellied Glider	V		Previously recorded within study area but not recorded during current surveys.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Unlikely. No suitable habitat.
Petroica rodinogaster	Pink Robin	V		Previously recorded within in vegetation adjacent to current transmission line easement but not recorded during current survey.
Phascolarctos cinereus	Koala	V		Potential habitat throughout study area.
Potorous tridactylus	Long-nosed Potoroo	V	V	Potential habitat present throughout study area and in particular where areas of both dense and open understorey occur together.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Potential foraging habitat present throughout study area.
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Unlikely. No suitable habitat present.
Sminthopsis leucopus	White-footed Dunnart	V		Potential habitat present throughout the study area in areas supporting open forest and heath.
Tyto novaehollandiae	Masked Owl	V		Potential foraging and roosting habitat present throughout study area.
Tyto tenebricosa	Sooty Owl	V		Unlikely. No suitable habitat.
Varanus rosenbergi	Rosenberg's Goanna	V		Potential habitat present throughout study area.
Xanthomyza phrygia	Regent Honeyeater	E	E	Potential foraging habitat present and has been previously been recorded in close proximity to study area.

E = Endangered, V = Vulnerable, TSC Act = *Threatened Species Conservation Act 1995*, EPBC Act = *Environment Protection and Biodiversity Conservation Act 1999*

8.3.3 Impact assessment

The potential habitat impacts of the proposal are summarised in Table 8.13. Stage one would result in the clearance of approximately 5.5 hectares of vegetation, including approximately:

» 1 hectare for the facility footprint;

» 0.9 hectares cleared for fire truck turning bay;

» 0.9 hectares for the gas pipeline; and

» 2.7 hectares for the electricity transmission corridor.

In addition, 3.5 hectares of hazard reduction would need to be undertaken for the proposed bushfire asset protection zones (refer Section 8.4).

Stage two would result in additional clearance of approximately 0.5 of a hectare of vegetation for the facility footprint on the site, and an additional 1.2 hectares of partial clearing for asset protection zones.

Potential impacts on threatened species were assessed in accordance with the DEC *Draft Threatened Biodiversity Survey and Assessment Guidelines* (2005). The study area supports extensive areas of native vegetation including the endangered River-flat Eucalypt Forest community and potential and known habitat for a number of threatened flora and fauna species. However, not all of these species or their habitats are likely to be impacted by the proposal. Given the large number of fauna species, these have been separated into guilds for assessing impacts, as in most cases species within each guild are likely to have similar habitat requirements. Full details of the impact assessment for each threatened species are provided in Appendix E.

Flora

There is potential for direct impacts on potential habitat for some threatened flora species due to vegetation clearance, including displacement or disturbance, as well as indirect impacts including runoff, sedimentation, edge effects (opening up remnants to weed invasion), disruption to the pollination cycle (if clearing is undertaken during flowering periods), disturbance to dormancy periods and seedbanks. Mitigation measures outlined in section 8.3.4 would be implemented during construction to minimise such impacts. As a result, it is considered unlikely that the proposal would have a significant impact on the lifecycle of any flora species.

Fauna

Potential impacts on each fauna guild are summarised in Table 8.14. Mitigation measures outlined in section 8.3.4 would be implemented during construction to minimise impacts. It is considered unlikely there would be significant impacts on any threatened fauna resulting from the proposal.

Table 8.13 Potential impacts of the proposal on habitat

Type of impact	Nature of impact	Significance of impact
Vegetation clearance	Total vegetation clearance for stage one would be approximately 5.5 hectares, plus approximately 3.5 hectares of partial clearing/hazard reduction for the bushfire asset protection zones. Total additional vegetation clearance for stage two would be approximately 0.5 hectares, plus approximately 1.2 hectares of partial clearing/hazard reduction for the bushfire asset protection zones.	None of the vegetation to be cleared is considered to be a part of an endangered ecological community. The majority of the clearing for the APZs would be in the form of partial clearing to ensure a discontinuous canopy and reduce fuel loads to acceptable levels and therefore would not result in clearance of all vegetation in these areas. The removal of vegetated areas would decrease the amount of potential fauna habitat present within the study area.
Loss of habitat for ground-dwelling mammals	Clearance of potential habitat for stage one would be: » Eastern Pygmy Possum: 0.9 hectares cleared, 1.9 hectares partially cleared » Southern Brown Bandicoot: 1.2 hectares cleared, 2.8 hectares partially cleared » White-footed Dunnart – 1.2 hectares cleared, 2.8 hectares partially cleared » Long-nosed Potoroo - 1.2 hectares cleared, 2.8 hectares partially cleared Additional clearance of potential habitat for stage two would be: » Eastern Pygmy Possum: 0.3 hectares cleared, 1.0 hectare partially cleared » Southern Brown Bandicoot: 0.4 hectares cleared, 1.3 hectare partially cleared » White-footed Dunnart: 0.4 hectares cleared, 1.3 hectare partially cleared » Long-nosed Potoroo: 0.4 hectares cleared, 1.3 hectare partially cleared	Within the proposed transmission line easements, vegetation would be slashed thereby enabling groundcover species and small shrubs to remain and regenerate which would reduce the potential impacts on this group. The majority of vegetation to be cleared would be along the margins of vegetated areas. In most cases, extensive areas of potential habitat would remain adjacent to the study area and occur throughout the locality for all of these species. Some family groups of these species with small home ranges may be lost, if present, however it is unlikely that the proposal would put a local population at risk of extinction.
Loss of hollow-bearing tress	The proposal would result in loss of potential habitat for arboreal mammals, owls and microbats in the form of hollow-bearing trees. Removal of hollow-bearing trees at the site would reduce the amount of den sites for the Yellow-bellied Glider. Hollow-bearing trees at the site may also provide roosting and nesting habitat for microchiropteran bats and owls.	Given that Yellow-bellied Gliders are territorial and do not have overlapping home ranges with other family groups there may be potential for this species to disperse to other hollow-bearing trees in the area if disturbed.

Type of impact	Nature of impact	Significance of impact
	The exact number of hollow-bearing trees that would need to be removed for the proposal is unknown, but where possible hollow-bearing trees would be avoided.	Given that microchiropteran bats and owls are highly mobile, have large home ranges and potential habitat in the form of hollow-bearing trees is present adjacent to the proposed development area, it is considered unlikely that the proposal would place a local population at risk of extinction. Removal of some hollow-bearing trees at the site would not result in the removal of all potential habitat for hollow-dependent species at the site, as hollow-bearing trees were also recorded in the adjacent areas.
Hydrological changes	Vegetation clearance/slashing within and adjacent to drainage lines is expected to result in some changes to hydrological regimes. Retention of groundcover along transmission line easements would minimise impacts. Establishment of large impervious layers at the site could limit groundwater recharge, impact vegetation composition and fauna habitat, alter soil moisture content, and create conditions conducive to invasion by exotic species.	It is unlikely the proposal would result in additional significant changes to hydrological regimes other than those associated with vegetation removal.
Erosion, runoff and sedimentation	Nutrients, pollutants and seeds of exotic species could be transported from the development area to remaining vegetation. Increased nutrient levels may create conditions more suitable for exotic species and therefore result in an increase in the level of weed invasion at the site. Construction works in close proximity to drainage lines can lead to sedimentation, which can prevent growth of many groundcover species, as covering the leaf surface with sediment can prevent photosynthesis. Furthermore, in areas where sediment loads are high, sprouting of new seedlings may be prevented due to the layer of sediment. There is potential for increase in erosion with the study area and adjacent National Park due to increased flows if stormwater and runoff are not managed at the site.	Provided appropriate stormwater and sediment detention systems are installed at the site, and appropriate management measures are implemented, there are not likely to be any significant impacts on the retained vegetation, National Park or drainage lines.
Edge effects	Clearing is proposed mostly along the fringes of vegetation in areas currently impacted by edge effects, particularly the transmission line corridor and the existing cleared area on site. Clearing would shift the influence of edge effects further within the current stands of vegetation. Edge effects are more likely at the site where exotic species are present. Weeds would need to be controlled to avoid spreading into adjacent native	Significant new weed invasion is not likely along transmission line easements. Provided weed control measures are implemented, it is unlikely the proposal would have detrimental impacts on vegetation of the adjacent Bamarang Nature Reserve.

Type of impact	Nature of impact	Significance of impact
	vegetation. There is potential for edge effects where the proposed pipeline passes through undisturbed vegetation along the reserve boundary.	
Corridor values/Isolation	Isolation between vegetation to the west of the site would increase marginally as the area is already highly modified. No further isolation would result between areas to the south and east of the site and adjoining lands. The proposed gas pipeline would result in isolation of two currently connecting areas of vegetation between the Bamarang Nature Reserve and land to the south. An important potential east-west movement corridor for fauna is present within the study area.	The proposal is unlikely to prevent movement and dispersal of any fauna species, although some species may be more prone to predation during movement across cleared areas. It is not anticipated that the proposal will sever the east-west movement corridor. All areas currently connected to the east, south and west of the proposed site would remain and potential corridors to the north currently isolated by Yalwal Road would not be further isolated as a consequence of the proposal. All riparian corridors currently present within the study area would also remain.
Alteration of light, noise and dust levels	Artificial noise and light levels are likely to increase during construction and may remain elevated above current ambient levels thereafter. Noise may disturb birds and mammals, and may result in some roosting and foraging areas close to the proposal becoming unsuitable for ongoing habitation. Alteration to the light regime may change the way in which fauna use the area. There is the potential for dust levels to increase during construction, which if inadequately controlled, could smother plants and may be subsequently washed into streams, impacting aquatic fauna and wading birds.	Provided appropriate measures are taken to minimise noise, light and dust, the proposal is unlikely to have a significant impact on flora or fauna in the area.
National park impacts	Vegetation would remain between the National Park and the proposed gas fired power facility. Furthermore, weeds would be managed within this zone.	The vegetation would act as a buffer. Management of weeds would prevent spread into the adjacent National Park.
Key threatening processes	Key threatening processes relevant to the proposal are: » Clearing of native vegetation (TSC Act) and land clearance (EPBC Act); » Removal of dead wood and trees (TSC Act); and » Predation by the European Red Fox (TSC Act & EPBC Act).	The two stage process would result in gradual modification of native vegetation and fauna habitat, providing the opportunity for some species to relocate to adjacent areas. Territorial species are unlikely to be able to relocate. There is likely to be an increased threat of predation on native fauna from the European Red Fox due to clearing along the proposed pipeline.
Disturbance regimes	The bushfire hazard assessment prepared for the proposal (refer Section 8.4) does not propose any alteration in current fire hazard reduction burning	The proposal is not likely to significantly alter

Type of impact	Nature of impact	Significance of impact
	regimes. Areas cleared as part of the asset protection zones would be periodically slashed in order to reduce fuel loads.	current disturbance regimes.
Habitat connectivity	The proposed clearing involves the removal of strips of vegetation along already existing easements and roadsides, as well as clearing an area of vegetation for part of the proposed power facility adjacent to a previously cleared area (where the existing abattoir building and stockyards are located).	Impacts on habitat connectivity would be minimal.
Critical habitat	There are no areas identified as critical habitat present at the site.	

Table 8.14 Potential impacts on threatened fauna

Guild	Threatened species	Potential impacts
Amphibians	Giant Burrowing Frog	It is unlikely the proposal would disrupt the lifecycle of or have a significant impact on this species or its habitat.
Reptiles	Rosenberg's Goanna	It is unlikely the proposal would have a significant impact on this species or its habitat.
Megachiropteran Bats	Grey-headed Flying-fox	It is unlikely the proposal would have a significant impact on this species or its habitat.
Microchiropteran Bats	Large-eared Pied Bat, Eastern Bent-wing Bat, Eastern Coast Freetail-bat, Fishing Bat, Large-footed Myotis	It is unlikely the proposal would have a significant impact on the lifecycle or habitat of any threatened Microchiropteran bats.
Woodland Birds & Owls	Glossy Black Cockatoo, Square-tailed Kite, Bush-stone Curlew, Pink Robin, Regent Honeyeater, Gang Gang Cockatoo, Barking Owl, Powerful Owl, Masked Owl	It is unlikely the proposal would have a significant impact on woodland birds and owls due to the small number of hollow-bearing trees likely to be removed and the prevalence of hollow-bearing trees within the locality.
Ground-dwelling Mammals	Eastern Pygmy Possum, Spotted-tailed Quoll, Southern Brown Bandicoot, White-footed Dunnart, Long-nosed Potoroo	It is unlikely the proposal would have a significant impact on any threatened ground-dwelling mammals or their habitat.
Arboreal Mammals	Yellow-bellied Glider, Koala	It is unlikely the proposal would have a significant impact on any threatened arboreal mammals or their habitat.

