9. Environmental impact assessment — key issues

This chapter assesses the key issues identified in the Director-General's Environmental Assessment requirements (DGRs) (see Appendix A). Chapter 10 assesses additional potential impacts identified through the environmental risk analysis (see Chapter 8).

9.1 Greenhouse gas emissions

This section summarises potential greenhouse gas emissions associated with construction and operation of the project, and identifies management measures to address these impacts. Greenhouse gas generation was identified as a key issue for assessment in the DGRs (see Appendix A).

9.1.1 Power station

Construction

Greenhouse gases could potentially be emitted as a result of the following construction activities for the proposed power station:

- energy use, as fuel to operate plant and equipment, and as electricity consumed for site compounds and any batching plants
- vegetation clearing, although this would not be material to greenhouse gas calculations due to the modest level of vegetation cover
- emissions embodied in materials used for construction, such as carbon dioxide (CO_2) generated during cement manufacture, or energy consumed in steel production.

The key direct emission source during construction of the power station would be diesel consumed to operate plant and equipment, with CO_2 the main greenhouse gas emitted.

Operation

The proposed power station has been designed as an open-cycle gas turbine peaking power station. Emissions would, therefore, result from direct combustion of natural gas, with no energy reclamation.

Anticipated turbine operations were modelled using the GateCycle (v5.6.1.0r) modelling program. The turbine characteristics input to this model are described in Chapter 7. Two operating scenarios were considered, based on the maximum summer temperature (44°C) and the daily average temperature. Ambient weather data was obtained from the Bureau of Meteorology (BoM) weather station at Dubbo, with two scenarios considered: maximum summer peak temperature with water injection, and daily average temperature. The modelling showed that greenhouse intensity was slightly higher during summer peak temperatures. Therefore, the results reported below have been calculated based on 100% operation during summer peak temperatures, providing a conservative or 'worst-case' assessment of potential impacts.

Operation of a modern, natural gas turbine power station, particularly in open-cycle mode, provides full combustion of methane (CH_4) and other hydrocarbons within the fuel. As such, the Australian Greenhouse Office's (AGO's) *Technical Guidelines – Generator Efficiency Standards* (AGO 2006a) state:

> There is no significant production of methane from combustion of natural gas in a boiler or gas turbine as methane emissions result from incomplete combustion … methane emissions must either be measured … or estimated. (p29)
>
> Nitrous oxide is generally formed under low temperature and reducing conditions, and as a consequence there is no significant production of nitrous oxide from natural gas-fired power plant … nitrous oxide emissions must either be measured … or estimated. (p30)

Therefore, emissions of CO_2 were based on the modelling undertaken, while emissions of CH_4 and nitrous oxide (N_2O) were derived using the modelled fuel consumption in conjunction with the emission factors provided by the AGO (AGO 2005). The emissions in Table 9-1 were calculated based on an annual operating capacity factor of approximately 4% (which equates to all four turbines operating for 350 hours, or one turbine operating for 1,400 hours), generating approximately 220 gigawatt per hour (GWh) of net emissions.

Table 9-1 Direct greenhouse gas operational emissions for the proposed power station

Gas	Annual quantity (tonnes)	Greenhouse warming potential[1]	Equivalent (t CO_{2-e})[2]
Carbon dioxide (CO_2)	97,040	1	97,040
Methane (CH_4)	19	21	407
Nitrous oxide (N_2O)	0.24	310	75
TOTAL (CO_{2-e})			**97,544**

Source: AGO 2006b

Notes: 1: Greenhouse warming potential is the quantified measure of the globally-averaged relative radiative forcing impacts of a particular greenhouse gas (Intergovernmental Panel on Climate Change 1996); 2: t CO_{2-e} = tonnes of carbon dioxide equivalent; 3: Greenhouse gas emissions calculated based on a capacity factor of 4% generating approximately 220 GWh

Based on the combined total greenhouse gas emissions, in CO_2 equivalent terms, operation of the proposed power station would emit approximately 98,000 tonnes of greenhouse gases each year, resulting in a greenhouse intensity of generation of 0.445 tonnes of CO_2 equivalent per megawatt-hour (t CO_{2-e}/MWh).

To place these emissions in perspective, emissions in the first year of operation would be 0.017% of Australian emissions in 2005, 0.035% of Australian emissions related to stationary energy, and 0.17% of emissions from NSW electricity generation (AGO 2007a).

Table 9-2 provides a comparison between the greenhouse intensity of the proposed open-cycle gas turbine peaking power station and other types of power stations. This indicates that operation of the proposed power station would result in a lower greenhouse intensity than all other types of power station in Australia.

Table 9-2 Greenhouse intensity comparison (direct emissions)

Source	Greenhouse intensity[4]
Brown coal power stations (2005 Australian average) [1]	1.338 (t CO_{2-e}/MWh)
All major power stations (2005 Australian average) [1]	1.021(t CO_{2-e}/MWh)
NSW annual pool value (2006) [2]	0.969(t CO_{2-e}/MWh)
Black coal power stations (2005 Australian average) [1]	0.936(t CO_{2-e}/MWh)
Natural gas – large power stations (2005 Australian average) [1]	0.569(t CO_{2-e}/MWh)
Open-cycle gas turbine plants with natural gas (best practice estimate)[3]	0.555(t CO_2/MWh)
Proposed Wellington gas-fired peaking power station	**0.445(t CO_{2-e}/MWh)**
Combined cycle gas turbine plant with natural gas/coal seam gas (best practice estimate; various conditions) [3]	355–360 (t CO_{2-e}/MWh)

Notes: 1 = AGO 2007b; 2 = IPART 2007; 3 = AGO 2006a; 4. t CO_{2-e}/MWh = CO_2 equivalent per megawatt-hour

As with all machinery, the productivity of the turbines used at the power station is predicted to decline over the life of the project. ‘Non-recoverable degradation’ is the degradation of a system in response to the effects of wear and tear over time, and is non-recoverable in the sense that, regardless of the amount of system maintenance conducted, losses in efficiency due to energy losses in the system would occur. Non-recoverable degradation for this project is predicted to occur at 0.3% per year for the first 10 years, followed by a less significant change. This would see the same quantity of fuel consumed in the same timeframe, but with reduced generation, such that the annual emissions would remain constant, resulting in a negative effect on greenhouse intensity. This effect would be minor, with the greenhouse intensity predicted to reach 0.457 t CO_{2-e}/MWh. As such, the proposed power station would still have less impact than nearly all the comparable fossil-fuel power stations listed in Table 9-2. Overall, the project is predicted to generate 2.93 megatonnes of CO_2 equivalent (Mt CO_{2-e}) over a 30 year life span.

This assessment has been conducted for direct emissions and does not consider ‘upstream’ greenhouse gas emissions — those associated with the extraction of the fuel, also referred to as ‘indirect’ or ‘Scope 3’ emissions. The AGO (2006a) provides guidance that 16.2 kilograms of CO_{2-e} would be emitted to provide each gigajoule of fuel to the power station. Based on the anticipated usage and associated fuel consumption of the power station, 39,240 t CO_{2-e} would be produced upstream. No details are provided as to the particular greenhouse gases emitted.

Generally speaking, operation of a gas-fired power station has the potential to generate a large quantity of greenhouse gases. However, in the context of comparable coal-fired generation, the proposed power station provides a low greenhouse intensity alternative, less than half that of equivalent coal-fired generation. The proposed power station would be environmentally beneficial in comparison to increasing the capacity and usage of the currently available power generation pool in Australia.

Consideration has been given to offsetting the greenhouse gas emissions associated with the operation of the proposed power station, which would result in higher operating costs. This would be reflected in a higher electricity feed-in tariff, which could reduce demand and electricity generation from the proposed power station. It would be detrimental to the NSW stationary energy sector’s greenhouse gas coefficient to request an offset program for this power station, given that its greenhouse gas coefficient (0.455 t/MWh) is twice as low per MWh of electricity produced than that of NSW as a whole (0.969 t/MWh).

Consumption of electricity from the proposed power station would provide a much greater overall improvement to the NSW stationary energy sector's greenhouse gas profile than requiring the power station's carbon to be offset. Offsetting of greenhouse gas emissions would be best undertaken at the most greenhouse-intensive plants in order to make lower greenhouse gas intensity plants more economically attractive. It is not, therefore, recommended that offsets be applied to the proposed power generation.

9.1.2 Gas pipeline

Construction

Construction activities for the proposed gas pipeline with the potential to generate greenhouse gas emissions would be similar to those for construction of the proposed power station. However, construction of the gas pipeline would likely require greater vegetation clearance than the power station (see Section 9.5), thus altering the emissions profile slightly. Cleared vegetation would decay or burn to release CO_2, with limited CH_4 emissions, if allowed to decay under anoxic (without oxygen) conditions.

Operation

For both safety and efficiency reasons, high priority would be paid to minimising any operational leaks from the pipeline and acting on these promptly should they occur. Leak rates are normally proportional to pipe age, length, remoteness of the pipe and the maintenance regime. Since the proposed gas pipeline would comprise two mainline valve stations at approximately 30 kilometre intervals along the pipe (see Section 7.2.2), leaks would be managed very efficiently through isolation of sections of the pipe, followed by prompt detection of the leak site and subsequent maintenance.

In Australia, loss rates are usually <0.05% of throughput. The proposed gas pipeline has been designed for a loss rate of <0.03%. Losses would have the same characteristics as the fuel specification, that is, 90% CH_4 and 5% CO_2, being 18.95 kilograms $CO_{2\text{-}e}$/kilogram of fugitive gas. This is considered to be a negligible contribution to project impacts.

9.1.3 Compressor station

Construction

Potential sources of greenhouse gas emissions from construction of the proposed compressor station would be similar to those associated with construction of the proposed power station and gas pipeline. As the footprint of the proposed compressor station would be smaller than the proposed power station, minimal vegetation clearance would be required. The key source of greenhouse gas emissions for this activity would be diesel consumption for plant and equipment.

Operation

The proposed compressor station would likely be powered by a reciprocating gas engine (see Section 7.3), streaming a small amount of natural gas from the pipeline for fuel. Operation of the compressor would depend on the required line-pack (i.e. the amount of gas required to be in the pipeline or distributed before the compressor can operate), the desired pressure at the out-take, the operating profile of the turbines, and the input pressure of the Central West Pipeline at the time. Detailed design would include selecting the compressor and setting the operating profile, and by optimising these, greenhouse gas emissions would also be reduced. With these measures, it is considered unlikely that the compressor operation would account for more than 5% of the project's power generation (that is, less than 11.6 GWh per year). This is not considered to be a significant component of the overall emissions.

9.1.4 Mitigation measures

General

During the construction phase, planning and implementing an efficient construction program would minimise greenhouse gas emissions. These controls would be implemented through the construction environmental management plan (CEMP) and would include:

- adequate maintenance and efficient operation of all equipment
- no unnecessary revving or idling of engines
- staging works to minimise double-handling (i.e. duplication of soil movements)
- preservation of existing on-site vegetation, and revegetation where feasible on completion of construction
- giving preference to locally sourced materials during procurement
- encouraging efficient transport to the construction site (e.g. by giving preferential parking to vehicles with multiple passengers).

Offsetting the greenhouse gas emissions associated with operation of the project would be considered if, in the future, the NSW pool coefficient was reduced such that the overall greenhouse gas intensity of the proposed power station was increased. Such a change to the current situation would require changes to the overall policy framework of generation in NSW.

Power station and compressor station

Good practice regarding construction and operation of the proposed power station and compressor station would provide greenhouse benefits. The following measures would be implemented to ensure this:

- Selection and design of the compressor would be optimised to reduce the gas consumption for operation.
- The design of the compressor station would incorporate insulation and/or ventilation to reduce temperature variation and keep ambient temperatures in a range that supports efficient operation.
- Good construction practices would be implemented, such as regular maintenance of plant and equipment, avoiding idling, and using local goods and services to reduce transport distances.
- A maintenance plan, detailing the level of maintenance, timeframe (in equivalent operating hours), specific measures if relevant, and anticipated outcomes, would be prepared prior to commencement of the power station and compressor station operations. A regular maintenance regime would ensure efficient operations, which would reduce gas consumption for the equivalent power output, and thereby reduce greenhouse gas emissions and greenhouse gas intensity.

Gas pipeline

Industry practices to minimise gas leaks, such as leak monitoring and prompt response to any leaks, would limit greenhouse gas emissions. Minimising gas leakage and loss rates would be part of the safety and operating plan for this section of the network, which should be prepared in accordance with Australian Standard *AS 4568-2005 Specification for general purpose natural gas*.

9.2 Air quality

Section 3.4 provided a description of the existing air quality of the study area. Air quality data and meteorological conditions have been sourced from a combination of measured and synthetically compiled (CSIROs TAPM) data from the BoM, and the NSW Department of Environment and Climate Change (DECC).

This section summarises potential air quality impacts associated with construction and operation of the project, and identifies management measures to address these impacts. Air quality impacts were identified as a key issue for assessment in the DGRs (see Appendix A). Detailed assessment of this issue is included in Technical Paper No. 4 – *Air Quality Impact Assessment*. The outcomes of the assessment are summarised in this section.

The air quality impact assessment was undertaken in accordance with the guidelines presented in the *Approved Methods and Guidance for the Modelling of Air Pollutants in New South Wales* (Department of Environment and Conservation (DEC) 2005). The assessment considered the potential for off-site air quality impacts and focused on potential ground level contaminant generation during operation of the project.

9.2.1 Air dispersion model

The American Meteorological Society/Environmental Protection Agency's regulatory model (AERMOD) was used to predict the air quality impacts of construction and operation of the proposed power station, gas pipeline and compressor station.

The proposed site layout, with boundaries, all relevant structures, and building and emission sources, were imported into the model. Meteorological data was then configured for the site using BoM data from Mudgee and Dubbo. Sufficient meteorological data was used within the input file to ensure that worst-case conditions were adequately represented in the model predictions.

AERMOD effectively accounts for terrain effects from elevated stack sources. As such, the topographical setting of the study area has been considered in the model predictions.

9.2.2 Emission sources

The predominant sources and types of air emission from the project during operation are presented in Table 9-3 and the following modelling scenarios were developed:

- open-cycle gas-fired power station during normal operations
- open-cycle gas-fired power station during start-up/shut-down
- natural gas-fired compressor station.

Table 9-3 Source and type of emissions during operation of the project

Source of emission	Pollutant emitted
Turbine emission points (four)	PM_{10}, NO_x (as NO_2), SO_2, CO[1]
	Air toxics (benzene, toluene, xylenes, formaldehyde, PAHs[2])
Compressor emission point (one)	NO_x (as NO_2), PM_{10}

Notes: 1: PM_{10} = particulate matter less than or equal to 10 µm in aerodynamic diameter, NO_x = oxides of nitrogen, NO_2 = nitrogen dioxide, SO_2 = sulfur dioxide, CO = carbon monoxide; 2: PAHs = polyaromatic hydrocarbons

The impact of organic emissions (air toxics) was assessed, although it is well established that air toxic emissions are relatively low for gas-fired turbines, compared to the combustion of other fuels (i.e. diesel or coal).

The predominant sources of dust emissions during construction of the project have been identified as:

- erosion of stockpiles and exposed areas on-site
- handling, transfer and storage of materials
- heavy earthwork operations (i.e. excavation)
- removal of vegetation, re-contouring of land and soil exposure for reseeding
- vehicle movements along internal access and haul roads.

Emissions are also likely to be associated with the combustion of diesel fuel and petrol. The operation of on-site machinery during construction and general site operations would generate carbon monoxide (CO), CO_2, oxides of nitrogen (NO_X), oxides of sulphur (SO_x) and trace amounts of non-combustible hydrocarbons. Emission rates and impact potential would depend on the number and power output of the combustion engines, the quality of the fuel and the condition of the combustion engines.

Slight odours may be detectable close to the emission source(s). However, based on the setting of the project site, the likely ambient air quality characteristics, low population density, limited number of emission sources and transient nature of odorous emissions, adverse impacts would not be expected. Exhaust emissions from mobile sources were not, therefore, considered further with regard to air impact predictions.

9.2.3 Power station

Construction

During construction of the proposed power station, the main potential air quality impacts would be associated with dust generation and emissions from the on-site movement of construction machinery and traffic.

Dust generation

Fugitive dust sources (i.e. dust derived from a mixture of sources; non-point sources) present during the construction phase of the project would include traffic on paved and unpaved roads, aggregate storage piles, clearing of groundcover and topsoil, earthmoving activities, and the transporting or stockpiling of spoil and construction materials.

Fugitive dust generation is caused by two basic physical phenomena:

- pulverisation and abrasion of surface materials by application of mechanical forces (wheels, blades)
- entrainment of dust particles by the action of turbulent air currents (wind erosion from an exposed surface).

Particulate emissions would be associated with a number of mobile sources and potential wind erosion from freshly exposed areas. It has been assumed that construction work would be undertaken during the daytime only (as per the construction hours identified in Section 7.5.1), with dust-generating potential limited to short-term periods of greater intensity activity.

The following is an indicative breakdown of anticipated sources and dust generating activities:

- dust from loading aggregate material onto trucks
- operation of a bulldozer
- emissions of dust from movement of vehicles on unsealed roads
- wind erosion from exposed surfaces associated with disturbed areas of 200 metres by 200 metres.

Worst-case total dust levels generated over a 10-hour construction day have been predicted between 50 kilograms (total suspended particulates (TSP)) and 14 kilograms (PM_{10}). Although the qualitative assessment cannot confirm compliance with current air quality goals, the anticipated levels of particulate matter impact potential are not considered excessive. Received impact levels would be expected to decrease significantly with distance from the source. Negligible dust impacts from construction activities would be anticipated beyond 200 metres from the dust generating activity.

During unfavourable meteorological conditions (i.e. dry and windy conditions) dust emissions may be higher and would require specific corrective measures. The calculated dust load generated during a typical construction day, however, is small and would not be expected to result in reduced local air quality at the nearest potentially affected receptors, should adequate mitigation measures be implemented (see Section 9.2.6).

Emissions from on-site movements

The operation of on-site machinery, heavy goods vehicles, cars and delivery vehicles during the construction works and general site operations would generate CO, CO_2, NO_x, sulfides and trace amounts of non-combustible hydrocarbons.

Emission rates and impact potential would depend on the power output of the combustion engines, the quality of the fuel and the condition of the combustion engines. The contractor(s) and site manager(s) would ensure that no equipment releases smoke in contravention of the *Clean Air Act 1970*, the *Protection of the Environment Operations Act 1997* and the Clean Air (Plant and Equipment) Regulation 1997.

On this basis, emissions from construction vehicles and plant would be unlikely to result in air quality impacts, so were not considered further.

Operation

The main impacts associated with operation of the proposed power station would arise from combustion emissions from the turbines.

Tables 9-4 and 9-5 present the air dispersion modelling results from the gas-fired turbines during normal operation and start-up. Normal operation is defined as all four turbines operating at full capacity. the start-up scenario is defined as where all four units are operating at 50% capacity/load. Fifty percent capacity is typically not used for peaking power stations; this scenario would only be representative of start-up levels. The results presented in Tables 9-4 and 9-5 are discussed below for each parameter.

Table 9-4 Air dispersion modelling results of emissions from the proposed power station gas-fired turbines — normal operation

Parameter	Averaging period	Predicted GLCs[1] at sensitive receptor locations (µg/m³)[2] Location[3]				Maximum predicted GLC (µg/m³)
		1	2	3	4	
PM_{10}	24-hour	0.49	0.58	0.46	0.38	1.29
	Annual	0.03	0.05	0.03	0.03	0.06
NO_x (as NO_2)	1-hour	21.8	34.3	8.6	9.3	63.3
	Annual	0.17	0.23	0.13	0.14	0.33
SO_2	10-minute	1.04	1.63	0.41	0.44	3.02
	1-hour	0.73	1.14	0.29	0.31	2.11
	24-hour	0.08	0.10	0.08	0.06	0.22
	Annual	5.76×10^{-3}	7.70×10^{-3}	4.39×10^{-3}	4.70×10^{-3}	0.01
CO	1-hour	5.28	8.33	2.10	2.26	15.4
	8-hour	1.64	1.90	1.50	1.34	4.30
Benzene	1-hour	0.05	0.07	0.02	0.02	0.13
	Annual	$3.50e^{-4}$	$4.70e^{-4}$	$2.7\ e^{-4}$	$2.9\ e^{-4}$	$6.80e^{-4}$
Toluene	1-hour	0.08	0.13	0.03	0.04	0.24
	24-hour	$9.70e^{-3}$	0.01	$9.14e^{-3}$	$7.57e^{-3}$	0.03
	Annual	$6.70e^{-4}$	$8.90e^{-4}$	$5.10e^{-4}$	$5.40e^{-4}$	$1.28e^{-3}$
Xylenes	1-hour	0.04	0.07	0.02	0.02	0.12
	24-hour	$4.79e^{-3}$	$5.61e^{-3}$	$4.50e^{-3}$	$3.74e^{-3}$	0.01
	Annual	$3.30e^{-4}$	$4.40e^{-4}$	$2.50e^{-4}$	$2.70e^{-4}$	$6.30e^{-4}$
Formaldehyde	1-hour	0.46	0.73	0.18	0.20	1.34
	24-hour	0.05	0.06	0.05	0.04	0.14
PAHs	1-hour	$1.43e^{-3}$	$2.25e^{-3}$	$5.70e^{-4}$	$6.10e^{-4}$	$4.16e^{-3}$
	Annual	$1.00e^{-5}$	$2.00e^{-5}$	$1.00e^{-5}$	$1.00e^{-5}$	$2.00e^{-5}$

Notes: Results representative of incremental impacts only; 1: GLC = ground level concentration; 2: µg/m³ = micrograms per cubic metre; 3: 1 = Mount Nanima, 2 = Cadonia subdivision, 3 = Keston Rose Garden Café, 4 = Nanima House (see Figure 3-4)

Table 9-5 Air dispersion modelling results of emissions from the power station gas-fired turbines — start-up

Parameter	Averaging period	Predicted GLCs[1] at sensitive receptor locations (μg/m³)[2] Location[3] 1	2	3	4	Maximum predicted GLC[1] (μg/m³)
PM_{10}	24-hour	0.47	0.54	0.50	0.41	1.31
	Annual	0.03	0.04	0.03	0.03	0.07
NO_x (as NO_2)	1-hour	141.0	166.8	53.8	69.5	**368.0**[4]
	Annual	1.14	1.44	0.90	0.99	2.26
SO_2	10-minute	1.09	1.29	0.41	0.53	2.83
	1-hour	0.76	0.90	0.29	0.37	1.98
	24-hour	0.08	0.10	0.09	0.07	0.23
	Annual	$6.14e^{-3}$	$7.72e^{-3}$	$4.82e^{-3}$	$5.33e^{-3}$	0.01
CO	1-hour	5.30	6.28	2.00	2.60	13.9
	8-hour	1.59	1.78	1.63	1.42	4.48

Notes: Results representative of incremental impacts only; 1: GLC = ground level concentration; 2: μg/m³ = micrograms per cubic metre; 3: 1 = Mount Nanima, 2 = Cadonia subdivision, 3 = Keston Rose Garden Café, 4 = Nanima House (see Figure 3-4); 4: Bold type indicates exceedance of DECC goals.

PM_{10}

The highest PM_{10} concentrations were predicted to be associated with operation of the proposed power station during start-up conditions.

The maximum predicted 24-hour average ground level concentration (GLC) of PM_{10} emissions from the proposed power station would be well below the 50 micrograms per cubic metre (μg/m³) goal proposed by the DECC (at 1.29 μg/m³ for normal operations and 1.31 μg/m³ for start-up conditions). This maximum would occur approximately 2.2 kilometres north-east of the proposed power station. Based on the conservative assumption that all of the PM_{10} is present as $PM_{2.5}$, compliance with the National Environment Measure (NEPM) investigation level of 25 μg/m³ would be anticipated.

NO_x

During normal operations, the maximum predicted 1-hour NO_x (as NO_2) GLC from the power station would be well below the 246 μg/m³ DECC goal (see Figure 9-1). Similarly, the maximum predicted annual NO_x (as NO_2) concentration would be well below the 62 μg/m³ DECC goal during normal operations (see Figure 9-2).

Figure 9-3 indicates that the maximum predicted 1-hour NO_x (as NO_2) concentration of 368 μg/m³ from the power station exceeded the DECC goal of 246 μg/m³ during start-up conditions only. This maximum was predicted approximately 2.4 kilometres north-east of the proposed power station. The NO_x levels at all sensitive receptors included in the dispersion modelling assessment were predicted to be below the air quality goal.

The predicted results were based on the conservative approach that 100% of the predicted NO_x concentration would be NO_2 for both modelled scenarios (normal and start-up operations). In reality, this is not expected to occur for normal operations. A more refined approach is presented below using the ozone limiting method to assess NO_2 impacts for normal operations. Adopting this approach, the estimated NO_x (as NO_2) levels were lower at all locations modelled.

During start-up operations, exceedances of the 1-hour NO_2 air quality goal were predicted to occur on the assumption that start-up emissions would exist for 1 hour. However, this would only occur over a maximum 6-minute period and would then decrease to levels predicted for normal operations. As the shortest time-averaging period for both the available meteorological data and air quality goal is 1 hour, the average concentration would comply with the NEPM goal. Therefore, emissions from the power station during start-up conditions would not adversely affect the nearest sensitive receptors or the receiving environment.

The highest annual NO_x concentration from the power station during start-up conditions was predicted to be well below the 62 µg/m^3 DECC goal (see Figure 9-4).