8.3.4 Recommended mitigation measures

The footprint of the proposed facility and the location of the proposed transmission line and pipeline have been chosen to minimise the direct and indirect impacts on biodiversity of the locality, especially in relation to threatened species and endangered ecological communities. Consequently, it is considered that significant impacts on the biodiversity of the area are unlikely. Nonetheless, a number of mitigation and management measures are proposed to prevent direct and indirect impacts of the proposal on flora and fauna and their habitat within the study area and locality. These include:

» Fencing of proposed development areas to ensure construction works do not breach the boundaries or enter the adjacent vegetation and surrounding areas;

» Installation of sediment detention basins, or similar, prior to construction to prevent untreated runoff and sediment entering drainage lines and creeks within the study area;

» Implementation of 'best practice' stormwater treatment measures to maximise:

  – Onsite pollutant retention and removal; and

  – Infiltration and sub-surface discharge of stormwater (NPWS 1998);

» Placement of stockpiles away from vegetated areas;

» Piling of soil that may contain seed of exotic species away from adjacent vegetation or drainage lines where they could be spread during rainfall events;

» Monitoring and management of weed invasion along the proposed gas pipeline route to ensure regeneration of native species takes place;

» Maintenance of a vegetated buffer between any development and the adjacent reserve;

» Appropriate fire management measures and asset protection zones to be implemented in accordance with the provisions outlined in the Bushfire Risk Assessment (Section 8.4) to prevent fires spreading from the site to adjacent areas;

» Allowance for regeneration to maximum acceptable height along drainage lines supporting potential habitat for Nowra Heath-myrtle;

» A more thorough inspection of the disused abattoir prior to demolition to verify the absence of the Eastern Bent-wing Bat;

» Retention of mature, hollow-bearing trees within the study area (where possible); and

» Where avoidance of hollow-bearing trees is not possible, hollow-bearing branches and trunks would be carefully removed and checked by an ecologist for any fauna and then placed within the adjacent woodland to provide habitat for other fauna species.

Delta acknowledges DEC's request for habitat offsets. Delta commits to commencing discussions with DEC on this issue.

8.4 Bushfire risk assessment

This section summarises the results of the bushfire risk assessment undertaken by GHD. The complete report is contained in Appendix F. The bushfire risk assessment considered legislative requirements, in particular clause 46 of the *Rural Fires Regulation 2002,* and the guideline '*Planning for Bushfire Protection'* (PlanningNSW, 2001).

8.4.1 Methodology

A site inspection was conducted to determine potential bushfire risks associated with the site and proposal. The guidelines for bushfire risk assessment contained in Planning for Bushfire Protection were used to determine potential bushfire risks. The guidelines recommend consideration of the type and distribution of fuels, slope, and fire management measures to minimise bushfire risk.

The Rural Fire Service was consulted regarding bushfire risks specific to the locality and any specific requirements for investigation.

Vegetation typically provides the principal source of fuel loading for bushfires. The vegetation of the site and surrounding areas was classed following assessment of the vegetation structure. Slopes affect the speed and intensity of bushfires, with steep upslopes carrying a greater hazard than flatter slopes or downslopes. Land on the site was classified into slope on the basis of angle over a distance of 140 metres. The gradient considered to be the most likely to influence fire behaviour was used to calculate the bushfire risks.

8.4.2 Existing fire risk

Much of the vegetation on the west of the side of the site has been cleared. However, scattered native trees remain and groundcover comprises mainly of native grasses, with some limited regrowth occurring in non-built up areas. A fire trail approximately 4 metres wide has been maintained around the perimeter and informal tracks are also evident through some of the site.

The current transmission line easements are regularly maintained by slashing and vegetation is maintained as grassy cover. Road reserves along Yalwal Road are also regularly slashed.

As noted in Section 8.3, ten vegetation communities were recorded within the study area. These communities were classified in accordance with likely flammability of each vegetation type, based on factors such as likely fuel loads, vegetation composition and presence of sclerophyllous species. Vegetation communities were assigned to three categories, with Group 1 representing the greatest fire hazard and Group 3 the lowest fire hazard (refer Table 8.15).

Table 8.15 Fire hazard for vegetation communities in the study area

Vegetation Community	PBP Vegetation Group	PBP Group Number
Red Bloodwood/Scribbly Gum/White Stringybark Forest (±Blackbutt, ±Grey Gum)	Dry Sclerophyll Forest	1
Spotted Gum/Grey Gum Forest	Dry Sclerophyll Forest	1
Red Bloodwood/Thin-leaved Stringybark Forest (±Grey Gum, ±Scribbly Gum)	Dry Sclerophyll Forest	1
Spotted Gum/White Stringybark (±Grey Gum Forest)	Dry Sclerophyll Forest	1
Red Bloodwood/Thin-leaved Stringybark/Grey Gum Forest (±Blackbutt, ±Scribbly Gum) – located on the site	Dry Sclerophyll Forest	1
Cabbage Gum/Forest Red Gum Forest (River-flat Eucalypt Forest)	Woodland	2
Red Bloodwood/Scribbly Gum/Thin-leaved Stringybark Open Woodland – located on the site	Woodland	2
Heath	Tall Heath	2
Disturbed Riparian Vegetation	Tall Heath	2
Pasture	Grassland (pasture)	3

Note: PBP = *Planning for Bushfire Protection* (PlanningNSW, 2001)

The slope of the site was generally flat and can be classified as '<0-5° upslope' (Planning NSW 2001) and therefore can be considered to provide a low risk in relation to upslope acceleration.

8.4.3 Recommended fire management measures

Fire management measures include the provision of bushfire asset protection zones (APZs), site access and water sources.

Bushfire asset protection zones

An APZ is an area of land, adjacent to a building, in which the bushfire fuel load is managed to significantly minimise the impact of fire on that asset. The APZ acts as a buffer zone between an asset and the bushfire hazard. Usually the focus is on reducing ground and shrub fuel layers, however in some situations tree canopies may need to be pruned or thinned.

The Rural Fire Service advised that the vegetation clearance required for the transmission line easements, together with the standard vegetation management measures implemented below transmission lines, would be suitable for managing fire risks in these areas. As a result, no additional management measures need to be implemented in relation to the electricity transmission line.

As the proposed gas pipeline would be located underground, no APZs are required in this area.

APZs would be required at the site, to surround the proposed facility. The APZs were determined in consultation with RFS and are shown in Figures 8.4 and 8.5 and listed in Table 8.16. It is considered that the implementation of APZs, together with other site management practices described below, would adequately protect the proposal from risk associated with bushfire hazards.

Table 8.16 Asset protection zones required for the site

Location	Required APZ
North of power facility	40 metres from edge of structure.
South of power facility	40 metres from edge of structure.
West of power facility	40 metres from edge of structure.
Any additional structure protruding from main structure	20 metres from edge of structure.
Adjacent to cooling tower	20 metres from edge of structure.

APZs are divided into inner protection areas and outer protection areas. The purpose of the inner protection areas is to minimise the impact of direct flame contact and radiant heat on the facility. The purpose of the outer protection areas is to decrease the fuel level to reduce the intensity of a fire and restrict fire to canopy fuels. This reduces the level of direct flame, radiant heat and ember attack on the inner protection areas.

The inner protection areas would be kept free of fuel through regular mowing with less than three tonnes per hectare of fine fuel present at any time. Specific requirements for the inner protection areas are detailed in Appendix F.

Outer protection areas would be 10 metres wide and located adjacent to the hazard where it begins at the vegetated areas. Any trees and shrubs in the outer protection areas would be maintained in a manner that ensures that the vegetation/fuel load is not continuous. Fuel would be manually removed from the outer protection areas, piled and burned in a cleared area during low fire danger conditions. In the absence of any other policy, the recommended fuel level is 8 tonnes per hectare (PlanningNSW, 2001).

Site access

Access to the site would be established and maintained, and include a perimeter fire trail around the entire site boundary. This would need to be located within the site. If possible, two access roads to the site are recommended along paths that are unlikely to be cut by a fire simultaneously and therefore ensure there is at least one safe evacuation point. However, given the location of the site and surrounding land uses, this may not be possible. Specific requirements for the site access are detailed in Appendix F.

Water supply

Appropriate watering points would be provided along the perimeter trail from a series of fire hydrants. These hydrants would meet the requirements of Australian Standard 2419–*Fire Hydrant Installation* and be delivered by a ring main system.

Figure 8.4 APZs for Stage One

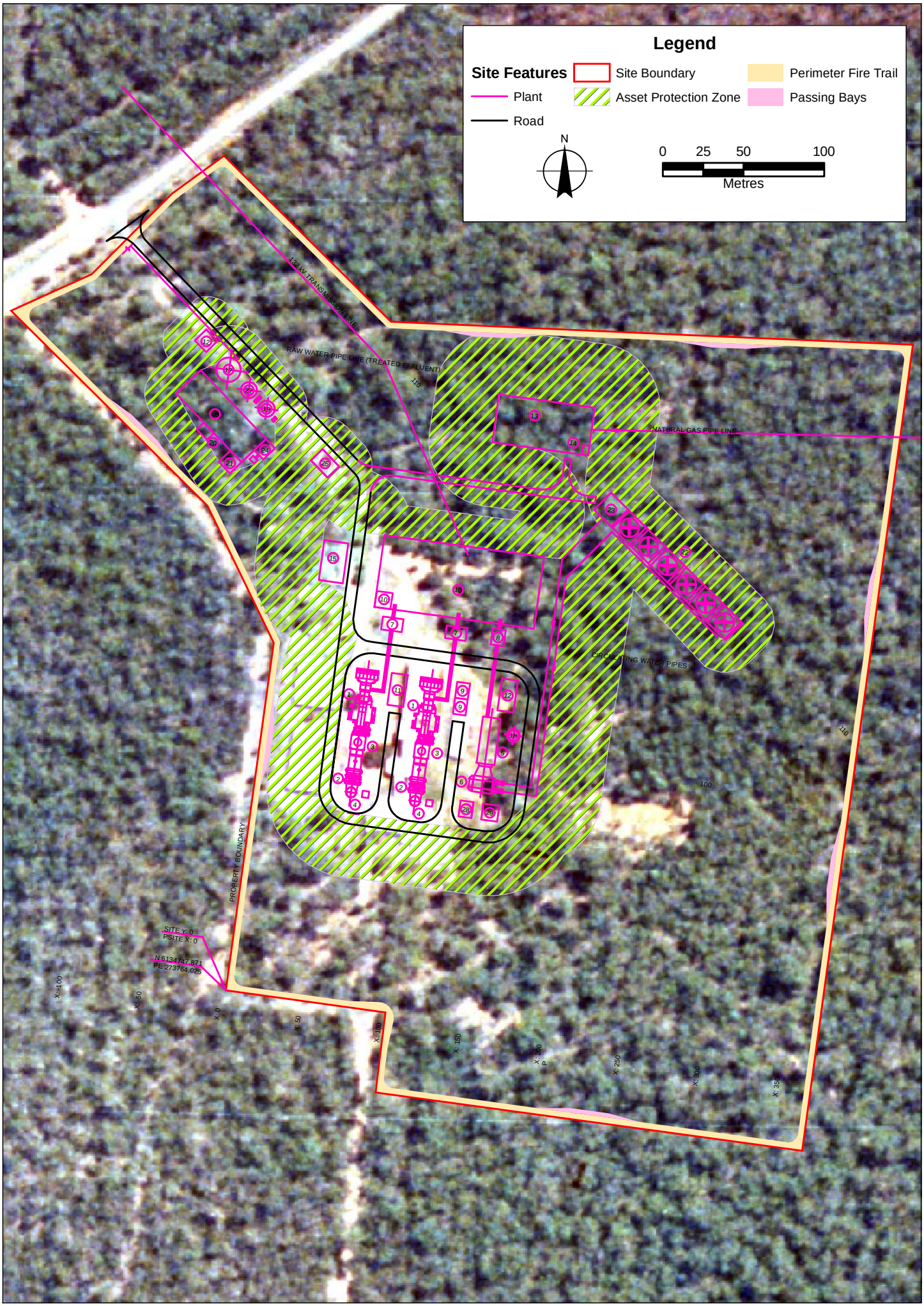


Figure 8.5 APZs for Stage Two

Document (MXD): G:\Projects\21138\51\GIS\Map Documents\EIS\APZ_Stage2.mxd

Building design, materials and construction standards

Based on the vegetation type present at the site, the category of bushfire attack would be high and therefore Level 2 (AS 3959 – 1999) construction standards would apply. As the proposal does not involve construction of a dwelling some of these provisions are not applicable. However, given the need to ensure a high level of protection for facilities on site, appropriate caution should be taken during the detailed design of the proposal. Most importantly, combustible materials likely to be impacted by radiant heat would not be used in construction of the proposal.

Additional recommendations

A number of additional recommendations have been made by the Rural Fire Service for fire protection during construction and operation of the proposal. These include:

» Preparation of an operation management plan that details fire prevention measures to be implemented during construction, including but not limited to:
  – Work involving risk of ignition would not be carried out during periods of total fire ban;
  – Fire suppression equipment would be available on site; and
  – Appropriate storage and maintenance of fuels and other flammable materials.
» Evacuation procedures would also be detailed for any persons located at the gas fired power facility during a bushfire; and
» The local Rural Fire Service control centre would be notified of the dates of construction, and the areas where 'hot works' are to be conducted would be highlighted.

8.5 Water

A water cycle management assessment was undertaken by GHD. The assessment considered the integration of water supply and sources, and management of stormwater, sewerage and process wastewater. This section provides a summary of the results of the assessment. The complete report is contained in Appendix G.

8.5.1 Existing environment

The following aspects were considered in order to assess the existing environment from the perspective of the total water cycle:

» Topography and drainage of the site and local region;

» The nature of existing water supply and water disposal infrastructure;

» The nature and proximity of groundwater aquifers; and

» Existing climate and rainfall patterns.

Further information on each of these is provided below.

Topography and drainage

The site is located at an elevation of approximately 110 metres, in close proximity to the catchment area of creeks that ultimately drain towards the Shoalhaven River. Bamarang Reservoir lies approximately 500 metres to the west of the proposed site and is part of the Nowra district water supply. Regional drainage is along the Shoalhaven River and towards the ocean to the east. The ocean is approximately 20 kilometres east of the proposed site.

A small area of the site drains to the west towards the Bamarang Reservoir, with the majority part of the site draining to Sandy Creek, to the east of the site.

The site has a slightly undulating topography and two tributaries of Sandy Creek convey surface water west to east across the proposed site. No steep escarpment areas occur in the area, with the nearest escarpments occurring to the north and east of the study area near the Shoalhaven River.

Four creek crossings are encountered along the easement proposed for the transmission line:

» Sandy Creek;

» Cabbage Tree Creek; and

» Flat Rock Creek; and

» Nowra Creek.

These creeks drain northwards to Shoalhaven River.

Local water and wastewater services

Water is considered a valuable commodity within the Nowra region with a high demand for good quality water arising from both industry, including Manildra Starches and Australian Paper, and agriculture, particularly dairy farms. The Nowra Water treatment plant, located on the northwestern side of Bamarang Reservoir, provides reticulated water to Nowra.

A raw water pipeline, carrying untreated water from the reservoir, passes to the northwest of the proposed site. This pipeline provides the raw water supply for industry in Nowra.

The town of Nowra is serviced by the Nowra and Bomaderry Sewage Treatment Plants (STPs). Shoalhaven Water (a division of Shoalhaven City Council) is implementing a Reclaimed Water Management scheme (REMS), whereby wastewater from a number of wastewater treatment plants is treated to a level where it is suitable quality for reuse. The Nowra and Bomaderry wastewater treatment plants are scheduled for upgrade in stage 1b of the scheme. This will produce approximately 7 megalitres per day of recycled water. However, this recycled water has generally been allocated for agricultural uses.

The site for the proposal does not currently have water or sewerage services connected.

Groundwater

Based on the regional geology map, the proposed site is located on the Berry Formation siltstone, sandstone and shale. Groundwater is expected to be fracture controlled with variable yields and salinities (Parsons Brinkerhoff, 2005b). The water level in the fractured rock aquifer is believed to vary from 4.5 to 24 metres below ground level with perched groundwater unlikely to exist at the site.

Climate and rainfall

While a weather facility exists at Bamarang, no rainfall data has been recorded. The Bureau of Meteorology Nowra rainfall gauge was used to obtain average rainfall statistics for the sites. The mean annual rainfall recorded at the gauge is 1,135 mm.

8.5.2 Water usage requirements and supply

Water usage requirements for the proposal would include:

» Process water, for the operation of the proposed facility; and

» Domestic water, for amenities including drinking water, kitchen facilities and toilets, and for grounds maintenance.

A simplified process flow diagram showing the major inputs and outputs to the water cycle for the proposal is provided in Figure 8.6.

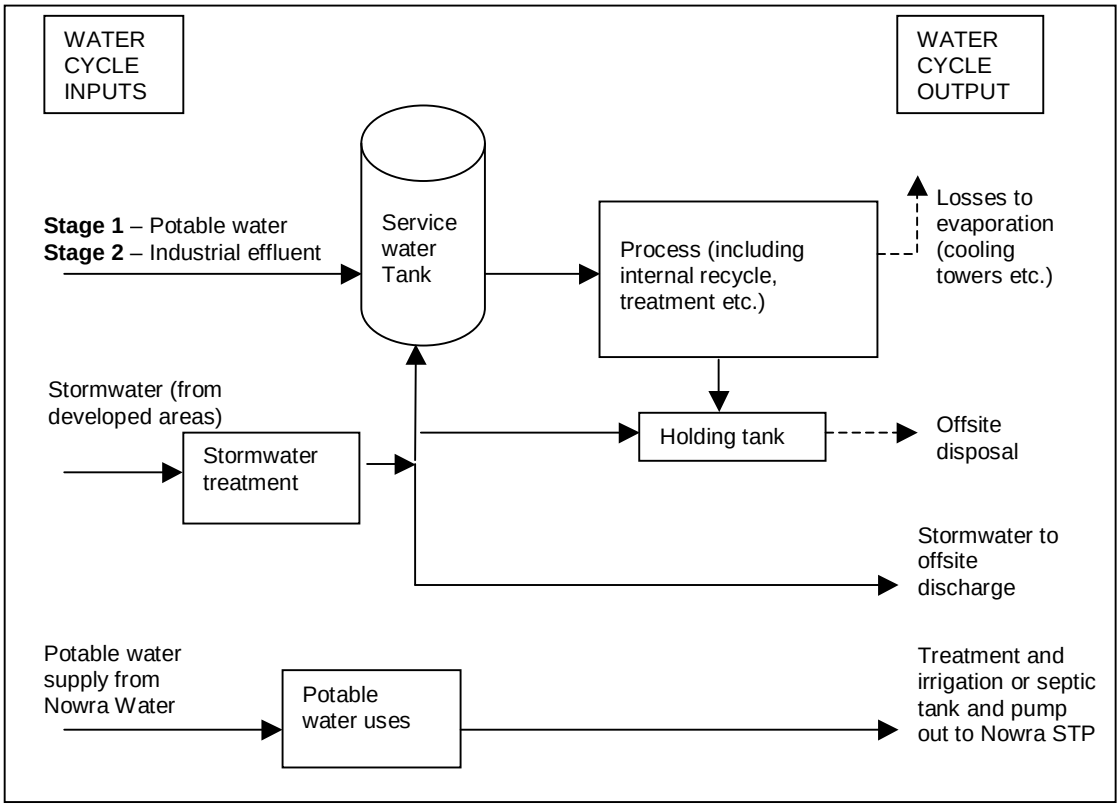


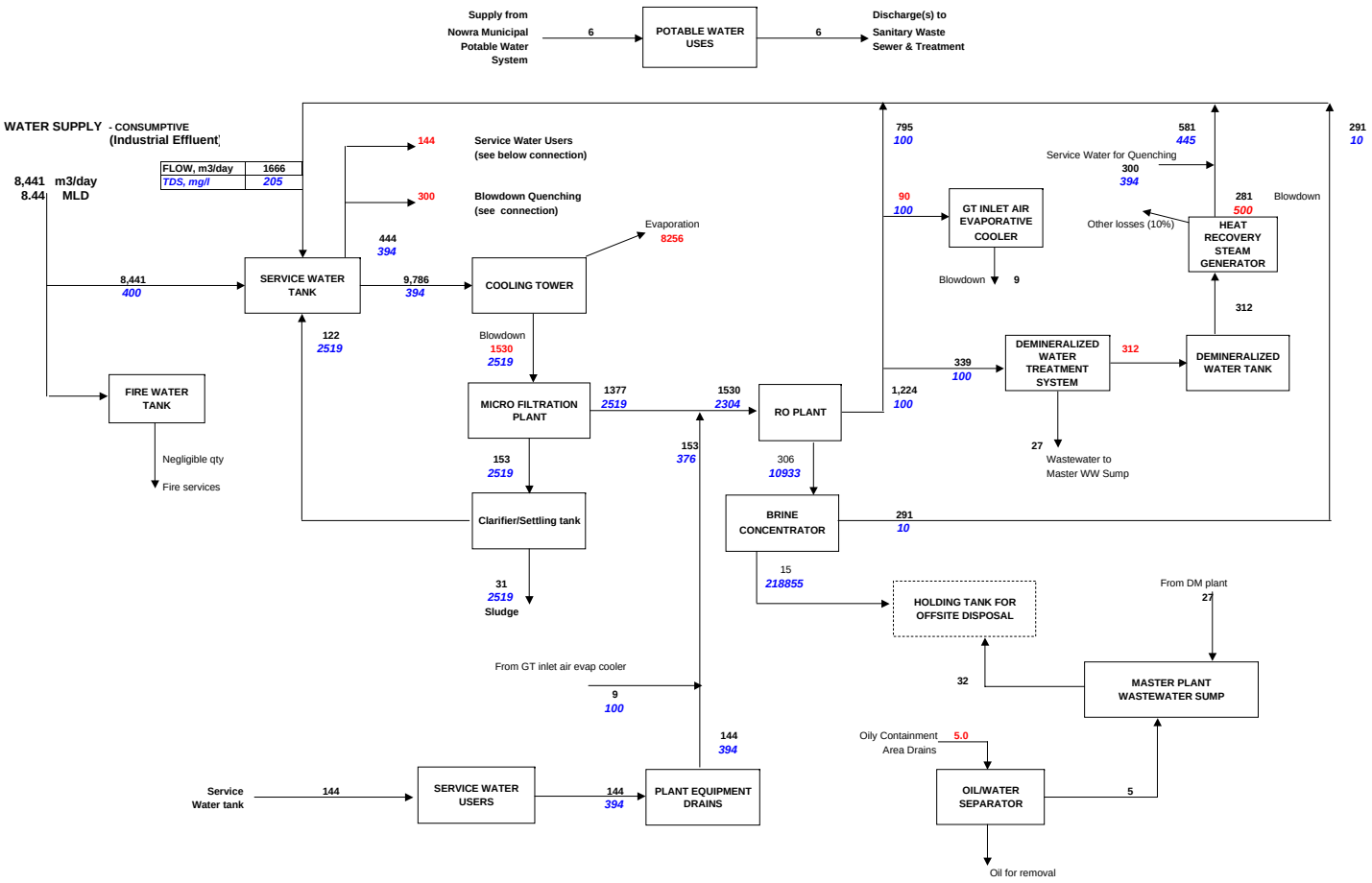
Figure 8.6 Water process flow diagram

During stage two there would be a much higher demand for process water, and the water cycle becomes more complex, with additional onsite treatment processes. A water balance for stage two is provided in Figure 8.7.

Process water

During stage one, the facility would have a minimal water requirement. Water is proposed to be sourced from the Nowra potable water supply. No treatment of this water is understood to be required (although this would be confirmed following detailed analysis). The total process water demand for stage one is estimated to be approximately 2 megalitres per annum.

The combined cycle facility proposed for stage two requires water for steam generation and cooling. The preferred option (subject to availability of water) is to use a water based cooling system, which would rely on evaporative cooling towers for cooling and condensing the steam from the steam turbines. This technology has a high net water demand (approximately 8.4 megalitres per day or 3,100 megalitres per annum). The preferred water source is to use industrial effluent. Manildra Starches and Australian Paper have been identified as possible sources of industrial effluent. Together these facilities generate sufficient quantities of effluent to supply the estimated stage two requirements.