SO_2

The maximum predicted 1-hour, 24-hour and annual average SO_2 concentrations from the power station were below their respective air quality goals during both normal operations and start-up/shut-down conditions. The maxima were predicted to occur approximately 2 kilometres north-east of the proposed power station.

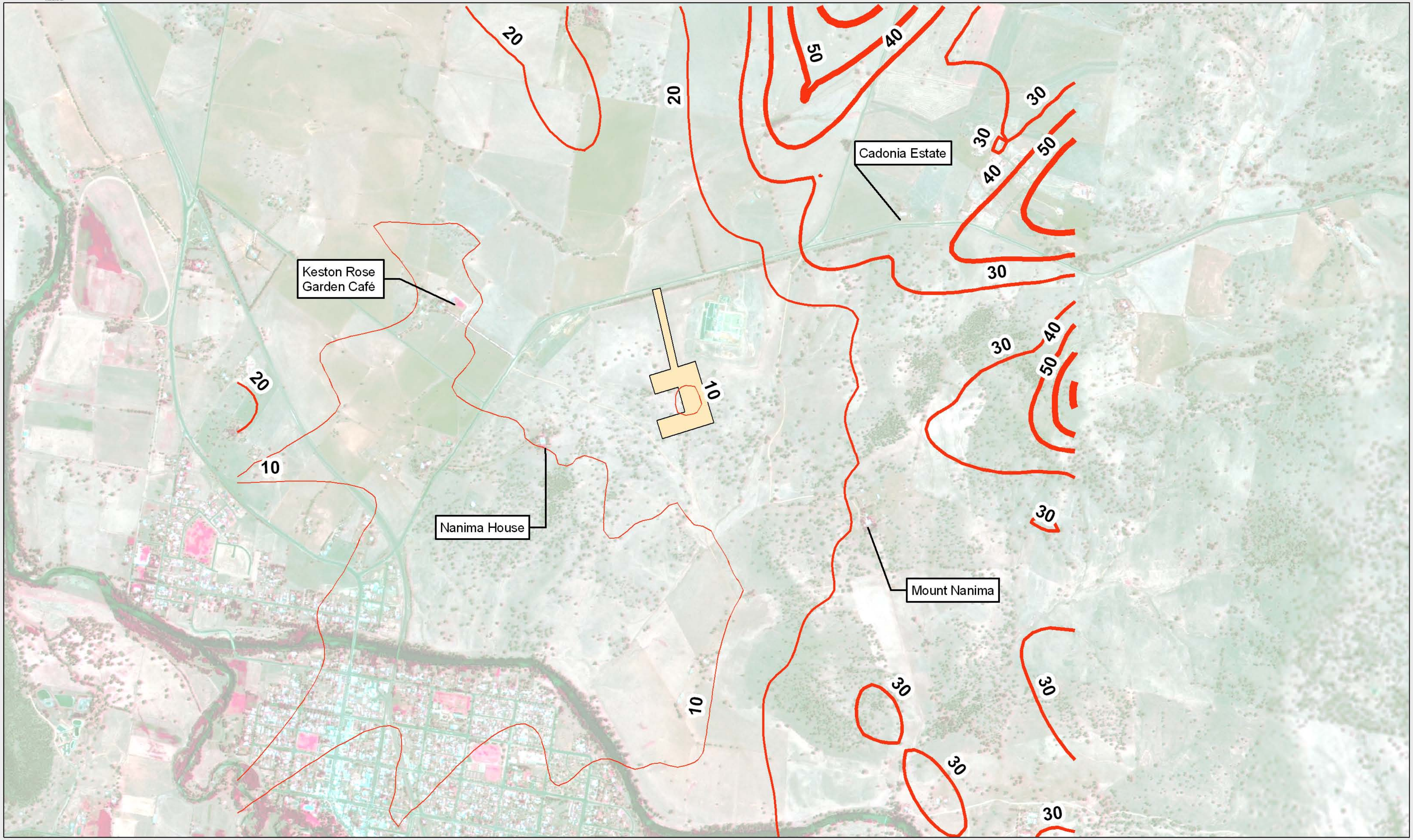
CO

The maximum predicted 1-hour and 8-hour CO concentrations from the power station were well below their respective air quality goals. The maxima were predicted to occur approximately 2 kilometres to the north-east of the proposed power station.

Other emissions

Other emissions that may arise during operation of the power station include:

- emissions from cars, delivery vans, and heavy goods vehicles entering/exiting the power station site, comprising 20–30 vehicle movements per day
- combustion emissions during the operation of the emergency diesel generator
- minor fugitive emissions from fuel and chemicals stored on-site (e.g. diesel, lubricant oils, cleaning chemicals).



Proposed power station site

Air quality guideline - 246 µg/m3

Figure 9-1 Maximum predicted hourly ground level NOx (as NO2) concentration (µg/m3) from the power station during normal operations

0 750 1,500 Metres

2116720A_2141b_Fig9_1_Normal_hourly_NOx.mxd GK April 14, 2008

PARSONS BRINCKERHOFF

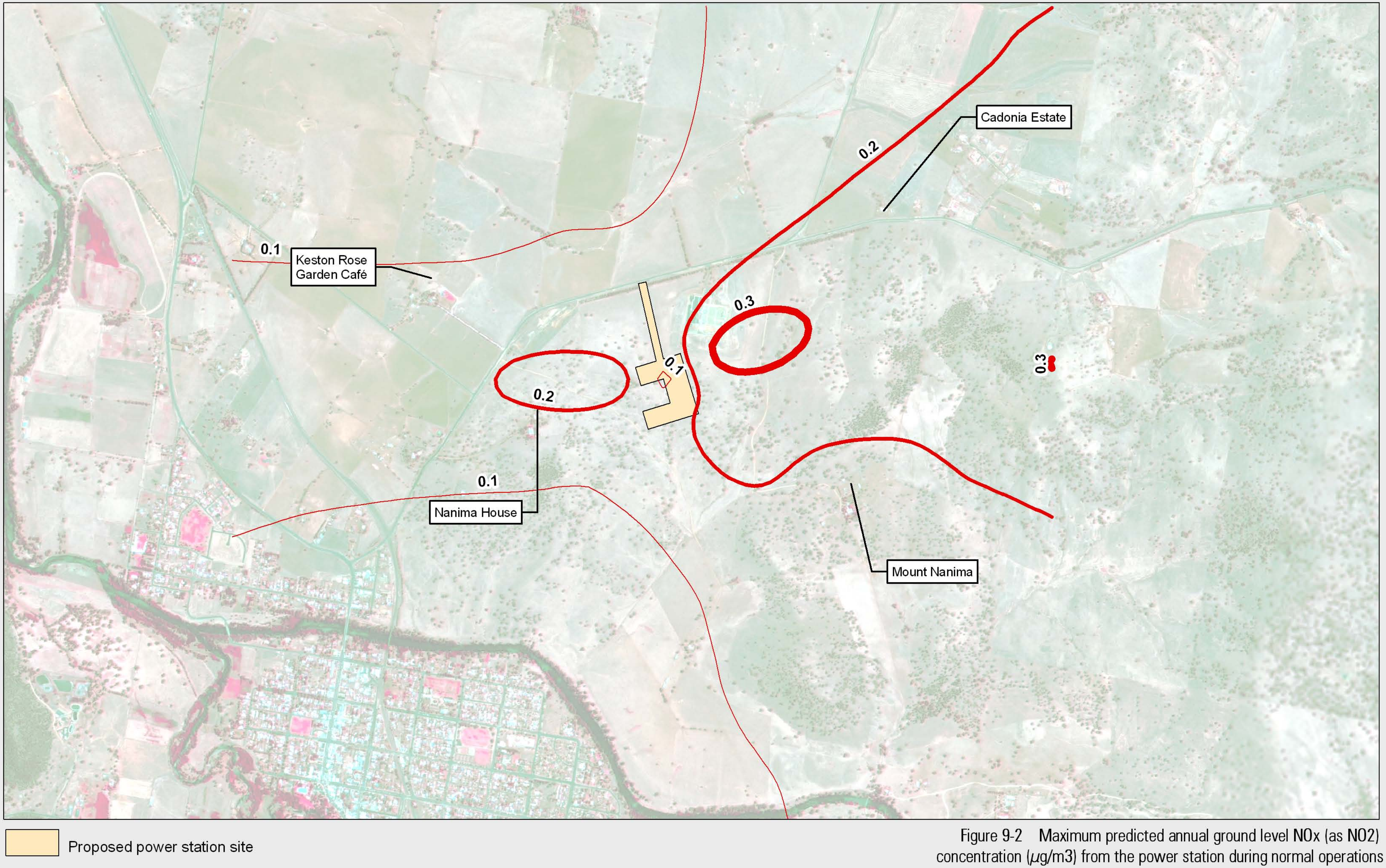
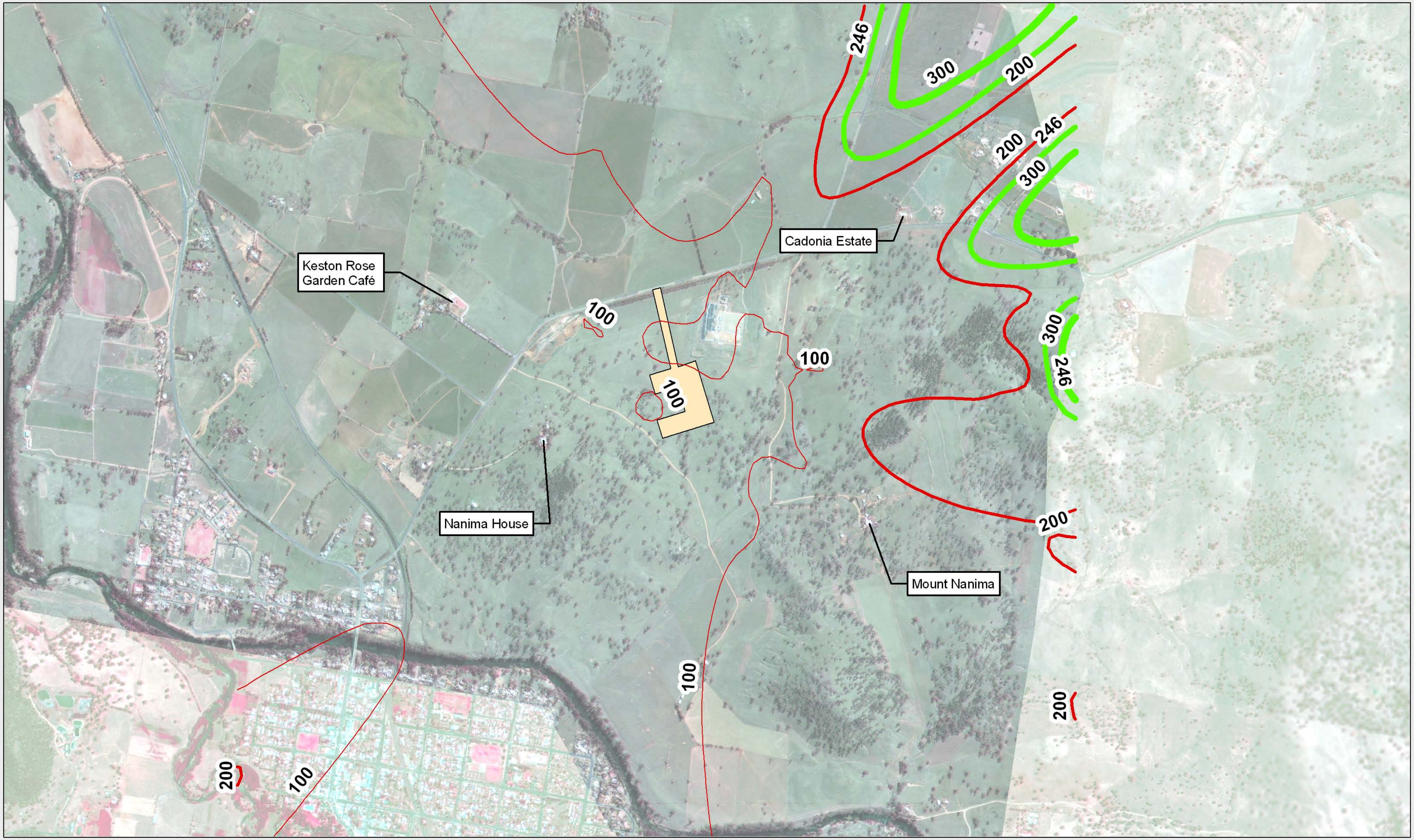


Figure 9-2 Maximum predicted annual ground level NOx (as NO2) concentration (µg/m3) from the power station during normal operations