NOTES:
1. Flows are in cubic meters per day(m3/day) and TDS in mg/
2. Arrangement shown is preliminary and subject to change during detailed desig
3. Water consumption estimate is based on GT Pro software output and projects of similar natur
4. RO plant output and reject based on discussions with vend
5. Raw water quality as per PB's water options repor
6. Flows and water balance are for stage-2 with plant running at full capacity, reduced capacity factor, ie. mid merit operation, will reduce flows in proporti

Figure 8.7 Water balance - stage two

FUEL	Natural Gas	CONDENSER COOLING	WET TOWER
NET PLANT OUTPUT (MW)	400	COOLING TOWER COC	6.4
LOAD FACTOR	100%		

GHD

ENGINEER SPM | DRAWN SPM | CHECK | DATE 1/09/2005

DELTA ELECTRICITY
PROPOSED GAS TURBINE POWER FACILITY, BAMARANG
WATER MASS BALANCE - STAGE 2
OPTIMUM DESIGN CONDITION- AMBIENT TEMPERATURE 25° C

JOB	DRAWING	REV
211385111	WMB	2

INDICATIVE-NOT FOR DESIGN

Domestic water

A potable water supply would be sourced from the Nowra Water treatment plant for domestic type uses. A pipeline would need to be installed from the existing reticulated water supply line, which passes to the north west of the site.

During stage one, the total potable water demand is expected to be approximately 200 kilolitres per annum, with the stage two domestic water demands expected to be approximately double that of stage one.

Preferred water supply

A number of potential water supply options were considered, including:

» Reclaimed effluent, from Shoalhaven Water's Reclaimed Water Management Scheme (REMS);

» Raw water, direct from Bamarang Reservoir;

» Industrial effluent, from industrial facilities in Nowra;

» River water, sourced from Shoalhaven River;

» Groundwater;

» Stormwater, collected from site;

» Site wastewater; and

» Potable water.

Industrial effluent (supplemented with stormwater collected from the site) is considered to be the preferred option for stage two process water as it would not divert more valuable water resources (potable water or raw water), from their existing uses. Reclaimed effluent (from the REMS scheme) was not considered a viable option at this stage, as the effluent has already been allocated to agricultural use. Shoalhaven Water (who are responsible for water management in the Shoalhaven area including the REMS scheme) has indicated that in the longer term, other water supply options could become available. This availability may coincide with the development of stage two, and hence a firm commitment to the preferred water source for this stage of the development cannot be made at the current time.

Other options were not viable as there is either insufficient volumes available, or the water is of a quality for which the cost of treatment makes it unviable.

If all water sources are found to be unviable then the use of a dry cooled process for stage two may be need to be considered.

8.5.3 Surface water management

Development typically increases the area of impermeable surfaces, through construction of pavements, hardstand areas, roads and buildings. This results in reduced infiltration of rainfall to the soil and higher volumes of water runoff.

The facility footprint and surrounds would be designed to drain in a northeast direction to Sandy Creek. The advantages of this are:

» A single discharge point from the site;

» Better control of surface water quality; and

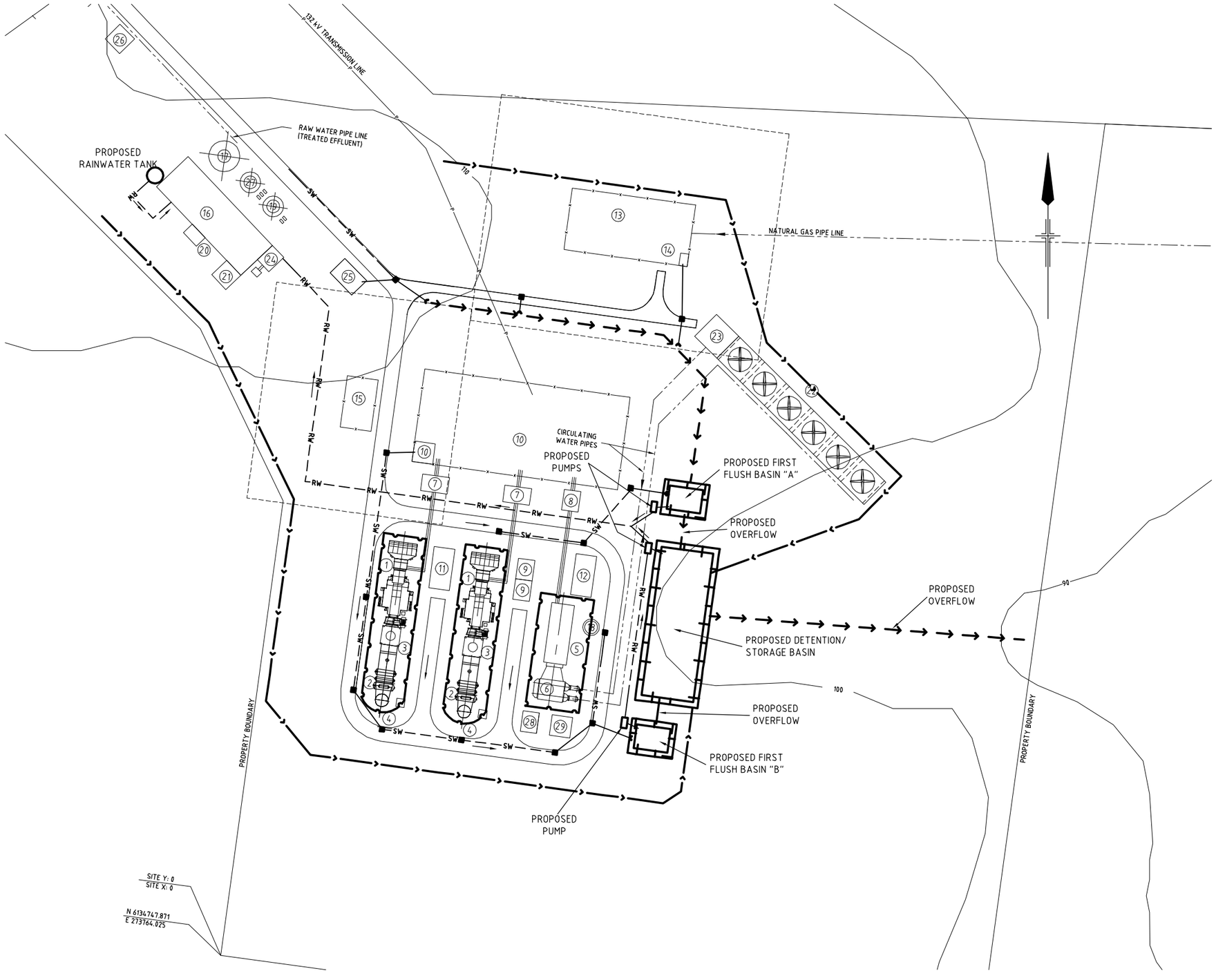
» No risk to the water quality in Bamarang Reservoir.

Only a portion of the site runoff would be captured for onsite use. The use of all runoff from the site, once developed, would deprive the receiving waterways of a significant volume of water and would potentially have an adverse impact on the environmental flows of local waterways. To ensure the runoff discharged from the site is of an appropriate quality to prevent adverse impacts on the environment, it would be necessary to implement management measures for surface water.

Site surface water management would involve the separation of clean stormwater from dirty stormwater. Dirty or contaminated stormwater would pass through treatment devices, such as oil/water separators and solids separation devices. Treated stormwater would then be integrated into the process water cycle, for example evaporation, grounds maintenance or other reuse (process), depending on the achievable water quality.

The quantities and quality of dirty stormwater cannot be determined until a detailed drainage plan is prepared for the site. This would be undertaken as part of the detailed design process. In general, the aim of drainage and stormwater management is to ensure that a similar runoff volume to the existing site runoff conditions, in terms of both quantity and quality, occurs post development, and that any excess stormwater is captured, treated and reused onsite.

The proposed stormwater management plan (for the stage two facility) is shown in Figure 8.8.



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

LEGEND

- SW — STORMWATER DRAINAGE LINE AND PIT
- RW — RE-USE WATER
- BIO-SWALE/SWALE
- CUT OFF DRAIN
- BUNDING

CONCEPT

No	Revision Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date
C	BASINS RELOCATED AND FIRST FLUSH BASIN ADDED	GW			16.11.05
B	POSITION DETENTION REVISED	JM			11.11.05
A	ORIGINAL ISSUE	GW	RB		27.09.05

0 10 20 30 40 50m
SCALE 1:1000 AT ORIGINAL SIZE

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Scale AS SHOWN	DO NOT SCALE	Client	DELTA ELECTRICITY
Drawn GW	Designed RB	Project	COMBINED CYCLE POWER PLANT - BAMARANG
Drafting Check	Design Check	Title	STORMWATER MANAGEMENT PLAN STAGE TWO Figure 8.8
Approved		Original Size	A1
Date		Drawing No:	21-13851-SK001
This Drawing must not be used for Construction unless signed as Approved		Rev:	C

Cad File No: G:\Projects\21\13851\CAD\CIVIL\ 21-13851-SK001.dwg Plot Date: 09 May, 2006 - 10:21 AM

8.5.4 Process wastewater management – use, collection and treatment

Potable water received at the site during stage one would be stored in a service water tank ready for use. The major water use at the site would be process water during stage two. For stage two, the industrial effluent received would need to undergo further treatment prior to entering the service water tank. While detailed analysis is yet to be conducted on this water source and its reliability for stage two process requirements, the treatment process is likely to involve filtration (with some chemical dosing) such as sand filters or dual media filters. More extensive treatment may be necessary (for example, additional microfiltration/reverse osmosis) if the effluent is found to be of a particularly poor quality. Backwash from the filters may need to be subjected to further treatment (chemical dosing/solids removal) to achieve further water recovery.

The main use of process water use would be in the cooling towers. A wet cooled system relies on evaporative (wet) cooling towers and requires significant amounts of make up water. Salinity in the cooling circuit is also controlled by blowdown, which is the removal of saline concentrated water from the cooling tower water recirculation system. A 'fresh' makeup water stream is added to replace the blowdown. It is proposed that the blowdown would be treated in a microfiltration/reverse osmosis plant to remove the dissolved salts, with treated water being re-used at site.

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

» Microfiltration is a pre-treatment step undertaken to remove solids, thus providing very low turbidity water, remove pathogens and prolong reverse osmosis membrane life. Backwash from the microfiltration unit would be treated and returned to the service water tank.

» Reverse osmosis, which occurs where a solution is placed under pressure causing water to pass through a semi permeable membrane while the solute is retained. The brine from the reverse osmosis would be concentrated prior to passing to a holding tank for offsite disposal.

The microfiltration/reverse osmosis plant would be sized to handle flows of around 1.5 megalitres per day.

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

Concentrated wastewater from the reverse osmosis process (brine) together with wastes from the demineralisation process and separated oil/water mixes would be pumped to a holding tank prior to offsite disposal during stage two (little or no wastes would be generated during stage one). Offsite disposal is likely to be via an ocean outfall, potentially in conjunction with effluent outfall from a sewage treatment plant (to assist in dilution and dispersion). In the event that such an option is not

available, then disposal via onsite evaporation or brine crystallisation would need to be investigated. This issue requires further consideration as part of the design process for stage two.

8.5.5 Impact assessment

The major interaction of the water cycle with the environment would be via the water source inputs of industrial effluent and potable water, and water cycle outputs of vaporisation, domestic wastewater and stormwater discharge and offsite disposal of brine concentrate. The use of large amounts of water within the process can impact on the water cycle by diverting water away from existing environmental pathways. Where a large wastewater stream is generated, the receiving environment for the discharge may also be impacted. As the proposal is not intended to have major water discharges, other than evaporation, the potential for impacts is significantly reduced.

Water cycle inputs

Any diversion of water from the current uses may have an impact on the local water cycle. For stage one, the major source of water is from the potable water supply. However, the total volumes required are not expected to have a significant impact on the total demand on the plant.

The proposed major water source for stage two is industrial effluent. Currently the effluent is understood to be discharged into either a receiving waterway (Shoalhaven River) or irrigated to land directly (by Manildra Starches). By diverting this water source from their existing receiving environments, there could be a positive impact as these waters may contain impurities that could result in impacts to the receiving environment.

Water cycle outputs

As noted, the aim for the site is to discharge minimal water. While large volumes of water would be received at the site, most water loss would be through release to the atmosphere (through the cooling tower and steam losses etc). Evaporation is a natural part of the water cycle and serves as a precursor to the processes of condensation and precipitation. Thus the release of water to the atmosphere is not considered to have a significant impact on the environment. Some water cycle outputs during stage two (approximately 50 kilolitres per day of the total 8.4 megalitres per day received at the facility, that is approximately 0.6%) would be a waste brine solution. It is proposed that this be disposed of into the ocean via an existing treatment plan. This would be subject to confirmation prior to stage two.

Stage one of the proposal would involve septic tank pump out of the domestic wastewater stream by licensed contractor and discharge to the Nowra STP. This would account for around 9 kilolitres per day of the total 3 megalitres per day (approximately) that currently passes through the Nowra STP (i.e. less than 1% of the flow). Wastewater at the STP is currently treated and discharged to both a receiving waterway and a use (irrigation) area. As a result of the small volume and quality of the wastewater generated during stage one, no impacts are expected. For stage two, the wastewater generation rate is expected to double relative to that of stage one of the proposal. However the relative proportion of wastewater from the proposed facility would still be expected to be less than 1% of the total flow received at the Nowra STP.