2116720A_2142b_Fig9_2_Normal_annual_NOx_GK_April 14, 2008

PARSONS BRINCKERHOFF



Proposed power station site

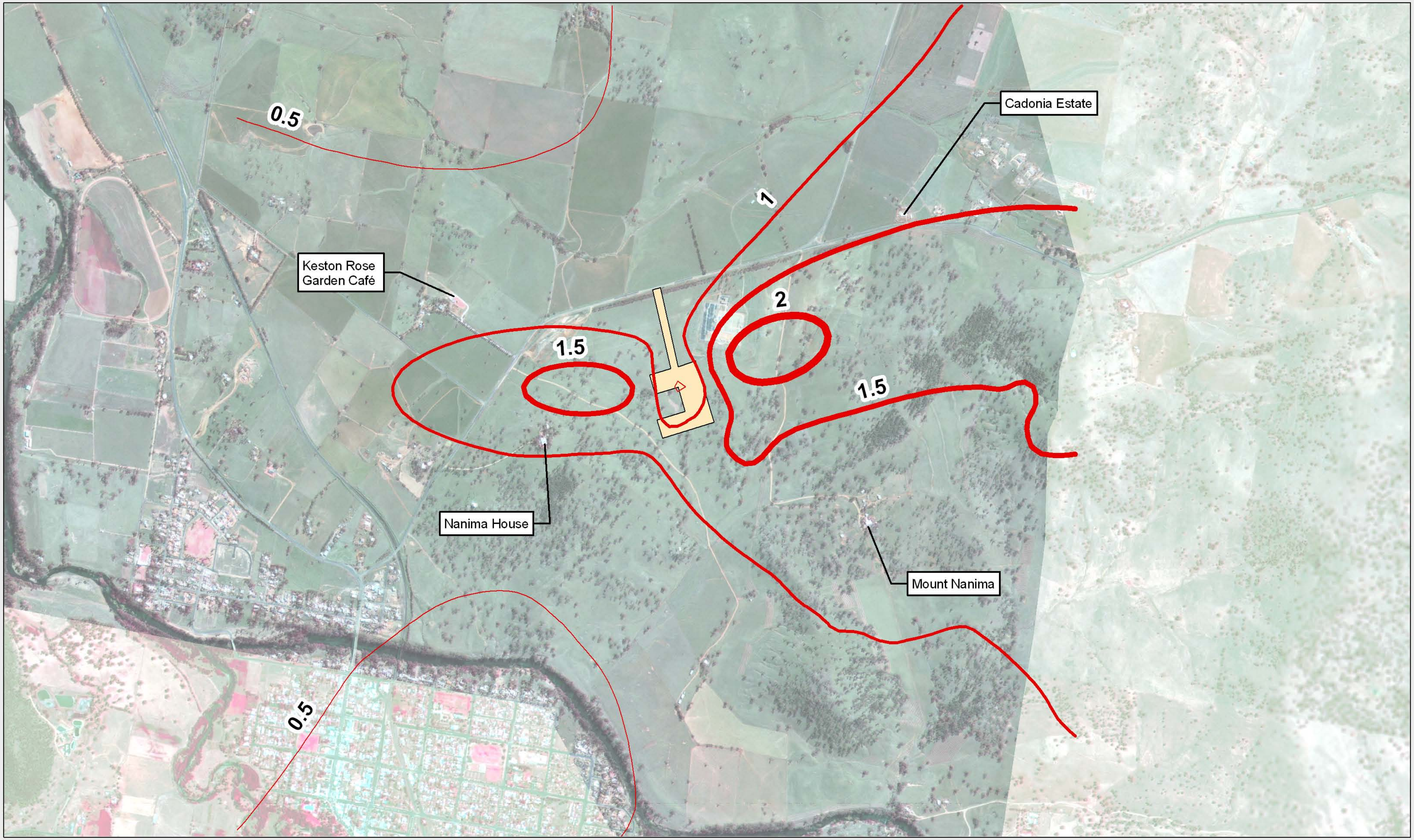
Air quality guideline - 246 µg/m3

Note: Modelled concentrations are start-up conditions for a 1 hour period. Actual start-up conditions would only occur for approximately 6 minutes.

Figure 9-3 Maximum predicted hourly ground level NOx (as NO2) concentration (µg/m3) from the power plant during start up/shut down

0 750 1,500 Metres

2116720A_2143b_Fig9_3_Normal_hourly.mxd, GK, 14 April 2008



Proposed power station site

Air quality guideline - 62 µg/m3

Figure 9-4 Maximum predicted annual ground level NOx (as NO2) concentration (µg/m3) from the power plant during start up/shut down

0 750 1,500 Metres

2116720A_2144b_Fig9_4_Normal_hourly.mxd, MPN, 11 February 2008

Assessment of NO_2 using the ozone limiting method

Details of the ozone limiting method are provided in Section 6.3 of Technical Paper No. 4.

The assessment for this project adopted the Level 1 ozone limiting method. It used the predicted NO_X concentration with background ozone (O_3) and NO_2 data, and assumed that all available atmospheric O_3 would react with nitrogen monoxide (NO) in the plume until either all the O_3, or all the NO is used up. This approach assumes that the atmospheric reaction is instant; in reality, the reaction occurs over numerous hours.

Three scenarios were addressed for the estimation of hourly and annual NO_2 levels:

- *Scenario 1* — maximum predicted hourly NO_x concentration with measured hourly NO_2 and O_3 levels for that hour
- *Scenario 2* — maximum predicted hourly NO_x concentration with maximum measured hourly NO_2 and O_3 levels over the 2004–2005 monitoring period
- *Scenario 3* — annual average NO_x concentrations with annual average NO_2 and O_3 levels.

The results of the ozone limiting method NO_2 predictions at four sensitive receptors (see Figure 3-4) are outlined in Table 9-6. Measured background NO_2 and O_3 concentrations form the nearest and most suitable air monitoring stations (Bathurst, Bargo and Bringelly) were adopted (see Tables 3-1 and 3-2).

Table 9-6 NO_2 predictions by ozone limiting method (μg/m^3) — normal operation

Scenario	Location[4] 1	2	3	4	Maximum predicted GLC (μg/m^3)
Scenario 1					
1-hour maximum					
Predicted maximum 1-hour average NO_X	21.8	34.3	8.6	9.3	63.3
Adopted maximum 1-hour average NO_2[1]			11.3		
Adopted maximum 1-hour average O_3[1]			7.9		
Estimate of maximum 1-hour NO_2 by ozone limiting method	**21.1**	**22.3**	**19.7**	**19.8**	**25.2**
Scenario 2					
1-hour maximum					
Predicted maximum 1-hour average NO_X	21.8	34.3	8.6	9.3	63.3
Adopted maximum 1-hour average NO_2[2]			121.0		
Adopted maximum 1-hour average O_3[2]			282.9		
Estimate of maximum 1-hour NO_2 by ozone limiting method	**150.1**	**144.0**	**129.6**	**130.3**	**184.3**

Scenario	Location[4] 1	2	3	4	Maximum predicted GLC ($\mu g/m^3$)
Scenario 3					
Annual mean					
Predicted annual average NO_X	0.17	0.23	0.13	0.14	0.33
Adopted annual average NO_2 [3]			13.5		
Adopted annual average O_3 [3]			47.1		
Estimate of annual NO_2 by ozone limiting method	**13.7**	**13.7**	**13.6**	**13.6**	**13.8**

Notes: 1: Adopted from measured NO_2 and O_3 background levels for DECC monitoring station located at Bargo (2004 and 2005) at time of maximum predicted hourly NO_x levels (on 11/04/05 at 8 am, as measured background NO_2 levels not available on this date, data on 12/04/04 at 4 am was adopted); 2: Maximum 1 hour measured concentration over 2004/2005 monitoring period; 3: Annual average of 1-hour averages over 2004 and 2005; 4: 1 = Mount Nanima; 2 = Cadonia subdivision; 3 = Keston Rose Garden Café; 4 = Nanima House (see Table 3-3).

The results indicate that the estimated ground level NO_2 concentrations would comply with the adopted 1-hour average DECC goal of 246 $\mu g/m^3$ and the annual average goal of 62 $\mu g/m^3$ at all sensitive receptors during all normal operations. As NO_x emissions would primarily be present as NO_2 during the start-up scenario, the ozone limiting method is not appropriate and hence was not considered.

9.2.4 Gas pipeline

Construction

The impacts on air quality associated with construction of the proposed gas pipeline would be similar to those for the power station (see Section 9.2.3).

Operation

No air quality impacts are predicted to be associated with operation of the gas pipeline.

9.2.5 Compressor station

Construction

The potential impacts associated with construction of the proposed compressor station would similar to those for the power station (see Section 9.2.3).

Operation

The main impacts associated with operation of the proposed compressor station would arise from combustion emissions.

Predicted emissions of NO_x (as NO_2) and PM_{10} from the gas-fired compressor station complied with relevant air quality goals for all the time averages modelled (see Table 9-7). Figures 9-5 and 9-6 present the results of the dispersion modelling assessment for the predicted operational emissions of NO_x from the proposed compressor station.

Table 9-7 Air dispersion modelling results of emissions from the proposed compressor station

Parameter	Averaging period	Predicted GCLs at sensitive receptor locations (($\mu g/m^3$)[1]		Maximum predicted GLC ($\mu g/m^3$)
		Mountain View	Property A	
PM_{10}	24-hour	0.26	0.10	31.4
	Annual	0.20	0.01	0.62
NO_x (as NO_2)	24-hour	2.92	1.75	48.7
	Annual	0.03	0.01	0.87

Note: 1: See Figure 3-4.

Other emissions

Other emissions that may arise during the operation of the compressor station would be similar to those associated with the proposed power station (see Section 9.2.3).

9.2.6 Mitigation measures

General

Construction

Dust and vehicle emissions represent the greatest potential for air quality impacts during the construction works. Dust suppression would be implemented during all construction work to reduce impacts throughout the local airshed. The implementation of effective management practices would minimise the potential for impact. The following mitigation measures and safeguards, which would be detailed in the project CEMP, would be implemented during the construction phase of the project:

- Dust minimisation measures would be developed in consultation with/with agreement of all parties prior to commencement of construction.
- Dust monitoring (dust deposition/PM_{10}) would be undertaken at selected locations to determine compliance with ambient air quality standards.
- A mechanism for receiving and responding to complaints would be put in place for the duration of the construction phase.
- Water would be applied to aggregate storage piles, internal unsealed access roadways and work areas; application rates would be related to atmospheric conditions and the intensity of construction operations.
- Where applicable, sealed roads would be swept to remove deposited material that could generate dust.
- Revegetation activities would proceed as soon as construction activities are completed within a disturbed area.
- Disturbed areas would be stabilised as soon as possible to prevent or minimise wind blown dust.

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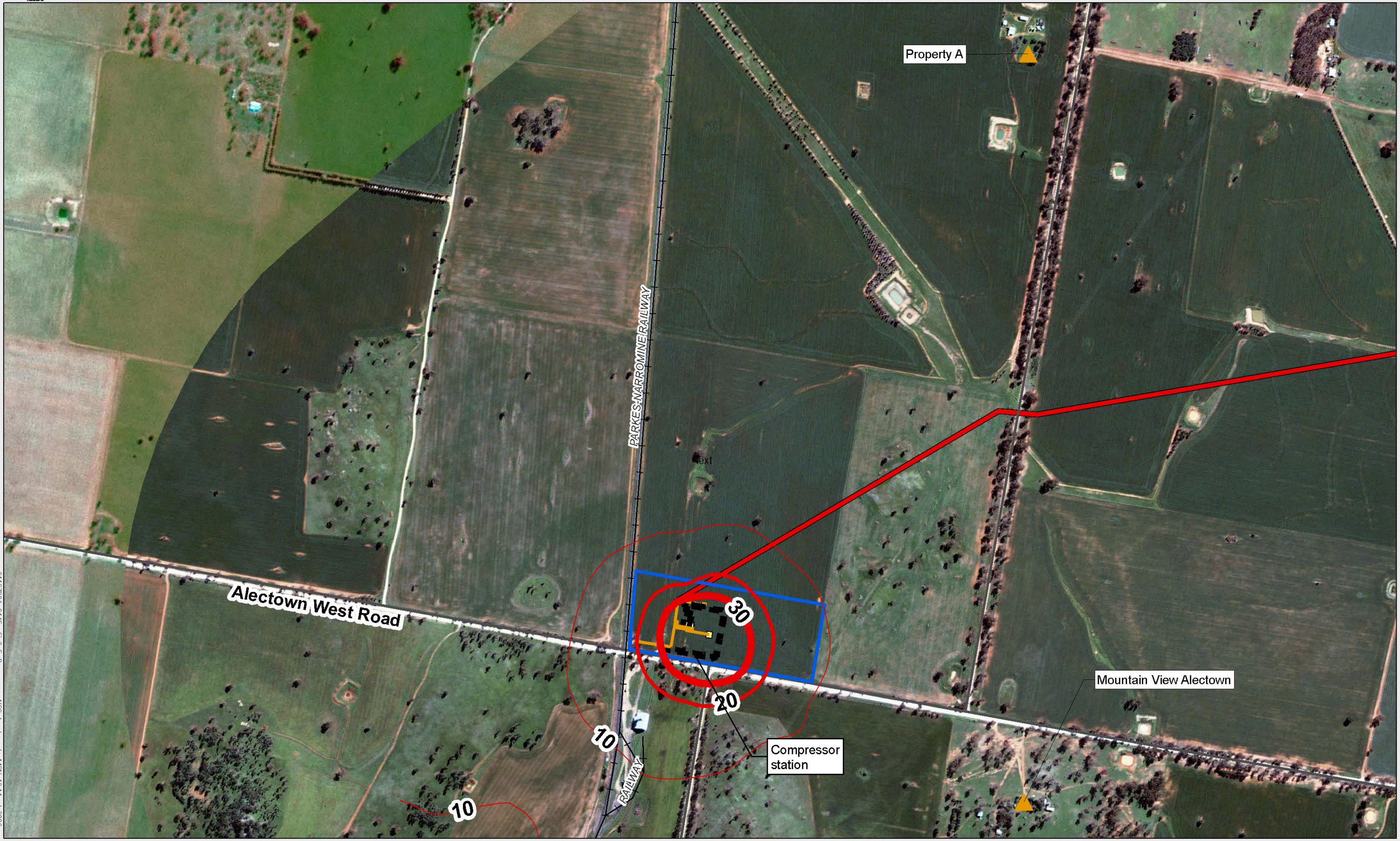