Surface water (stormwater) runoff is another of the outputs from the water cycle. This is recognised as one of the main potential impacts requiring management as part of the design and operation of the proposal.

Stormwater runoff impacts

Development results in increased impermeable surfaces, which can affect the hydrological cycle. This 'hardening' of the surfaces results in reduced infiltration of rainfall to the soil and more rainfall becoming runoff. If not managed effectively, impacts from runoff could include:

» Impacts to the water balance, in groundwater recharge. This has the potential 'knock-on' impact on local base flows effecting streams, groundwater and water bodies;

» Stormwater pollution by runoff and accidental spills entering the stormwater system and discharging off the site;

» Development and infrastructure on the site could lead to increased recharge due to removal of vegetation, over-irrigation, and structural leakages; and

» Increased stormwater runoff peak flows and flood risk (both on-site and local); and

» Construction phases impacts, such as erosion and sedimentation.

The implementation of stormwater management practices would ensure the potential for these kinds of impacts are minimised.

Potential causes of pollution of stormwater discharging from the site. They include:

» Increased runoff volume during regular rainfall events would more readily entrain and mobilise pollutants (particularly first flush) and increase pollutant loads to the receiving environment;

» The type of development and associated activities may introduce differing pollutant profiles; for example, vehicular traffic could increase hydrocarbon introduction. The movement of vehicles, particularly during dry periods, could result in dust, and disturbed surfaces could provide a source of sediment, substantially contributing to the total suspended solids. In general, typical pollutants include litter, sediment, suspended solids, nutrients, hydrocarbons and toxicants;

» Accidental spills on unbunded areas of the site could discharge to the site stormwater system and the receiving environment. In addition this could lead to groundwater contamination;

» The generation of wind borne sediment/material by any of the operational activities could be deposited in to the stormwater system;

» Cross-contamination from on-site waste streams site entering the drainage system and groundwater;

» Contamination from storage facilities (for example stockpiles, machinery storage and chemical), and covered/uncovered works areas which may include fuel, oil, grease, coolant, chemicals, solvents and/or cleaning agents; and

» During construction there is a risk of increased stormwater pollution.

Recommended management measures described in Section 8.5.6 would be implemented to minimise the potential for the above impacts. As a result, there is expected to be minimal potential for significant operational impacts as a result of the proposal.

Potential for impacts on Bamarang Reservoir

Surface water runoff

As noted previously, Bamarang Reservoir is located approximately 500 metres to the west of the proposed site. Stormwater runoff from the majority of the site currently drains towards the northeast, to Sandy Creek. A small area of the site drains to the northwest towards the Bamarang Reservoir.

As noted in Section 8.5.3, the facility footprint and surrounds would be designed to drain in a northeast direction to Sandy Creek. This would ensure that there is better control of site surface water quality and no risk to the water quality in Bamarang Reservoir.

To ensure that runoff discharged from the site is of an appropriate quality, surface water management would be undertaken in accordance with the measures recommended in Section 8.5.6.

Groundwater

Another potential pathway for impacts to Bamarang Reservoir might be via groundwater. However, as discussed in Section 9.3, it is considered that given the relative low risk of any spills on the site and minimal disturbance of the sub-soil structure, the proposal would not pose any significant threat to the local environment via groundwater contamination.

Air emissions

As noted in Section 8.1.3, the dominant wind direction is from the west-northwest (that is, the from Bamarang Reservoir towards the site). Analysis of prevailing wind directions informed the selection of the cooling tower location and orientation (located to the northeast of the facility) to avoid cooling tower drift (steam) falling onto the switchyard and other electrical equipment.

Atmospheric pollutant isopleths (contours), provided in Appendix D, indicate that neither the recreational amenity nor the water quality of the nearby Bamarang Reservoir would be impacted by emissions from the proposed facility.

Construction phase impacts

During the construction phase, clearing and earthmoving activities have the potential to impact on surface water quality in the vicinity of the site and along the transmission and gas pipeline routes, especially during high rainfall events. The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

» Earthworks undertaken immediately prior to rainfall periods;

» Work areas that have not been stabilised, and clearing of land in advance of construction works;

» Stripping of topsoil, particularly in advance of construction works;

» Bulk earthworks and construction of pavements;

» Washing of construction machinery;

» Works within drainage paths, including depressions;

» Stockpiling of excavated materials;

» Storage and transfer of oils, fuels, fertilisers and chemicals; and

» Maintenance of plant and equipment.

The potential for construction related impacts to water quality would be managed by the implementation of a comprehensive environmental management plan for the construction period.

Summary of impact assessment

Hydrological simulations were undertaken to support this assessment, and these indicated that detention strategies could effectively mitigate the impacts of development on stormwater runoff peaks. In addition, on-site opportunities for re-use of runoff have been identified to supplement process water. The potential for negative impacts would be effectively managed by the implementation of measures detailed in the following section.

Ongoing monitoring would be undertaken to ensure that stormwater management measures are working effectively. Details of the recommended monitoring program are provided in Section 8.5.6.

8.5.6 Recommended mitigation and management measures

Mitigation measures to minimise the potential for impacts on the receiving environment are integral to the selected water management process. In particular, water would be sourced from an existing industrial use (if available) or through the use of an existing raw water allocation.

In order to minimise water use (and hence any impacts on the water source), best practice water minimisation equipment would be used (for example high pressure hoses for cleaning, water saving water fixtures for domestic water uses such as dual flush toilets etc).

Domestic wastewaters will be transported offsite in accordance with Council requirements and by licensed contractors.

Stormwater

As a portion of the stormwater would still be released to the environment, management and mitigation of stormwater impacts is considered a high priority for the site. Overall, it is considered viable that the future site platform can be orientated to drain the entire site in a northeast direction via Sandy Creek, to the Shoalhaven River.

In order to effectively manage and mitigate the impacts identified above, the following mitigation measures are proposed:

» Water balance:
  – Provision of stormwater retention strategies and infiltration;
  – Rainwater harvesting;
  – Management and monitoring of onsite water related activities and infrastructure;
» Stormwater management:
  – Treatment of stormwater, by targeting pollutants;
  – Bunding;
  – First flush systems;
  – Implementation of the proposed surface water management measures described in Section 8.5.3;

» Construction phases impacts:

  – Development and implementation of a soil and water management plan as part of the construction environmental management plan;
  – Implementation of standard erosion and sediment control strategies in accordance with relevant guidelines; and
  – Ongoing monitoring and maintenance of erosion and sediment control strategies.

These strategies would be incorporated into the construction and detailed design of the proposal, and measures to monitor their effectiveness would be included in the construction and operation environmental management plans.

Recommended monitoring program

Monitoring would be undertaken to ensure that stormwater management measures are working effectively. Monitoring would rely primarily on visual inspections and sampling. Visual inspections would be undertaken of sediment basins, pits, diversion and catch drains and all other stormwater conveyance structures. A general indication of frequencies for inspections is provided in Table 8.17. An inspection log detailing the monitoring program would be kept.

Table 8.17 Water monitoring program

Sample location	Collection mechanism[1]	Frequency first six months[2]	Frequency normal operation
Sediment basins	Visual Inspection	Every runoff event	Monthly
Inlet pits	Visual Inspection	Every runoff event	Monthly
Trunk drainage channels	Visual Inspection	Every runoff event	Monthly
Overland flow paths	Visual Inspection	Every runoff event	Monthly
Trafficable areas	Visual Inspection	Every month	
Bunded areas	Visual Inspection	Every runoff event	
Other works areas, potentially contaminating stormwater	Visual Inspection and system operation testing	Every month	

Notes:

1. For every inspection, date, time and ambient weather conditions would be recorded.
2. Runoff event must be sufficient, iInspect after 24 hour retention period (i.e. 24 hrs after runoff event).

Chapter 9. Management of other environmental issues

9.1 Overview

The preceding chapter addresses what are considered to be the key potential environmental impacts associated with the proposal. In addition to the key potential impacts, there are a range of other issues that have been considered to order to develop an appropriate environmental management framework for the construction and operation of the proposal.

These issues include:

» Management of operational noise;

» Construction noise and vibration;

» Management of soils;

» Visibility of the proposal and the potential for visual impacts;

» Management of cultural heritage resources;

» Hazards and risk; and

» Management of traffic, particularly during construction.

This chapter considers the nature of the potential environmental issues and the management initiatives proposed to ensure the potential for environmental impacts during construction and operation are minimised. The proposed management practices form the basis for the draft Statement of Commitments located in Chapter 10.

9.2 Noise

The POEO Act provides the regulatory tools for managing noise impacts from new and existing noise-producing developments. Under the Act, DEC has responsibility for control of noise emissions from premises licensed by DEC under Schedule 1 of POEO Act (scheduled premises). As noted by Chapter 3, the proposal would require a licence under the POEO Act.

The NSW Industrial Noise Policy (INP) was released by the EPA in January 2000. The INP provides a framework and process for deriving operational noise criteria for development consents and licences, allowing the control of noise from premises scheduled under the POEO Act. The corresponding guidelines for construction noise are contained in the Environmental Noise Control Manual (EPA 2000).

A noise impact assessment for the proposal was undertaken by GHD. This assessment provides details of existing noise levels at nearby receivers, calculates the noise impact assessment criteria based on existing noise levels and relevant DEC guidelines, predicts the noise levels that are expected to result from the operation of the site, and provides an assessment of these levels against

relevant criteria. A summary of the key noise assessment findings is provided in this section, and the full report is included in Appendix H.

9.2.1 Noise criteria

Existing noise levels

Table 9.1 presents the results of noise monitoring undertaken in three locations representative of the nearest noise sensitive receivers near the site.

Table 9.1 Existing noise levels (rating background levels)

Location	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
Location 1 - Make it Mudbricks (lot 22 DP 746233)	32 $L_{A90(day)}$	28 * $L_{A90(evening)}$	29* $L_{A90(night)}$
Location 2 - 213 Gannet Road	32 $L_{A90(day)}$	28* $L_{A90(evening)}$	28* $L_{A90(night)}$
Location 3 - 190 Bamarang Road	30 $L_{A90(day)}$	28* $L_{A90(evening)}$	27* $L_{A90(night)}$

Note - * The INP states that where the rating background level is less than 30 dB(A), then it should be set at 30 dB(A), therefore these values have been adjusted to 30 dB(A) for further calculations.

Background noise levels are relatively low which is indicative of a rural environment with low traffic levels. No significant traffic or existing industrial noise sources are present within the vicinity of the site. During fieldworks, local fauna and noise sources consistent with the land use and setting of the site were the primary influence on ambient noise.

Target noise emission levels for operation

Assessment of noise sources in accordance with the INP involves consideration of two criteria:

» The 'intrusiveness' criterion – this is aimed at controlling the relative audibility of operational noise compared to the background level, and limits noise levels to a value commonly described as 'background noise plus 5dB'; and

» The 'amenity' criterion - aims to limit continuing increases in noise levels in an area from new industrial noise sources.

The standard approach is to calculate both sets of criteria, and apply the lowest of the two in each time period.

Using the criteria set by DEC and the existing noise data presented above, noise criteria were derived as shown in Table 9.2.

Table 9.2 Project specific noise levels

	lot 22 DP 746233			**213 Gannet Road**			**190 Bamarang Road**		
Criterion	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am	Day 7 am to 6 pm	Evening 6 pm to 10 pm	Night 10 pm to 7 am
A: Rating Background Level	32 $L_{A90(day)}$	28* $L_{A90(evening)}$	29* $L_{A90(night)}$	32 $L_{A90(day)}$	28*$L_{A90(evening)}$	28* $L_{A90(night)}$	30 $L_{A90(day)}$	28* $_{90(evening)}$	27*$L_{A90(night)}$
B: Intrusiveness Criteria (A + 5dB)	37 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	37 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$
C: Rural Amenity Criteria (Table 2.1 INP)	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $_{Aeq(evening)}$	40 $L_{Aeq(night)}$
D: Amenity Criteria: (INP Table 2.2 Adjusted)	50 $L_{Aeq(day)}$	45 $L_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $_{Aeq(evening)}$	40 $L_{Aeq(night)}$	50 $L_{Aeq(day)}$	45 $_{Aeq(evening)}$	40 $L_{Aeq(night)}$
E: Project Specific Noise Level (Pg 21 INP)	37 $L_{Aeq(15min)}$	35 $L_{Aeq(15min)}$	35 $L_{Aeq(night)}$	37$L_{Aeq(15min)}$	35 $_{Aeq(evening)}$	35 $L_{Aeq(night)}$	35 $L_{Aeq(15min)}$	35 $_{Aeq(evening)}$	35 $L_{Aeq(night)}$

Note - * Adjusted to 30 dB for further calculations.