2116720A_2145c_Fig9_5_Compressor_NO2_hourly.mxd MPN 18 March 2008

Figure 9-5 Maximum Predicted Hourly Ground Level NOx (as NO2) Concentration (μg/m3) from the compressor

0 250 500 Meters

Air quality guideline - 246 μg/m3

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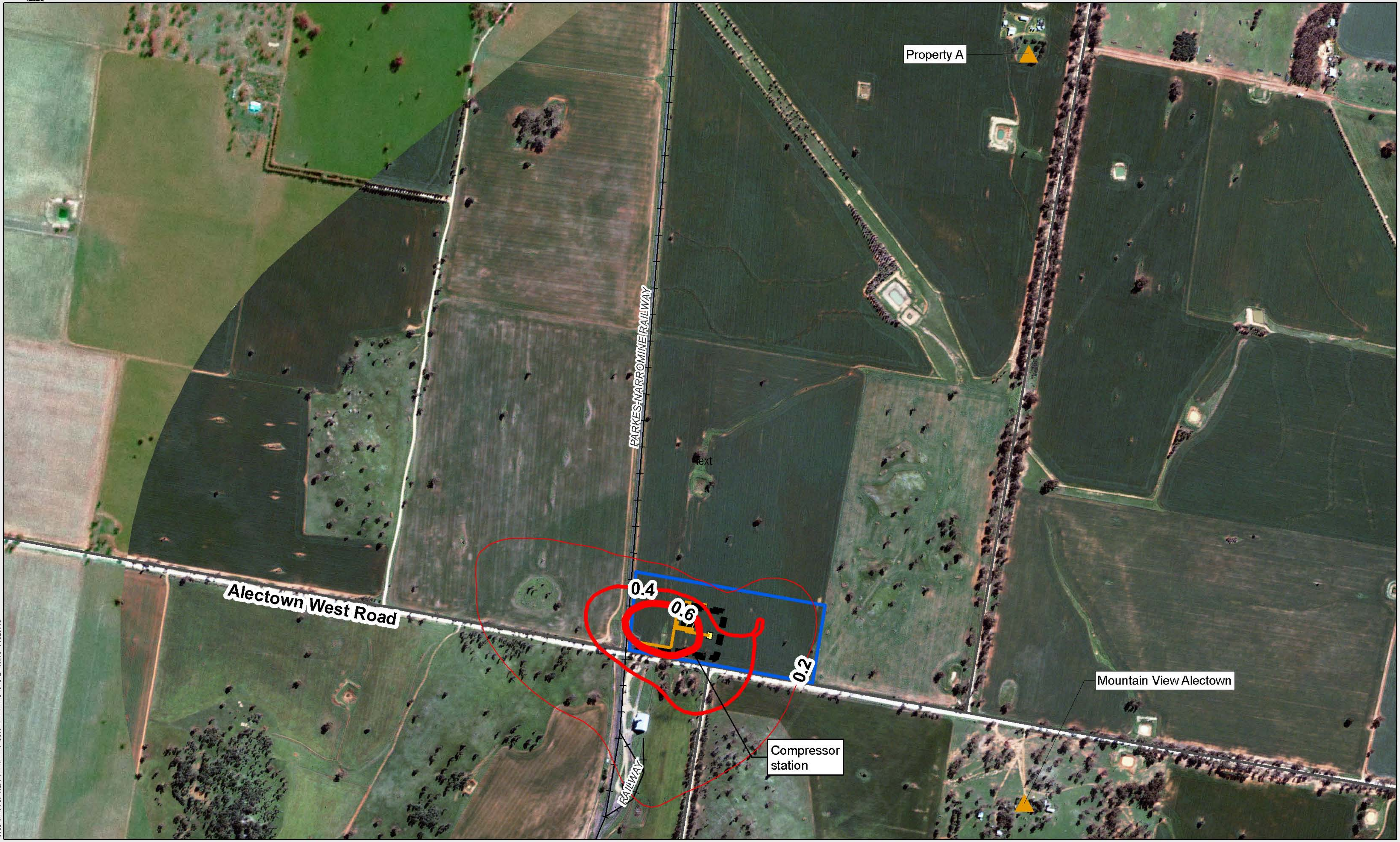


2116720A_2146b_Fig9_6_Compressor_NO2_Annual.mxd, MPN, 18 March 2008

Figure 9-6 Maximum predicted annual ground level NOx (as NO2) concentration (µg/m3) from the compressor

Air quality guideline - 62 µg/m3

0 250 500 Meters

- Dust generating activities (particularly clearing and excavating) would be avoided or minimised during dry and windy conditions where practicable.
- Vehicle and machinery movements during construction would be restricted to designated areas.
- Rumble grids and wheel-wash facilities would be provided at the site exit(s) to remove mud and dust from vehicles if deemed necessary.
- Vehicles transporting material to and from the site would be covered immediately after loading to prevent wind blown dust emissions and spillages; tailgates of road transport trucks would be securely fixed prior to loading and immediately after unloading.
- Construction plant and equipment would be well-maintained and regularly serviced so that vehicular emissions remain within relevant air quality guidelines and standards.
- Good site engineering practices would be adhered to, to reduce the potential for dust generation.
- All site vehicles and machinery would be switched off or throttled down to a minimum when not in use.
- Excess or unnecessary revving of engines would not be permitted.
- All contractors would be required to ensure that vehicles and machinery are maintained in good order.
- On-site speed limits would be enforced for all vehicles.

Operation and construction

All other on-site sources are considered minor and of minimal significance. Notwithstanding this, mitigation measures would be implemented as follows:

- adherence to site speed limits
- switching off idling engines or limiting throttling down
- not permitting excess or unnecessary revving of engines
- storing chemicals and fuels in sealed containers or sealed buildings
- venting diesel during unloading via return hoses that recirculate vapours from delivery to receiver.

Power station

Operation

The following mitigation measures would be put in place to minimise emissions of combustion gases during the power station operation.

The gas-fired turbines would use dry, low NO_x technology. During the normal operational mode, the system would be expected to achieve best practice NO_x emissions of 25 parts per million for gas-fired power stations, complying with emission limits stipulated in the Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005.

The following mitigation measures would be put in place to minimise emissions to the atmosphere:

- Emissions from the turbines would be regulated by operating in-stack limits.
- Periodic extractive monitoring would be undertaken by both the operator and the regulatory authority to demonstrate compliance with in-stack limits.
- A regular and documented maintenance and inspection program would be implemented for all plant items through the operation environmental management plan (OEMP).
- On-site good housekeeping and raw material handling practices would be stringently controlled through the OEMP.
- An ambient air monitoring program would be established to ensure all pollutants comply with ambient air quality limit values.
- Gas detectors would be installed to detect fugitive gas emissions.
- All pumps would be rubber sealed to prevent release of natural gas.

Compressor station

Operation

The following mitigation measures would be put in place to ensure emissions from the compressor station are minimised:

- Emissions from the compressor would be regulated by operating in-stack limits. This may include periodic monitoring by both the operator and the regulator to demonstrate compliance with in-stack limits.
- A regular and documented maintenance and inspection program would be implemented for all plant items through the OEMP.
- On-site good housekeeping and raw material handling practices would be stringently controlled through the OEMP.

9.3 Noise and vibration

Section 3.5 provided a description of the existing ambient noise environment of the study area. Existing background noise profiles were characterised for daytime, evening and night-time noise periods within the study area through unattended and operator-attended noise monitoring. The measured background noise profiles were used to determine adopted noise design goals for the associated construction and operational stages of the project, which are identified in Section 9.3.1.

This section summarises potential noise and vibration impacts associated with construction and operation of the project, and identifies management measures to address these impacts. Noise impacts were identified as a key issue for assessment in the DGRs (see Appendix A). Detailed assessment of this issue is included in Technical Paper No. 3 – *Noise and Vibration Assessment*. The outcomes of the assessment are summarised in this section.

The noise and vibration assessment was undertaken in accordance with the DECC *Industrial Noise Policy* (Environment Protection Authority (EPA) 1999) and associated *Industrial Noise Policy Application Notes*, and with consideration of the NSW *Environmental*

Criteria for Road Traffic Noise (EPA 1999) and Chapter 171 *Noise Control Guideline, Construction Site Noise, Environmental Noise Manual* (EPA 1994).

The Industrial Noise Source Policy (INP) (Department of Environment and Conservation 2000) was referenced in relation to assessment of the influence of meteorological conditions on potential noise impacts. All data sets compiled from the region indicate that noise enhancing conditions are prevalent in the region.

9.3.1 Adopted noise design objectives

The *Protection of the Environment Operations Act 1997* regulates noise generation and prohibits the generation of 'offensive noise' as defined under the Act. In addition to the regulatory requirements under the Act, the DECC provides guidelines regarding acoustic goals and noise controls.

Construction noise

The noise design objectives for construction, established in accordance with regulatory requirements, are presented in Table 9-8.

Table 9-8 Acoustic design objectives for construction activities

Construction period	Acoustic design objective
<4 weeks	Received $L_{A10} \leq L_{A90}$ + 20 dB(A)
4–26 weeks	Received $L_{A10} \leq L_{A90}$ + 10 dB(A)
>26 weeks	Received $L_{A10} \leq L_{A90}$ + 5 dB(A)

Source: EPA (1994)

Notes: L_{A10} = noise level 10% of the time, L_{A90} = A-weighted sound pressure level exceeded for 90% of the time (background), dB(A) = decibels, A-weighted; The recommended goals are planning goals only.

Construction noise goals established in this report are planning levels only. Factors such as social impacts (annoyance) and other environmental effects of the project have been considered with regard to the approval process.

The DECC recognises that individuals accept higher perceived noise impacts for emission sources with a limited duration and identified end date. Construction of the proposed power station is expected to take 18–20 months, construction of the gas pipeline is expected to take 12–14 months, and construction of the compressor station is expected to take approximately 3 months.

Acoustic objectives for construction of each project component have been determined based on an adopted daytime background noise level of 30 dB(A) L_{A90}, determined from the unattended noise monitoring undertaken at the nearest potentially affected receptors (see Section 3.5). These are presented in Table 9-9.

Table 9-9 Construction noise design objectives established at the nearest potentially affected receptors of each project component

Project component	Noise design objective
Power station	35 dB(A) L_{A10} determined from L_{A90} of 30 dB(A) + 5 dB(A)
Gas pipeline	50 dB(A) L_{A10} determined from L_{A90} of 30 dB(A) + 20 dB(A)
Compressor station	50 dB)A) L_{A10} determined from L_{A90} of 30 dB(A) + 20 dB(A)

Notes: L_{A10} = noise level 10% of the time, L_{A90} = A-weighted sound pressure level exceeded for 90% of the time (background), dB(A) = decibels, A-weighted.

Operational noise

Noise design objectives for operation of the proposed power station and compressor station require adherence to the INP, which sets out two goals that are used to assess potential off-site noise impacts:

- intrusive criterion — aimed at controlling intrusive short-term noise impacts for residences
- amenity criterion — aimed at maintaining the long-term amenity of particular land uses.

The relevant intrusive criterion can be summarised as: $L_{Aeq\ (15\ min)} \leq$ rating background level + 5 dB(A).

Where the rating background level is found to be <30 dB(A), then it is set at 30 dB(A). As identified in Section 3.5.1, the rating background levels in the study area during the daytime, evening and night-time periods are below this figure. Therefore, all background levels have been assumed as 30 dB(A).

The acceptable amenity criterion limits for rural areas range from 40 dB(A) L_{Aeq} for residential areas at night-time to 70 dB(A) L_{Aeq} for in-use industrial premises.