Construction activities

The DEC's preferred approach to the control of construction noise involves the following elements:

1. Noise level restrictions: For a construction period greater than 26 weeks duration (construction of both stages would involve a period of greater than 26 weeks), the LA10(15minute) noise level emitted by the works should not exceed the LA90(15minute) rating background level by more than 5 dBA when measured at a residential receiver. Criteria developed for the proposal are provided in Table 9.3.

Table 9.3 Construction noise criteria

Construction Period	Level Restrictions	Bamarang 1 L_{A10}	Bamarang 2 L_{A10}	Bamarang 3 L_{A10}
More than 26 weeks	Background + 5 dB	37	37	35

2. Time restrictions – hours of work:

   Monday to Friday – 7am - 6pm;

   Saturday – 7am to 1pm if inaudible at a residential premises; otherwise 8am to 1pm; and

   No work on Sundays or Public Holidays.

3. Noise controls: All practical measures should be used to silence construction equipment, particularly in instances where extended hours of operation are required.

9.2.2 Operation noise management

Potential noise issues

The gas turbines, heat recovery steam generators and ancillary equipment such as the air cooled condensers have the potential to generate noise. To minimise the potential for noise impacts to be experienced by residential receivers, acoustic mitigation features would be incorporated into the final design. The aim of the acoustic mitigation features would be to ensure that off site noise levels remain at or below the levels listed in Table 9.2.

Modelling was undertaken under differing meteorological and operational (that is, with and without noise attenuation measures in place) for both stages of the proposal. Acoustic modelling was undertaken using the Computer Aided Noise Abatement (CadnaA) model.

Initial modelling was based on raw noise data provided by major equipment manufacturers for the respective equipment prior to incorporation of any noise mitigation measures. Results of the initial modelling indicate that, in the absence of any noise attenuation measures, project specific noise goals have the potential to be exceeded. The results of modelling, including noise contours for all modelled scenarios, are presented in Appendix H.

It is noted that the major components of the proposal (such as the gas turbines, heat recovery steam generators and steam turbine) would be selected following a competitive tendering process, which would occur as part of the detailed design development of the proposal. It is expected that the components selected would be 'off the shelf' units, provided by manufacturers. Components would be evaluated on the basis of proven levels of efficiency, reliability and operability. Exact noise outputs, and therefore the necessary features that would need to be incorporated in the design to

ensure that noise criteria would be achieved, can only be determined once the tendering process is complete.

CADNA-A was used to provide a mitigation scenario for each set of equipment having a sound power level of 91 and 96 dB(A) located 4m above the ground. This corresponds to the general industrial practice requirement of noise level not to exceed 80 and 85 dBA (SPL) respectively at 1 metre from the noise source. From this, the predicted emissions (as a result of operation with acoustic mitigation incorporated in the design) at the receiver points can be determined as a guide.

CADNA-A was used to provide a mitigation scenario for each set of equipment having sound pressure level 80 and 85 dBA (SPL) respectively at 1 metre from the noise source which corresponds to general industrial practice noise requirements. These sound pressure levels were converted to sound power for levels for modelling purposes using the equation:

SPL = SWL – 20logr –11

Where:

» SPL = Sound Pressure Level

» SWL = Sound Power Level

» r =1 metre

The resultant sound power levels used in the model were 91 and 96 SWL dB(A) respectively. From this, the predicted sound pressure levels at the receiver points can be determined as a guide.

Modelled sound pressure levels at the residential receiver locations for stage two of the proposal represents a worst-case scenario with all plant items operating, including noise generating equipment from stage one. Therefore the stage one development, with SWL specified as 91 dB(A) for all significant noise generating equipment, is predicted to meet the relevant project specific noise goals.

Predicted noise contour plots are presented in Appendix H. Modelled sound pressure levels at the residential receiver locations with noise attenuation measures are summarised in Table 9.4.

Table 9.4 Modelled unattended receiver sound pressure levels dB (A) with noise attenuation measures

	Upgrade 80 dB(A) Neutral Weather	Upgrade 80 dB(A) F Class towards north west	Upgrade 80 dB(A) F Class towards south east	Upgrade 85 dB(A) F Class Neutral Weather	Upgrade 85 dB(A) F Class towards north west dB(A)	Upgrade 85 dB(A) F Class towards south east	*Project Specific Noise Goals dB(A)*
Lot 22 DP 746233	39.2[1]	32.9	29.2	34.2	37.9[1]	34.2	*35*
213 Gannet Road	19.4	19.4	23.8	24.6	24.6	29	*35*
Bamarang 190 Road	11.9	15.1	11.9	17	20.2	17	*35*

Note – 1 scenario exceeds project specific noise goal.

The revised noise mitigation scenario based on general industrial practice suggests that if all equipment are attenuated to a minimum sound power level of 91 dB(A), then the project specific noise goals for stages one and two can be met at the monitoring locations. It is recommended that such noise level specifications be imposed on all equipment manufacturers.

Noise mitigation options

The specification provided to prospective equipment suppliers would dictate the acoustic performance the units would be expected to meet, based on the conditions of consent for the proposal. The equipment suppliers would develop the mitigation measures such that the noise attenuation is maximised and impacts are minimised. The usual practice is to provide a performance-based approach involving a sound level specification, rather than a prescriptive requirement to include specific mitigation measures. This promotes design flexibility and the ability to achieve the optimum outcome in an efficient and effective way.

Delta commits to placing a requirement on the contractor responsible for the design and management of the overall facility to ensure they meet the required noise performance. The designer would be expected to incorporate appropriate mitigation features in the overall design to ensure that noise criteria at residential receivers are not exceeded.

The following represents typical noise mitigation strategies for major equipment of similar power facilities. Final selection would be undertaken by the contractor, in accordance with the above requirement.

Gas turbine

» Air inlet silencing.

» Acoustic insulation on the outside of the air inlet.

» Upgrades of the standard acoustic enclosure.

» Upgrades of the cooling system with low noise fans and/or acoustic treatment.

» Upgrades of exhaust silencing.

» Acoustic walls and/or additional acoustic treatment for the generator enclosure.

» The air inlet and cooling systems are generally outdoor sources and could potentially be attenuated.

» Placing the gas turbine in a building is usually the last resort due to capital outlay considerations.

Heat recovery steam generator

» The installation of a silencer in the exhaust stack.

» Increasing the casing thickness/mass of the transition and/or boiler sections.

» Erecting barrier walls.

» Installation of an acoustical shroud over all or portions of the transition duct.

» Installation of silencer in the transition portion.

Steam turbine

» Insulation of steam turbine casing with acoustic blankets.

» Increase insulation thickness of all steam piping leading to steam turbine.

» Installation of acoustic casing for steam turbine.

» Indoor installation of entire steam turbine for the purpose of noise mitigation and weather protection.

In addition, a noise monitoring program would be developed and implemented as part of the operation environmental management plan.

9.2.3 Construction noise management

Proposed construction activities, vehicles and equipment are described in Section 6.5. During the construction of the proposal, in a worst-case configuration, noise levels have the potential to reach project specific noise levels. However, it is highly unlikely that all of the machinery would be operating at full power at the same time for an extended period.

A noise management strategy would be prepared as part of the construction environmental management plan, detailing the methodology proposed by the construction contractor and the relative phasing of different construction activities in different areas. The timing of construction activities with respect to rise and fall of background noise levels would serve as a primary means by which impacts are managed. It is recommended that the noise management strategy incorporate the following:

» The use of quietest plant available, regularly maintained and fitted with appropriate mufflers;

» Restricting construction hours to the hours listed above; and

» Noise monitoring to ensure best practice is being implemented.

Traffic noise

There are no criteria for noise from traffic associated with construction. It is assumed that noise from traffic associated with construction would be minimised as much as possible by limitations on construction hours and the Australian Design Rules that apply to road registered vehicles.

9.2.4 Vibration

The Environmental Noise Control Manual provides guidelines for vibration levels. These are summarised in Table 9.5.

Table 9.5 Vibration guidelines criteria at residences

Place	Time	Continuous Vibration	Intermittent or Impulsive
Residential	Day	2	60
	Night	1.4	20

Construction pile driving is potentially the greatest source of vibration associated with construction equipment expected to be used. By avoiding impact pile driving where possible in vibration sensitive areas, through the use of drilled piles or the use of sonic or vibratory piles, adverse vibration impacts could be significantly minimised.

Based on distance to the nearest anticipated receivers, the type of equipment proposed to be used and the likely building form, it is considered that operational vibratory impacts would not be an issue.

9.3 Soil and groundwater issues

9.3.1 The site

Potential contamination issues

There have been two previous studies relating to potential contamination at the site:

» Phase 1 Environmental Site Assessment, 681 Yalwal Road, Bamarang, URS Australia Pty Ltd, 23 January 2004; and

» Bamarang Gas Turbine Power Station Site, Asbestos Assessment, Parsons Brinckerhoff, 13 October 2004.

The key issues arising out of these reports are summarised below.

The site is understood to have been a 'greenfield' (undeveloped) site prior to construction of the existing abattoir buildings in the early 1980s. The site was never actually used as an abattoir. However, a number of other activities have occurred on-site, including:

» Vehicle maintenance and repair (on a very small scale);

» Scrap sorting and storage;

» Sand blasting (which occurred for around 10 months from September 2001, under a Development Approval granted by Shoalhaven City Council);

» Burning of household wastes, in two localised areas around an existing residential type cottage plus one area around an existing amenities building;

» Burning of green waste, in one localised area near the southern extremity of the site's cleared area;

» Surface deposition of wastes in some localised areas;

» Apparent burial of waste (construction debris) in an area south of an existing amenities building; and

» Keeping of livestock (goats and chickens).

It was also noted (by Parsons Brinkerhoff) that at least one of the existing site buildings contained asbestos, in the form of bonded fibre cement sheeting. Furthermore, a spoil heap located in the southeastern corner of the cleared area was noted to contain suspected fibrous cement fragments. The majority of asbestos has been removed from the site. Some asbestos still remains in the amenities building (gables).

Two underground fuel storage tanks were reportedly present in an area adjacent to one of the large site sheds. These tanks were reportedly never used.

A single above ground fuel storage tank was present at the site, on a concrete pad adjacent to the supposed location of the USTs. The capacity of the tank was estimated by URS at 5,000L. It was reportedly used to store diesel fuel during initial site development, but remained disused since. The above ground tank has been removed from the site.

The site is surrounded by forested land. As such, the potential for the site to be impacted by contamination derived from adjoining properties was considered to be low.

No sampling of site soil and/or groundwater quality has been undertaken. Overall, however, the potential for the site to be subject to significant, widespread soil contamination was considered to be low.

Construction

Construction of the proposal is unlikely to introduce any substantial contamination, provided works are managed in accordance with an appropriate construction phase soil and water management plan, which would form part of the construction environmental management plan.

Operation

The operation of the proposal is unlikely to have any significant impact on soil or groundwater quality. In particular, the proposal would incorporate an engineered drainage system, combined with appropriately bunded enclosures for the storage of fuels and oils.

The proposal would not use PCB-bearing oils and hence there is no potential for spills of these compounds. The proposal would be gas fired, and hence no ash would be produced requiring disposal.

As detailed in Chapter 6, runoff would be collected, and reused. No groundwater extraction is proposed, and no infiltration to groundwater is intended.

Hydrogeology/groundwater

A search of the groundwater database maintained by (then) DIPNR identified no registered groundwater bores within a 1.5 kilometres radius of the site. However, groundwater quality in the general area is broadly identified as 'suitable for all stock'.

Neither the depth to groundwater, nor the direction and rate of groundwater flow beneath the site can be confirmed based upon existing data.

It is considered that given the relative low risk of any spills on the site and minimal disturbance of the sub-soil structure, the proposal would not pose any significant threat to the local environment.

9.3.2 Proposed pipeline and transmission corridors

Proposed pipeline

There appears to have been no previous environmental (contamination) studies specifically relating to the areas through which proposed pipeline would pass.

The proposed pipeline would traverse heavily vegetated bushland, with minimal potential to be subject to pre-existing contamination. As such, spoil generated during excavation works is likely to be readily manageable.

The proposed pipeline is unlikely to introduce contamination that could significantly impact on soil and/or groundwater quality.