Rating background levels were determined from the unattended noise monitoring and, because there is no existing industrial influence, the intrusive design goals are applicable. Therefore, the operational noise impact of the project at any residential receptor in the local area was assessed relative to a goal of 35 dB(A) for the daytime, evening and night-time periods. This criterion is considered indicative of a worst-case scenario during night-time operations, when the background noise environment is most sensitive.

This assessment goal of 35 dB(A) was determined by the addition of 5 dB(A) to the lower limiting adopted background noise level of 30 dB(A). It assumes that there would be no annoying characteristics to site-related noise emissions.

Road traffic noise

Road traffic noise impacts may be associated with construction and operation of the project. The *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA 1999) guideline recommends base goals for land use developments with the potential to create additional traffic on collector and arterial roads of:

- daytime $L_{Aeq,\ 1hr}$ = 60 dB(A)
- night-time $L_{Aeq,\ 1hr}$ = 55 dB(A).

These base goals have been adopted for the purposes of this assessment.

Sleep disturbance goals

The emission of peak noise levels for an instant or very short time period can cause sleep disturbance to residents. In accordance with regulatory requirements, the L_{A1} level (noise level 1% of the time) of any specified noise source should not exceed the background noise level (L_{A90}) by more than 15 dB(A) when measured outside the bedroom window of the nearest potentially affected receiver.

Having adopted a background noise level of 30 dB(A) for the project, a sleep disturbance criterion of 45 dB(A) L_{A1} has been applied to the nearest potentially affected receptors for the purposes of this assessment.

Sleep disturbance is subjective and not all individuals are affected by noise to the same degree. The noise goals for sleep disturbance are designed to protect potentially affected residents from sleep arousal.

9.3.2 Noise assessment approach

Construction

A construction noise impact assessment was undertaken for the worst-case 15-minute period assuming all construction equipment would be operating at once.

Road traffic noise

Due to the low number of traffic movements for each project component compared with existing vehicle numbers on the local traffic network, road traffic noise was assessed based on qualitative factors informed by road traffic studies (see Section 10.1).

To determine potential road traffic noise impacts, the guideline *Calculation of Road Traffic Noise* (CoRTN) (UK Department of Transport 1988) was referred to.

Operation

Power station

SoundPlan noise propagation modelling software (Version 6.4) was used to assess potential operational noise impacts for key noise generating sources associated with the power station at the nearest potentially affected receptors. The modelling was based on a range of geographical, meteorological, technical and operational factors (see Section 7.1 in Technical Paper No. 3). Point and area sources were considered in regard to the transmission of noise, with sound emission data for the Siemens gas-turbine model provided by ERM Power.

Compressor station

Detailed design of the compressor station had not been finalised at the time of the noise and vibration assessment. Where considered necessary, assumed compressor station noise source profiles were applied.

An operational noise propagation model was established for the assessment of potential noise impact from operation of the compressor station at the nearest potentially affected receptors. The modelling was based on a range of geographical, meteorological, technical and operational factors (see Chapter 8 in Technical Paper No. 3).

9.3.3 Meteorological data

The NSW INP was referenced in relation to the influence of meteorological conditions on potential noise impacts. The data sets referenced, based on the location of referenced sites and the length and extent of conditions compiled, provide only an indication of noise enhancing conditions.

Gradient wind flows

The INP states:

> Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source-to-receiver wind speeds (at a 10m height) of 3m/s or below occur for 30 percent of the time or more in any assessment period (day, evening, night) in any season.

An analysis of regional wind-enhancing noise conditions was undertaken, including an assessment of all hours of recorded wind flow patterns. The assessment was based on wind speed data obtained from the BoM Dubbo station (I.D. 065070) for 2004–2005. The data were separated into the four seasons and then into the daytime, evening and night-time assessment periods. Further to this, the data were separated into flow vectors relevant to each of the nearest potentially affected receivers considered.

A review of the data indicated that no gradient or drainage wind flow regime was present for more than 30% of the time (upon consideration of both directional and prevailing vector wind patterns) throughout the year during the night-time period.

Winds were not a feature for the area based on the 2004–2005 Dubbo dataset.

Temperature inversions

In order to determine the presence of temperature gradients, an analysis of cloud cover and wind speed was undertaken. The winter evening and night-time (6 pm to 7 am) period was assessed.

Three-hourly cloud cover data was assessed for Wellington (2004–2005). Standard deviation wind profile data was not available from the BoM, nor was net radiation data.

Temperature inversions are a feature when they occur for at least 30% (approximately 2 nights per week) of the total evening and night-time period in winter, with inversions considered to be present during F-class (moderate inversion) or G-class (strong inversion) stability conditions. Wind speeds of less than 2 metres per second are generally associated with G-class (strong inversion) conditions, irrespective of cloud cover, with wind speeds of 2–3 metres per second associated with F-class (moderate inversion) conditions, when cloud cover is less than or equal to 3/8 octaves.

This assessment procedure requires cloud coverage data at night for the winter period. The meteorological data available from the BoM Wellington site (I.D. 065034/65) for this period was reviewed with the 3-hourly cloud cover data for 2004–2005. This indicated that less than 3/8 octaves of cloud cover was present for approximately 50% of the time, with average cloud cover data generally between 3/8 and 4/8 octaves during the night-time winter period. This indicates a reasonable potential for occurrence of moderate F-class stability categories (wind speeds up to 3 metres per second).

When wind speed conditions during the night-time winter period only were considered, an occurrence of less than 16% was present in 2004–2005 (Dubbo), based on wind speed conditions of 3 metres per second and less (F-class (moderate inversion) stability conditions). When a wind speed of 2 metres per second and less (G-class (strong inversion) stability conditions) was considered, an occurrence of less than 49% in 2004 and 32% in 2005 (Dubbo) was present.

Analysis of the synthetically compiled meteorological file (from the CSIRO TAPM program) indicated that inversion conditions may be present for up to 29% of the time, with wind speeds of 3 metres per second and less (G-class (strong inversion) stability conditions). When wind speeds of 2 metres per second and less (F-class (moderate inversion) stability conditions) were considered, a frequency of less than 8% was present.

The data and screening analysis approach adopted indicates that temperature gradients, and F- and G-class stability categories (occurring separately or in combination) may potentially be a feature of the area.

9.3.4 Power station

Construction

Table 9-10 details predicted noise impacts associated with construction of the proposed power station at the nearest potentially affected receptors, and compares these predictions with construction impact design goals.

Table 9-10 Predicted noise impacts from construction of the power station

Sensitive receptor[1]	Approximate distance from works (metres)	Construction L_{A10} noise impact (dB(A))[2]		
		Predicted	Criterion	Compliance
Mount Nanima	1,300	42.5	35	No (+ 7.5)
Cadonia subdivision	2,500	37	35	No (+ 2)
Keston Rose Garden Café	1,500	41.5	35	No (+ 6.5)
Nanima House	700	48	35	No (+ 13)

Notes: 1: See Figure 3-4; 2: L_{A10} = noise level 10% of the time, dB(A) = decibels, A-weighted; Noise levels to nearest 0.5 dB(A)

The modelling used to determine these impacts did not consider potential reductions in received noise levels due to intervening elevated ground and topographical features.

Ground clearance and excavation works would be the dominant influence on received predicted noise impacts. These were predicted to have a received noise impact range of 39.5–50.5 dB(A) L_{A10}. Following completion of these works, installation of the power station would occur. The predicted received noise impact of the installation works was predicted as 30.5–41.5 dB(A) L_{A10}.

The predicted received noise impacts detailed in Table 9-10 are not expected to occur throughout the full program of works. Once ground clearance and excavation works have been completed, a reduction in noise impact would be expected such that compliance with DECC goals would be achieved.

Road traffic noise

Hourly L_{A10} noise levels from light vehicle and truck movements were determined based on an assumed speed of 75 kilometres per hour and a total vehicle flow of 14 light vehicle movements and 24 truck movements.

The basic noise level was predicted to be 61 dB(A) $L_{A10,\ 1\ hour}$. At a distance of 20 metres between a given façade and the middle of the near side road carriageway, applying a CoRTN distance correction, the basic noise level would be approximately 59 dB(A) $L_{A10,\ 1\ hour}$. This corresponds to an approximate received level of 56 dB(A) $L_{Aeq,\ 1\ hour}$.

Hourly noise levels from vehicle movements were predicted to be less than the ECRTN noise goal of 60 dB(A) $L_{Aeq,\ 1hr}$, although this goal applies to long-term operational noise rather than short-term construction noise.

Vehicle movements associated with the project are not considered significant when compared to existing traffic flows on the nearby highways (Mitchell, MR233 and Newell). Truck movements would be via existing major transport routes.

Given the separation distances between noise receptors and the local roads, and the low number of vehicle movements, received noise levels would be expected to comply with the 'base' criterion.

Truck manoeuvring at construction sites and the loading and unloading of spoil and equipment were considered as part of the construction noise impact assessment.

Operation

Table 9-11 lists the key operational noise source sound power levels for each of the four gas turbines of the power station, as adopted for the purposes of this assessment.

Table 9-11 Key operational noise source sound power levels (per turbine) of the power station

Noise source	Sound power level (dB(A))
Exhaust stack with absorption silencer	98
Exhaust stack area source	98
Fin fan coolers – low noise design	96
Diffuser with acoustic enclosure	94
Transformers – low noise design	93
Inlet air filter house with absorptive silencer area source	90
Gas turbine building area source	85
Gas turbine ventilation	85
Unidentified sources	90

Note: dB(A) = decibels, A-weighted.

The propagation of noise was considered in regard to both point and area sources. The influence of 'directivity' was considered in regard to noise propagating from the exhaust stack tip. Directivity is a measure of the radiation pattern from a source, indicating how much of the total energy is radiated in a particular direction. For the purposes of the assessment, a 90° angle of propagation was assumed for the exhaust stack tip, with a resultant sound power level of 96 dB(A).

Predicted received noise levels at the nearest potentially affected receptors to the power station site under worst-case scenario conditions (four turbines cumulative operation) are detailed in Table 9-12. Received noise impacts were predicted for neutral and noise enhancing meteorological conditions: wind speeds greater than 3 metres per second or temperature inversion conditions.

Table 9-12 Predicted noise impacts from operation of the power station

Location[1]	Received noise level (dB(A), $L_{Aeq, 15min}$)[2]		
	Neutral conditions	**Adverse conditions**	**35 dB(A) compliance**
Mount Nanima	36	38.5	No
Cadonia subdivision	26.5	29.5	Yes
Keston Rose Garden Café	34.5	37	No (adverse conditions)
Nanima House	43	44.5	No

Notes: 1: See Figure 3-4; Noise levels shown to the nearest 0.5 dB(A)

Potential received noise levels at the Wellington township are predicted to be less than 25 dB(A) L_{Aeq}.

A noise impact isopleth for the power station and surrounding environment under neutral conditions, with a +5 dB low frequency modifying correction factor, is shown in Figure 9-7.

Below is a discussion of the above noise impact predictions as they relate to each sensitive receptor.

Mount Nanima

For neutral metrological conditions, received operational noise levels at Mount Nanima were predicted to marginally exceed the adopted noise design goal by 1 dB(A). Where meteorological conditions provide noise enhancing conditions, the extent of exceedance was predicted to be 3.5 dB(A).

Cadonia subdivision

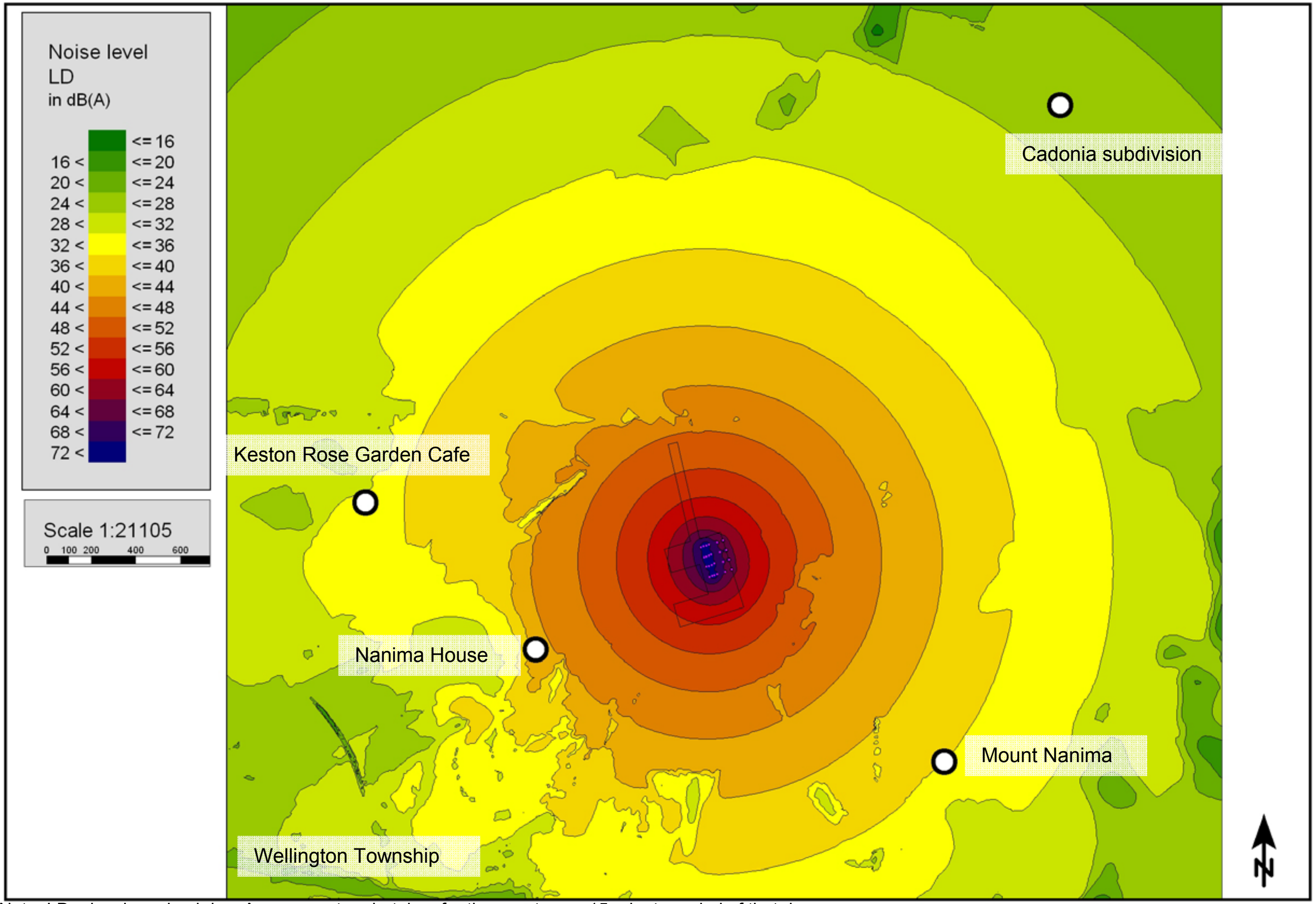
Operational noise levels received at the Cadonia subdivision were predicted to comply with the adopted noise design goal during both neutral and noise-enhancing meteorological conditions.

Keston Rose Garden Café

Operational noise levels received at the Keston Rose Garden Café during neutral conditions were predicted to comply with the adopted noise design goal. However, during noise-enhancing meteorological conditions, received noise levels were predicted to exceed the adopted noise design goal by 2 dB(A).

Nanima House

Nanima House was predicted to receive the greatest operational noise impact of all receivers. Under neutral meteorological conditions, received operational noise levels were predicted to exceed the adopted noise design goal by 8 dB(A). For noise enhancing meteorological conditions, a noise level exceedance of 9.5 dB(A) was predicted.



Note: LD = level received day. Assessment undertaken for the worst-case 15-minute period of that day

Figure 9-7 Predicted noise impact isopleth (neutral conditions with +5 dBA low frequency modifying correction factor) for the power station and surrounding environment

Road traffic noise

Road traffic volumes associated with operation of the power station were estimated to comprise approximately six to eight light vehicles and, as required, trucks for deliveries. During the peak morning and evening hourly periods this would equate to less than 10 light vehicle movements per hour and infrequent truck movements.

Given the frequency of vehicle movements and the minimum separation distances between the power station site and the nearest potentially affected receptors, road traffic noise levels from the power station operations were predicted to comply with ECRTN base goals of 60 dB(A) $L_{Aeq,\ 1\ hour.}$

Sleep disturbance

Where the power station and associated infrastructure would become operational during the night-time period, the change in ambient noise level could be sufficient to disrupt sleep, and wake occupants of nearby potentially affected receptors.

The level of sleep disturbance would be dependent on the level of L_{A1} noise emissions from the power station. Referencing available L_{Aeq} data, it is considered reasonable to assume that there is potential for short-term L_{A1} noise levels above the recommended noise design goal. However, exceedance of the noise goal is not a definitive indicator of sleep disturbance, as this is a subjective issue. Guidance provided within the ECRTN (EPA 1999) indicates that short-term external noise levels of 60–65 dB(A) would not cause awakening reactions. However, this does not take into account issues relating to getting back to sleep or changes in sleep state.

The only location likely to experience an exceedance of the adopted sleep disturbance criterion of 45 dB(A) L_{A1} (see Section 9.3.1) is Nanima House, and only under adverse meteorological conditions. At all other locations, there would be only a small risk of non-compliance.

Vibration

Operation of the power station is not expected to result in vibration levels at the nearest potentially affected receptors in exceedance of annoyance or structural limits.

Vibration is not expected to occur outside the immediate locality of operational plant.

9.3.5 Gas pipeline

Construction

Table 9-13 details the predicted noise impacts from construction of the gas pipeline at a range of distances to potentially affected sensitive receptors, and compares these predictions with construction impact design goals.

Table 9-13 Predicted noise impacts from construction of the gas pipeline

Distance from works (metres)	Construction L_{A10} noise level (dB(A))		
	Predicted	Criterion	Compliance
300	56.5	50	No (+ 6.5)
350	55.5	50	No (+ 5.5)
400	54	50	No (+ 4)
500	52	50	No (+ 2)

Note: Noise levels to nearest 0.5 dB(A)

The nature of the pipeline construction excavation works would be such that noise impacts at individual properties would only be expected to occur for very short periods.

Construction of the gas pipeline would occur at a minimum separation distance of 300 metres from the nearest potentially affected receptors. Worst-case noise levels associated with the pipeline construction works at this distance were predicted to exceed the noise design goal by up to 7 dB(A). Periodic use of excavation equipment would be required. This has been identified as the likely dominant source of construction noise and was predicted to result in an increase in short-term received noise levels of up to 5 dB(A) L_{A10}, which is reflective of the intensity of the potential noise impact. Since very few properties would be located in the vicinity of the 100 kilometre pipeline route, construction noise is not expected to be a significant issue.

Road traffic noise

Road traffic volumes associated with construction of the gas supply pipeline would comprise approximately 20 heavy vehicles and, as required, light vehicles. This would correspond to approximately one to two truck movements per hour and infrequent light vehicle movements.

Given the frequency of vehicle movements and minimum separation distances between the work site and the nearest potentially affected receptors, road traffic noise levels associated with the pipeline works would be expected to comply with the ECRTN base goal of 60 dB(A) $L_{Aeq, 1 hour}$.

Operation

Operation of the gas pipeline would not result in noise impacts at any of the nearest potentially affected receptors along the pipeline route.

9.3.6 Compressor station

Construction

Table 9-14 details predicted noise impacts from construction of the compressor station at the nearest potentially affected sensitive receptors, and compares these predictions with construction impact design goals.

Table 9-14 Predicted noise impacts from construction of the compressor station

Sensitive receptor[1]	Approximate distance from centre of project site (metres)	Construction L_{A10} noise level (dB(A))		
		Predicted	Criterion	Compliance
Mountain View, Alectown	660	47.5	50	Yes
Property A	1,650	42	50	Yes

Notes: 1. See Figure 3-5; Noise levels to nearest 0.5 dB(A)

The predicted noise impacts at the nearest potentially affected receptors complied with the adopted noise goals. Separation distances between the proposed compressor station and the nearest receptors would be sufficient to attenuate construction plant noise.

Road traffic noise

Road traffic movements required for the construction of the compressor station are likely to be less than one truck per hour and approximately two light vehicle movements per hour.

Road traffic movements of this frequency would not be expected to influence existing hourly noise levels and should comply with ECRTN base noise goals.

Operation

Table 9-15 lists the predicted key operational noise source 1/1 octave sound power levels for the compressor station, as adopted for the purposes of this assessment.

Table 9-15 Key operational noise source sound power levels of the compressor station

Noise source	Sound power level (dB(A))
Compressor station housing	85
Driver exhaust (silenced)	96
Radiator fans	96
Process piping	100
Control valve	99

The compressor station housing level in Table 9-15 is based on experience from previous assessments. This data and the operational plant sound power levels would need to be confirmed during the detailed design.

Predicted noise levels at the nearest potentially affected receptors to the compressor station site under worst-case scenario night-time operations are detailed in Table 9-16.

Table 9-16 Predicted noise impacts from operation of the compressor station

Location	Received noise level (dB(A), $L_{Aeq, 15min}$)	
	Noise level	35 dB(A) compliance
Mountain View, Alectown	34.5	Yes
Property A	31	Yes

Notes: 1. See Figure 3-5; Noise levels to nearest 0.5 dB(A)

The predicted operational noise levels complied with the adopted noise design goal for the nearest potentially affected receptors.

Further assessment of noise source emissions would be required during the detailed design to determine potential annoyance characteristics, source configuration, operating conditions and anticipated noise emission levels.

Road traffic noise

Road traffic volumes associated with operation of the compressor station would most likely be infrequent, as the compressor station is likely to be unmanned. The frequency of vehicle movements and minimum separation distances between the access roads, compressor site and the nearest potentially affected receptors, are such that road traffic noise levels associated with the compressor station operation would be expected to achieve the ECRTN base goal of 60 dB(A) $L_{Aeq,\ 1\ hour}$.

9.3.7 Mitigation measures

This section details recommended measures to mitigate or reduce received noise impacts from the project at the nearest potentially affected receptors, to achieve compliance with the intent and guiding principles of the INP.

All measures have been identified considering the principles of ‘best practice management’ and ‘best available technology economically achievable’, and would be subject to costing and feasibility assessment by ERM Power.

General

Construction

The following pre-construction and construction phase measures and management practices would be implemented to mitigate and reduce noise impacts:

- Construction noise management measures would be formulated as part of the development of the project CEMP to provide a framework for addressing noise impacts associated with construction works. Noise control options, including site mitigation and the investigation of low noise plant, would be detailed in the CEMP, as would the delivery of best practice noise management on-site.
- Construction works would adopt best management practice and best available technology practices that are economically achievable, as encouraged by the DECC and addressed in current acoustic guidelines. In addition to the best management practices discussed in the above sections, this also includes encouraging a general staff attitude to reducing noise emissions. Contractors would be made aware of the problems associated with noise. Best available technology practices that are economically achievable involve incorporating the most advanced and affordable technology to minimise noise emissions. All plant would be selected after considering noise emissions.
- Information would be provided to potentially affected local residents prior to commencement of noisy activities. Construction methods, duration and timing of events would be outlined.
- Temporary and permanent construction sites would display appropriate signage, including project information and relevant contact details for public information and enquiry.

- Standard construction noise mitigation techniques would be applied. As a minimum, these would include the following measures:
  - Residential class mufflers and, where applicable, engine shrouds (acoustic lining) would be used. All equipment would be maintained in good order, including mufflers, enclosures and bearings to ensure unnecessary noise emissions are eliminated.
  - Construction works would be restricted to between 7 am and 6 pm Monday to Friday, and between 8 am and 2 pm Saturdays, with no works on Sundays or public holidays.
  - Engines would not be started and no on-site activities (including entry or departure from the site) would be undertaken outside of the specified construction hours.
  - Construction activities would be undertaken in accordance with *AS2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites*. All equipment used on-site would be required to demonstrate compliance with the noise levels recommended within AS 2436-1981.
  - Appropriate use of all plant and equipment and reasonable work practices would be applied, including no extended periods of ‘revving’, idling or ‘warming up’ in proximity to existing residential receivers. Any excessively loud activities would be scheduled during periods of the day when general ambient noise levels are greatest. This would reduce the potential for cumulative noise impacts (relating to worst-case elevated operations) and extended periods of off-site annoyance.
  - Minimising reversing alarm noise emissions from mobile plant and transport truck operations would be considered, provided occupational health and safety requirements are satisfied. Where practicable, site entry and exit points would be managed to limit the need for reversing.
  - Regular maintenance would be undertaken on all plant and machinery used throughout the constructions works.

Operation

Noise levels are predicted to comply with adopted noise design goals for operation of the gas pipeline and compressor station. Consequently, no mitigation measures are proposed. However, because the design of the compressor station was not finalised at the time of the noise and vibration assessment, emission data and the acoustic performance of the operational plant would be confirmed with the supplier during the detailed design. Operational plant for the compressor station would be installed to achieve compliance with the adopted noise design goal.

Exceedances of operational noise goals at the nearest potentially affected receptors would be avoided, where practicable, through the implementation of all practicable reasonable and feasible mitigation measures. Based on this principle, management of the operational noise impacts from the power station would be undertaken considering the following zones of impact:

- *Zone 1: compliance zone* — up to 35 dB(A) $L_{Aeq,\ 15min}$
- *Zone 2: noise management zone* — >35 – 40 dB(A) L_{Aeq} (for the amelioration of internal noise environments)
- *Zone 3: acquisition zone* — >40 dB(A) L_{Aeq} (for the negotiation of property procurement).