Proposed transmission line

The majority of the proposed transmission line would be situated above ground, and the potential for installation of the above ground section to cause substantial soil and/or groundwater contamination is very low.

The potential for substantial soil contamination to exist along the alignment of Yalwal Road west of the urban area is considered to be low, although some localised areas of uncontrolled fill may exist. Furthermore, the proposed transmission line west of the urban area would be above ground, and hence disturbance of any contaminated soils along the route is likely to be minimal. Overall, the potential for gross soil contamination to exist that would impact upon the proposed transmission line west of the urban area is considered to be low.

West Nowra consists mainly of residential dwellings, with scattered commercial and light industrial premises. It is noted that the proposed transmission line would be placed underground in this area; hence some soil disturbance is anticipated.

Excavation to permit installation of the underground section through West Nowra may require disturbance of some localised contaminated soils (although this has not been confirmed, as no quantitative studies of soil contaminant concentrations have been undertaken at this stage). Although the risk of substantial soil contamination along the proposed excavation route is considered to be low, the potential for localised contamination cannot be ruled out at this stage.

It is not considered necessary to conduct intrusive investigations along the proposed transmission line route prior to installation. This is predominantly due to the fact that any contamination encountered during excavation works is likely to be readily manageable, through the implementation of the construction environmental management plan, along with appropriate supervision and contingency planning. However, certain precautions would be implemented during excavation works, to ensure that any contamination present along the excavation route is identified and appropriately managed. The recommended managed measures are described below.

9.3.3 Management

Overall, the potential for the site to be subject to contamination that would inhibit its suitability for the proposal is considered to be low. It is considered that operation of the proposal would have no appreciable impact upon local soil or groundwater quality.

Development of the underground section of the proposed transmission line may require disturbance of some contaminated soil, particularly within the urban area. Management of this process would be defined by the development and implementation of a comprehensive construction phase soil and water management plan, accompanied by appropriate OH&S and contingency plans, to form part of the construction environmental management plan for the proposal.

Recommendations

It is recommended that all dumped and buried wastes be removed from the site, either prior to, or as part of the construction process.

At this stage, it appears likely that all dumped wastes comprise largely inert building wastes and scrap (ie, no putrescible or liquid wastes). However, if evidence of putrescible or oily / liquid wastes are noted during removal, then these materials would be sampled and analysed, to permit

classification for off-site treatment and disposal, in accordance with the Environmental Guideline Assessment, Classification and Management of Liquid and Non-Liquid Wastes (NSW EPA, May 1999). Furthermore, it should be assumed that any stockpiled or buried wastes may potentially contain friable asbestos. As such, these materials must be handled by an appropriately licensed contractor, and disposed of at a solid waste management facility licensed to accept asbestos bearing wastes.

All existing fuel storage facilities would be appropriately decommissioned and removed prior to site development. All formed excavations would be validated in accordance with the provisions of the Guidelines for Assessing Service Station Sites (NSW EPA, 1994).

During the construction phase (including site construction, plus pipeline / transmission line installation), soil and groundwater would be protected from contamination via the installation of appropriate bunds, drainage networks and (if required) lined detention basins. These environmental control mechanisms would also be implemented in order to avoid excessive erosion during construction works. Furthermore, the potential for excessive dust generation during construction works must be managed, via the provision of appropriate dust suppression measures. A construction phase soil and water management plan would be developed, detailing environmental control mechanisms to be implemented during the construction phase. The soil and water management plan would also document procedures for the characterisation and management of any spoil to be generating during construction works. The management plan would specify practices recommended to minimise the potential for any contamination impacts, including:

» Any fill material imported to the site would be validated in accordance with applicable NSW EPA policy prior to placement on-site;

» The potential for the spillage of fuels and oils must be negated, via the appropriate construction and bunding of any fuel / hazardous materials storage areas;

» Existing fuel storage facilities would be appropriately decommissioned and removed, if not required as part of the proposal;

» Plant and equipment used during development works must be appropriately maintained, to minimise the potential for incidental hydrocarbon spills; and

» Existing wastes deposited at the site (both buried and stockpiled) would be characterised in accordance with applicable NSW EPA policy, prior to off-site disposal.

It is noted that some (localised) contaminated soils may potentially be encountered during excavation works for the underground section of the proposed transmission line through the West Nowra. As such, the following precautionary measures are recommended, to account for any potentially contaminated soil that may be encountered:

» Excavation works through West Nowra would be supervised by an appropriately qualified environmental consultant, who shall conduct real-time air monitoring of the excavation zone, using a photoionisation detector (PID)[2];

» A detailed Occupational Health and Safety (OH&S) Plan would be developed, prior to excavation works occurring, documenting OH&S protocols to be adopted during the excavation works; and

[2] The PID is a hand-held device used to measure volatile organic concentrations in ambient air. It can therefore be used as a preliminary screening tool to check for the possible presence of volatile organic contaminants (such as benzene or light-fraction petroleum hydrocarbons).

» A Contingency Plan would be developed, documenting procedures to be adopted in the event that potqentially contaminated soils or uncontrolled fill are encountered during excavation works.

9.4 Hazard and risks

A Preliminary Hazard Analysis (PHA) was prepared by Advitech in accordance with the requirements of SEPP 33. The full report is included in Appendix I. A summary of the findings is provided below.

The PHA was prepared generally in accordance with the Department of Planning (then Department of Urban Affairs and Planning) publications Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 - Guidelines for Hazard Analysis (1992) and Multi-Level Risk Assessment (1997). An assessment of the proposal with respect to the recommended fatality, injury and irritation risk criteria presented in the publication HIPAP No. 4 - Risk Criteria for Land Use Safety Planning (1990) has been undertaken.

A PHA aims to provide sufficient information and assessment of risks to demonstrate that a proposal satisfies the risk management requirements of the proponent and relevant public authorities. Within this context, the primary role of a PHA is to demonstrate that residual risk levels are tolerable in relation to surrounding land uses, and that risk would be appropriately managed.

9.4.1 Risk screening

The SEPP 33 threshold screening value is exceeded by the storage of sulphuric acid (or hydrochloric acid), sodium hydroxide and sodium hypochlorite, which are classified as Class 8 dangerous goods. The threshold quantity is 25 cubic metres and the proposed storage quantity is 44 cubic metres. The transportation screening thresholds for Class 8 dangerous goods are also exceeded on the basis of the minimum quantity per load. As a result, the proposal is potentially hazardous and requires a PHA.

The qualitative risk assessment/hazard identification study identified a number of potential hazard scenarios of risk requiring further consideration. These included:

» Discharge from wastewater pond;

» Bushfire initiated from activities on-site;

» Fire/explosion from failure of branch gas pipeline;

» Fire/explosion from failure of pipe or fitting at gas metering station; and

» Bushfire entering the site.

9.4.2 Assessment

Based on the analysis undertaken the report concluded that none of the other hazard scenarios identified had the potential to present an unacceptable risk to surrounding land uses. However, the high and medium risk scenarios confirmed that the proposal was a ‘potentially offensive’ industry and therefore adequate safeguards would be needed to ensure any discharges from the development are contained or at least controlled to an acceptable level.

Based on the results of the qualitative risk assessment, the following scenarios associated with fire/explosion at the gas metering station were identified as being worthy of a quantitative analysis:

» Damage to the above-ground section of the 150 mm branch gas pipeline at the gas metering station by vehicle impact;

» Flange leak in the above-ground section of the 150 mm branch gas pipeline at the gas metering station; and

» Failure or damage to 12.7 mm fuel gas-tubing connection on the gas metering station outlet.

The quantitative analysis concluded that the cumulative risk values for off-site fatality, injury and damage at the site boundary were below the HIPAP criteria for all adjacent land uses. Similarly the on-site fatality risk values for industrial sites were well below the suggested criteria.

9.4.3 Management

Risk reduction measures

The proposal would be designed with a number of risk reduction and mitigating measures in place to reduce hazards. These measures were considered as part of the hazard identification process (refer Table 6.1 of Appendix I). Standard measures and design features include undertaking a detailed hazard and operability study (HAZOP) during design; installation of a fire protection system in accordance with the requirements of the Building Code of Australia; compliance with dangerous goods storage and transport codes; regular inspections and maintenance of critical components; bunding of chemical storage tanks and standard operating procedures for activities which could have the potential to cause hazards or risk.

Recommendations

It is recommended that safeguards be employed to ensure any loss scenario involving the failure of pipes and/or fittings at the gas metering station and/or wastewater pond are kept to a minimum. There are three strategies for reducing risk: elimination, management and mitigation. The complete elimination of the potential loss scenario is not an option for this proposal as natural gas is the primary fuel source for the process. Therefore risk management and mitigation procedures need to be employed.

Implementation of management procedures incorporating practices to prevent risk scenarios occurring is recommended, including:

» Minimising build-up of combustible materials on-site; and

» Installing bollards/protective barriers around gas metering station.

Mitigation measures are practices that control the impact after a risk scenario has occurred. It is recommended that emergency management procedures be developed covering response to fire and explosion that may be initiated from either on-site or off-site sources.

9.5 Visual amenity and landscape

9.5.1 Potential visual issues

Heavily wooded bushland areas, which include land contained within Crown land and reserves, dominate the landscape of the majority of the study area. The site is located at an elevation of approximately 110 metres. The landform undulates gently to the south and east, with a steeper fall towards Shoalhaven River towards the north and northwest. Other landscape features include:

» Steep hill slope running behind (to the south of) Bamarang Road;

» Floodplain adjoining Shoalhaven River;

» Pulpit Hill to the northwest; and

» Nowra Hill (and lookout) approximately 6 kilometres to the southeast.

The development pattern in the broader area consists of:

» Scattered rural dwellings interspersed in the bushland;

» Rural and rural residential development approximately 2 kilometres to the east of the site in the vicinity of Cabbage Tree Lane;

» Roads and a number of transmission corridors;

» Public utilities and associated infrastructure including:

  – Radio transmission mast approximately 1 kilometre to the northeast;

  – Waste disposal facility located approximately 3.5 kilometres to northeast;

  – Water treatment plant approximately 1 kilometre to the northwest;

  – Transmission corridors, including the corridor through Bamarang Nature Reserve (which includes a water pipeline and 33 kilovolts electricity transmission line) to the north, the 132 line to the east, and the Eastern Gas Pipeline; and

  – Bamarang Reservoir approximately 500 metres to the west.

» Shoalhaven campus of Wollongong University located approximately 4.5 kilometres to the northeast;

» Urban areas of West Nowra approximately 7 kilometres to the east; and

» HMAS Albatross approximately 4.5 kilometres to the south.

Landscape features and potential visually sensitive receivers in the vicinity of the main elements of the proposal are described below.

The site

The site is located within the catchment of Sandy Creek, which flows to the Shoalhaven River approximately 5 kilometres to the northeast. The site is set back from the road and is surrounded by heavily wooded bushland areas, dominated by a tall upper storey of trees of approximately 30 metres in height. Existing buildings on site reach a similar height.

The majority of the proposal would be surrounded by heavily wooded areas which significantly reduces its overall visibility. The concept design for the proposed facility has also attempted to maximise the use of existing cleared areas on the site to reduce the potential impacts associated with clearing. An artist impression of the proposed facility is shown at Figure 9.1.

Potential visual issues are considered in Table 9.6.

Table 9.6 Potential visual issues

Potential Visual Receiver	Number of viewers	Comment
Yalwal Road	Moderate	Filtered views of the proposal would be possible from the road for passing traffic. As described previously, some clearing of vegetation would be needed for the proposal (particularly the asset protection zones) and the transmission corridor. However, sufficient vegetation would remain to provide a degree of screening from the road. The majority of the structures are also offset slightly to the southwest, which would limit the visibility of the proposed facility from the site entrance.
Bundanon	Low	Across the Shoalhaven River from Bundanon, the landform rises steeply to approximately 100 metres and then flattens to a plateau. The site is set back approximately 1 kilometre from the edge of the plateau. As a result, the proposal is not expected to be visible from Bundanon. The heavily forested landscape in the area would further screen the proposal from view.
Bamarang Road residents	Low	The main views for houses along Bamarang Road are to the north, towards Shoalhaven River. The steep slope located to the south of the road limits the opportunity for views towards the site.
Rural residential development in the vicinity of Cabbage Tree Lane.	Low-moderate	The potential for views of the proposal would be limited by the distance from the site (approximately 2 kilometres) and the significant screening that would be provided by surrounding bushland. Limited background views of the top section of the stack may be possible, however the potential for visual impacts are considered to be low as a result of the distance from the site.
Nowra Hill	Low	The potential for views of the proposal would be limited by the distance from the site (approximately 6 kilometres) and the significant screening that would be provided by surrounding bushland. The top section of the stack may just be visible from the look out, however the potential for visual impacts are considered to be low as a result of the distance from the site.

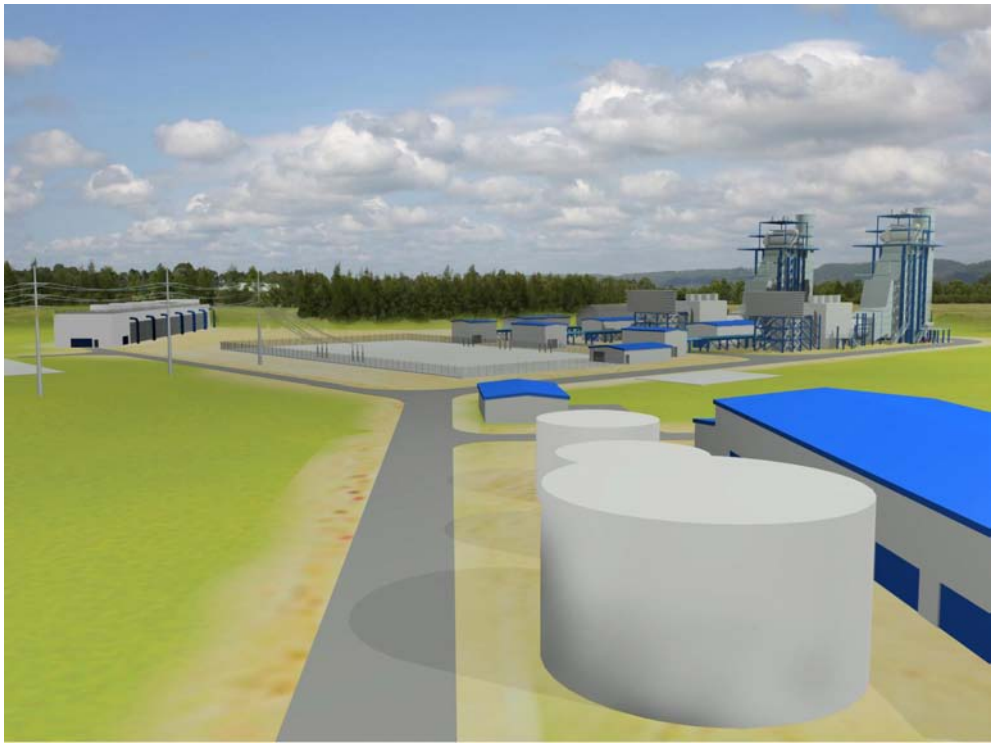

Figure 9.1 Artist's impression of the facility facing south, from near site entrance

Proposed pipeline

Although the clearing required to construct the proposed pipeline and maintain the corridor would result in change to the landscape, the pipeline would be located underground and would be surrounded by bushland. The limited visibility of the site reduces the potential for visual impacts.

Proposed transmission line

The route for the proposed transmission line has been chosen to maximise use of existing cleared corridors, and therefore reduce the potential impacts associated with clearing. The visibility of the majority of the transmission line would be reduced by the proposed location:

» Along the existing corridor through Bamarang Nature Reserve. This section (approximately 2.75 kilometres long) would be buffered from Yalwal Road and surrounding land uses by bushland. The limited visibility of the corridor reduces the potential for visual impacts; and

» Approximately 1.25 kilometres would be located underground between Flat Rock Creek and the substation.

A section approximately 2.8 kilometres long would be located alongside Yalwal Road (to the south). This section would be visible to people using Yalwal Road, and the residents located in this area. The potential for visual impacts are considered to be reduced by the fact that there is an existing transmission line in this location, which would be replaced by the proposed 132 kilovolts line. The poles required would differ from the existing timber poles, however they would be similar to concrete poles along the 132 kilovolts transmission corridor located in West Nowra (refer Figure 9.2).

The section of the proposed transmission line that crosses Yalwal Road between the site and the transmission corridor through Bamarang Nature Reserve would also be visible to users of Yalwal Road.

Figure 9.2 Typical 132 kilovolts transmission pole

9.5.2 Management

It is recommended that the following management measures be implemented to reduce the potential for visual impacts:

- Maximising the use of existing cleared areas for on-site facilities and the proposed transmission line;
- Retention of existing vegetation outside the areas required to be cleared (for fire protection, facility footprint and transmission corridors);
- Maintaining the existing understorey beneath the transmission line where possible;
- Additional tree planting at the site entrance; and
- Appropriate choice of building materials and treatments, including:
  - Minimal use of reflective elements, and use of textual cladding where practicable;
  - Use of darker green/brown colour tones on the buildings and plant to minimise the potential for contrast with surrounding bushland; and
  - Use of a lighter green colour on the upper portion of built elements (including the stack) to minimise the potential for contrast with the sky and tree tops.

9.6 Cultural heritage

9.6.1 Aboriginal heritage

An Aboriginal cultural heritage assessment was undertaken for the proposal by Navin Officer. The full report is included in Appendix J. A summary of the key outcomes is provided below.

Findings

The proposed transmission line and pipeline easements have been variously impacted by clearing and pasture development; track, road and side-drain construction; fencing; the installation of above and below ground services; and the flooding of Flat Rock Creek to form a reservoir.

As noted in Section 2.2, two Aboriginal sites and one possible historic Aboriginal site were identified during the field survey of the study area, in the vicinity of Yalwal Road. The significance of these sites is described in Section 2.2. The assessment did not identify any Aboriginal sites within the site for the proposed facility. As a result, there are no Aboriginal cultural heritage constraints to development on the site.

Depending on the final location of transmission poles, there is potential for sites BG1 and BG2 to be impacted by the construction of the proposed transmission line. This would be confirmed during the detailed design process. It may be possible to avoid the location of these sites by careful placement of the transmission poles.

Site BG3 would not be impacted by the proposal.

Recommendations

The following recommendations/mitigation measures are proposed:

» Where practical, disturbance to site BG1 would be avoided, or limited to the existing areas of disturbed ground adjacent to the Yalwal Road verge. If avoidance were feasible, then the area with surface artefacts would be temporarily fenced to identify a 'no-go' area excluding machinery and ground disturbing activities.

» Where practical, disturbance to site BG2 would be avoided.

» If impact were anticipated in the areas of sites BG1 and BG2, then the surface artefacts would be managed according to the requirements of the local Aboriginal community. This may involve their placement in nearby locations away from the construction zone, or alternatively, their permanent recovery for placement in a Keeping Place or Museum. The allowance of disturbance with no mitigation may also be an option for community consideration.

» If impact is anticipated in the area of the potential archaeological deposit associated with BG1, then a limited archaeological program of salvage excavation would be conducted in the anticipated disturbance areas such as the pits for the placement of transmission line poles.

» In order to satisfy the policies of the DEC three copies of the cultural heritage assessment report would be provided to the Southern Aboriginal Heritage Unit at DEC; and

» One copy of the report would be provided to Nowra Local Aboriginal Lands Council and Jerrinja Local Aboriginal Lands Council.

9.6.2 Historic cultural heritage

Navin Officer Pty Ltd undertook a historical cultural heritage assessment for the proposal. The full report is included in Appendix K. A summary of the findings is provided below.

Findings

As noted in Section 2.2, one historic site was identified during field investigations undertaken for the assessment. The site is located to the north of Yalwal Road and would not be impacted by the proposal.

Based on the results of the investigation documented in the historical cultural heritage assessment report, there are no historic cultural heritage constraints to the proposal, and no further recommendations are made.

9.7 Traffic

9.7.1 Traffic generation

Construction Access Route

Access to the site would be from Yalwal Road.

According to RTA's B-Double map routes, Princes Highway, Kalandar Street and Albatross Road have been designed to accommodate B-Double type vehicles. It is expected that Yalwal Road could accommodate heavy vehicles during construction stages.

Figure 9.3 illustrates existing conditions on Yalwal Road at the existing access driveway to the site.

Figure 9.3 Access to site via Yalwal Road

Construction traffic

The average number of construction staff during each construction stage is likely to be as follows:

» Stage 1: 100 employees; and

» Stage 2: 200 employees.

The peak period traffic generation during stage two has been calculated to be in the order of 273 vehicles. The generation of 273 vehicle movements is only likely to occur during a two-month period and is known as the worst-case scenario. It can be assumed that between 90% (246 vph) or 100% (273vph) of the construction staff would be from locations situated near to the Princes Highway and would result in traffic travelling via Yalwal Road and the intersection of Yalwal Road and Albatross Road.

Based on a similar study undertaken by Masson Wilson Twiney (2001) for a proposed gas-fired power plant in Tomago, the maximum number of heavy vehicle movements generated during construction could be estimated to be between 2 to 20 heavy vehicle movements per day.

Using the above assumptions, the peak traffic generation during construction stages is likely to be in the order of 293 (7% heavy vehicles) vehicles, and will occur during a two-month period. Traffic generated during other periods are likely to be in the order of 110 (10% heavy vehicles) vehicles in stage one and 210 (5% heavy vehicles) vehicles in stage two.

Operation - employees

The maximum number of employees likely to be on site at any one time has been estimate to be approximately 2 during stage 1 and 18 after the site is fully developed (stage 2). The AM and PM peak hour traffic generation is likely to be in the order of 2 vehicle trips per hour (vtph) during stage one and 18 vehicle trips per hour (vtph) after completion of stage two.

In order to understand the likely peak period traffic generation the following assumption have been adopted:

» The mode split for car drivers would be 100%; and

» Between 90% and 100% of staff travelling by vehicles would be from the Nowra area and are likely to travel via Yalwal Road and through the intersection of Yalwal Road and Albatross Road.

Based on the above assumptions, the total number of employees travelling by private vehicles along Yalwal Road is likely to be 18 vehicles during AM and PM peak hours. No impacts on the surrounding road network are anticipated.

Operation - deliveries

It is expected that chemicals and oil needed for operation of the plant would necessitate 1-2 truck deliveries per week.

9.7.2 Key traffic and access issues

The key issues associated with the proposal (in relation to traffic and access) are as follows:

» The signposted speed limit changes from 60 km/h to 100 km/h at a point approximately 500m west of the intersection with Albatross Road;

» There are no obscured access points, restrictive curves or gradients along the sections of Yalwal Road likely to be impacted by the construction and operation of the proposal;

» Due to increase in number of heavy vehicles during construction stages it would be appropriate to reduce the speed limit to provide a safer road environment for drivers;

» Trucks travelling to the site are expected to be small utility trucks and medium rigid vehicles;

» Based on the Austroads Rural Road Design Manual, section 4.4, for roads with ‘very low traffic volumes, a narrow carriageway (5 to 6 metres) can be adequate’. Traffic flow along the Yalwal Road is considered to be low, especially in the vicinity of the proposed site. The lane width has also been measured to be between 5-6 metres wide; and

» The majority of land uses that could generate significant volumes of traffic are located at or near to the eastern section of Yalwal Road (between Georges Evans and Albatross Roads). These

land use types vary from residential to large businesses, such as metal recyclers, garbage depot, TAFE and a university campus, and concrete plant. Existing development is unlikely to be impacted by the operation of the site, but may be impacted during the construction stages. This would be appropriately managed as part of any construction management plan.

» It is understood that a total of up to 60 heavy vehicles per day (30 in/30 out) are generated by Burrier Quarry. These vehicles are likely to travel along Yalwal Road to transport products from the quarry to their destinations.

9.7.3 Management

Recommended management measures, mainly relating to the construction period, are provided below:

» The current signposted speed limit along the Yalwal Road is 100 km/hr. During construction, a temporary reduction to the signposted speed limit would be imposed to provide a safer road-operating environment for intense periods of heavy vehicle movements. The procedures for the installation and operation of such traffic control devices are provided in AS 1742.3-1996 Traffic Control Devices for Works on Roads, and would be followed by the contractor;

» Yalwal Road narrows at a bridge to the east of the proposed site and should be adequately signposted through the provision of additional advanced warning signage on both approaches;

» Traffic operating conditions during the AM and PM peak for the Princes Highway could be impacted by the transportation of materials and should be considered in the construction planning stage. This potential impact could be minimised by restricting the hours of operations, which would aim to limit intense heavy vehicle movement during peak commuter periods and encourage movement during the off peak period;

» Adequate area and management controls would be introduced at the site entry to safely control the movement of vehicle into and from the site;

» Loading, unloading and manoeuvring of vehicles would always occur on-site and must be in accordance to AS2890.1 and AS2890.2;

» All construction worker parking spaces would be provided off road/ on-site during the entire construction period; and

» A rural type ‘A’ intersection would be installed at the access point to the site.