To achieve compliance with the adopted noise design goals, the following reductions in received noise levels, dependent on meteorological conditions, would be required at the affected receptors:

- Mount Nanima: 1.5 – 4 dB(A) $L_{Aeq,\ 15min}$ (Zone 2)
- Keston Rose Garden Café: 2 dB(A) $L_{Aeq,\ 15min}$ (adverse conditions only) (Zone 2)
- Nanima House: 8 – 10 dB(A) $L_{Aeq,\ 15min}$ (Zone 3).

Compliance with adopted noise design goals would not be feasible through the application of on-site noise mitigation measures alone, due to technology constraints. Table 10-1 in Technical Paper No. 3 provides an overview of potential noise management and mitigation measures to demonstrate that all reasonable and feasible measures have been applied to the power station design, in order to achieve reductions in source noise emissions and received noise levels. The recommendations in that table have been made considering the principles of best management practices and best available technology that is economically achievable. Of the nine noise management and mitigation techniques considered, two have been identified as viable options:

- *procurement of property* — This option is feasible as Nanima House is the only property identified to receive predicted noise levels that would place it in Zone 3: acquisition zone. Purchase of Nanima House would address compliance at that property; however there would still be exceedance of the 35 dB(A) noise criterion by 1.5–4 dB(A) at Mount Nanima and up to 2 dB(A) at the Keston Rose Garden Café.
- *amelioration at residential properties* — Acoustic treatment would be required at Mount Nanima and Nanima House to meet the noise criterion during neutral conditions, and potentially at the Keston Rose Garden Café should it be determined that noise-enhancing conditions are prevalent. Treatment could include glazing, building wall and roof insulation, or passive ventilation/air conditioning systems to limit the transition of external airborne noise to the internal environment. Amelioration would need to be undertaken in a manner consistent with the intent of the Department of Planning (DoP) and the DECC (reflected in any approval conditions).

The strategy for management of power station operational noise impacts for the nearest potentially affected receptors would include:

- negotiation with the land owner of Nanima House under Section 8 of the INP for property procurement, or similar
- adoption of an operational noise design goal of 39 dB(A) for Mount Nanima where a low frequency modifying correction factor is applicable; 35 dB(A) at all other times
- adoption of an operational noise design goal of 37 dB(A) for the Keston Rose Garden Café where a low frequency modifying correction factor is applicable; 35 dB(A) at all other times.

The above strategy would be deemed reasonable assuming the application of noise amelioration measures as presented for Zone 2: noise management zone.

The proposed maximum allowable noise contributions would be in close agreement with the INP developed goals for both Mount Nanima and the Keston Rose Garden Café.

Gas pipeline

Construction noise at pipeline excavation sites would be mitigated through the erection of temporary screening, which would comprise solid facades enclosing the work site.

9.4 Visual impact

Resolve Planning undertook an assessment of potential impacts on visual amenity that may arise from the project.

Section 3.10 provides a description of the existing landscape and visual environment in the area. This section summarises potential impacts of the proposed power station and proposed compressor station on the area's visual amenity and outlines management measures to address these impacts. No visual assessment was undertaken for the proposed gas pipeline as the proposed structure would be underground, with relatively minimal alteration to the existing landscape and thus the visual environment.

Visual amenity was identified as a key issue for assessment in the DGRs (see Appendix A). Detailed assessment of this issue is included in Technical Paper No. 5 – *Visual Assessment*. The outcomes of the assessment are summarised in this section.

9.4.1 Methodology

Prior to on-site visual assessments, desk-based assessment was undertaken using aerial photography and topographic maps to identify potential visual receptors around the proposed power station and compressor station sites. These sensitive receptors are identified and discussed in Sections 3.10.1 and 3.10.2 respectively.

For the on-site visual assessment of the proposed power station, a crane was placed in the proposed position of the third exhaust stack (the third stack from north to south; see Figure 7-4) and its arm was extended to reflect the position of the stack. The crane was placed in this location to:

- physically locate the proposed power station in its visual context
- enable the identification of the sensitive receptors most likely to be visually affected by the proposed power station
- facilitate the later production of photomontages from the identified most sensitive receptors
- provide a reference point for the community to site the location of the proposed power station in the landscape.

With the crane arm in place, a visual assessment was undertaken from each of the 11 identified sensitive receptors (see Section 3.10.1). Four receptors were identified as most likely to be visually affected by the proposed power station site. Photographs of the proposed power station site (using the crane arm as a reference point) were taken from each of these sensitive receptors using a 50 millimetre zoom lens. These photographs were then used to prepare four photomontages.

A photomontage is the accurate placement of a 3D model into a photograph using advanced geographic information system (GIS), global positioning system (GPS) and three-dimensional (3D) techniques to simulate proposed conditions in a photo-realistic manner. A 3D model of the proposed power station was built to scale using site layouts and technical specification data. The 3D model was textured and coloured using reference to similar power stations. Digital software was then used to accurately place the 3D model into the photographs to create the photomontages.

The photomontages enabled a more thorough assessment of the potential visual impact of the proposed power station from the four most potentially affected sensitive receptors. The photomontages were created and assessed based on the current environment (i.e. existing paddock trees); the assessment did not account for any potential losses of these trees through construction of the proposed power station.

The visual impact assessment of the proposed compressor station was undertaken by viewing the sensitive receptors from Alectown West Road and/or the proposed compressor station site. Topographic maps, the proposed layout and details of the technical specifications (e.g. maximum structure heights) were used to further the assessment.

9.4.2 Power station

Skyline and tree line

The undulating topography of the area and the proposed location of the proposed power station site in a vegetated valley are such that the proposed power station's impact on the skyline is expected to be minimal. In addition to the undulating topography, the informal patterns of existing vegetation (at heights of 15–20 metres) form a diverse tree line across the study area. Such tree lines would be formed in the fore- and middle-ground when looking toward the power station site, thus reducing the visual impact of the proposed power station. Consequently, the location of the proposed power station has been well-selected, as the landscape has the ability to effectively absorb the visual impact of the proposed development. This ability to absorb the visual impact of the development would be lessened if proposed in a flat landscape.

Sensitive receptors

Of the 11 sensitive receptors identified (see Section 3.10.1), four have the greatest potential to be significantly affected by the proposed power station. As discussed in Section 9.4.1, photomontages were prepared to simulate views to the proposed power station from these receptors (see below). The locations of the visual receptors for which photomontages were created are indicated in Figure 9-8.

Site 1 — Nanima House

The proposed power station site (using the crane as a reference) would not be visible from the north-eastern corner of Nanima House due to topography and the scattered mature Eucalyptus trees within the paddock below the house. However, the site would be visible through a small gap in vegetation from an angled section of the veranda at the western end of the house. The photomontage created from this location (see Figure 9-10) indicates that all four exhaust stacks would be partially visible. This veranda is not, however, an outdoor entertaining area and no windows from the house take advantage of this view (see Figure 14 in Technical Paper No. 5). As such, only minor landscaping works would need to be undertaken to mitigate the impact of the proposed power station on this view (see Section 9.4.4).

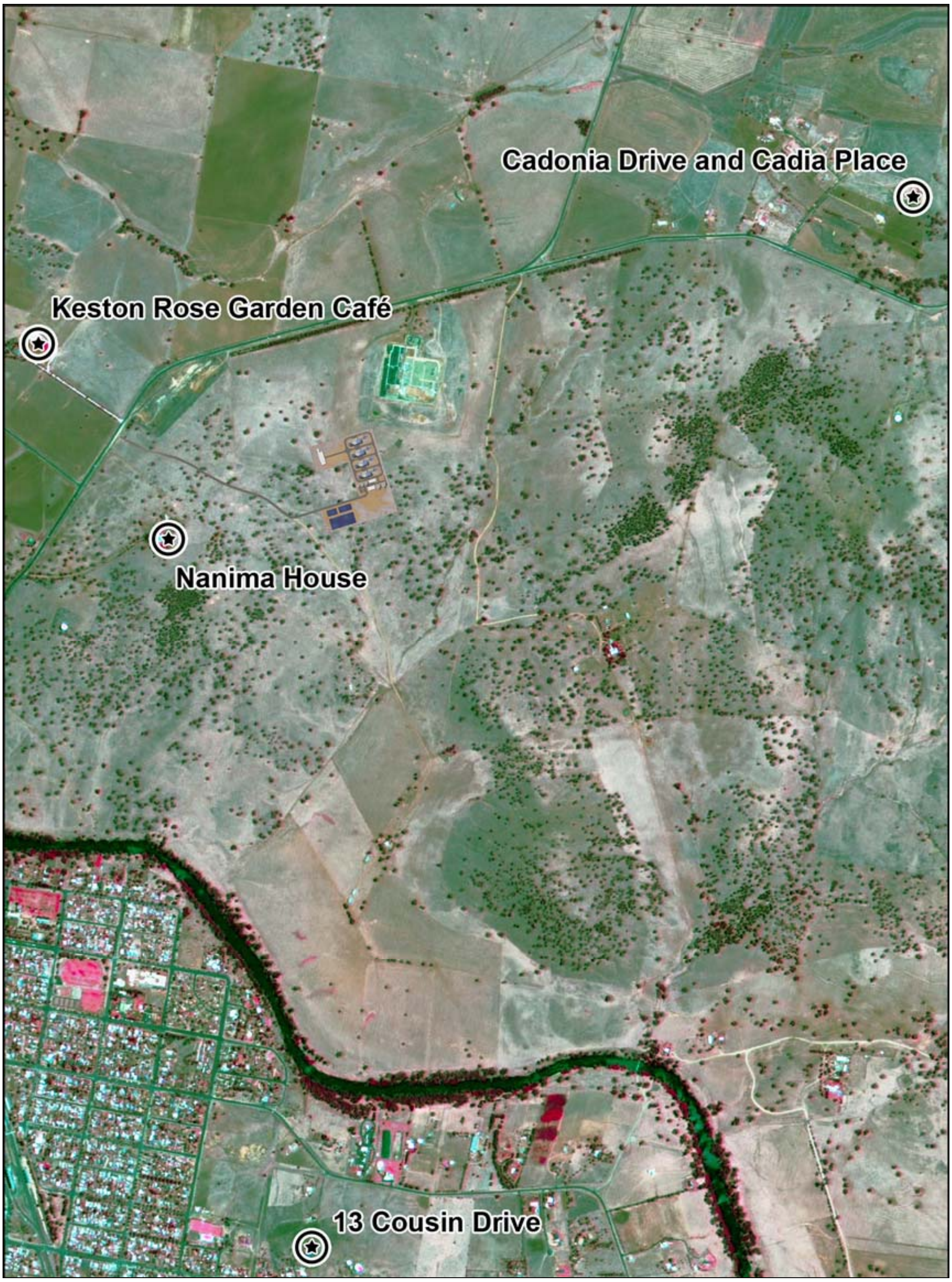


Figure 9-8 Sensitive receptors for which photomontages have been created

Figure 9-9 Photomontage of the proposed power station from Nanima House

Site 2 — Keston Rose Garden Café

A photomontage was created from the east-facing veranda of the café (see Figure 9-10); this indicates that the top quarter of one of the exhaust stacks would be visible from this location. Much of the view of the proposed power station would be blocked by the mound of the council-owned gravel site (quarry) on Gulgong Road. As this is a temporary structure, it is anticipated that removal of this mound would open the view to the proposed power station, which may result in greater visibility of the exhaust stack.

Figure 9-10 Photomontage of the proposed power station from the Keston Rose Garden Café

Site 6 — Cadonia Drive and Cadia Place

The photomontage prepared from the subdivision at 32 Cadonia Drive indicates that the existing vegetation and ridgeline located between the subdivision and the proposed power station site would completely screen the proposed power station from view (see Figure 9-11). Since the location from which the photomontage was prepared is at a higher elevation than most other dwellings within the subdivision, it is anticipated that most other residences would also be unable to see the proposed power station.

Glimpses of the proposed power station could be visible from sites along Cadia Place. It is anticipated, however, that impacts would be minimal, so mitigation measures would not be required.

Figure 9-11 Photomontage of the proposed power station from 32 Cadonia Drive

Site 9 — 13 Cousin Drive

The majority of the proposed power station (including all four exhaust stacks) would be visible from 13 Cousin Drive (see Figure 9-12). A house is proposed to be built on a vacant block just down slope of this location. However, given the considerable distance to the site, the partial screening by mature vegetation and the absorption of the proposed power station within the landscape, the overall visual impact would be minimal.

Figure 9-12 Photomontage of the proposed power station from 13 Cousin Drive

Other sensitive receptors

Table 9-17 provides a summary of the potential visual impact of the proposed power station on the remaining seven sensitive receptors, which were assessed without the preparation of photomontages.

Table 9-17 Visual impact of the proposed power station site on other sensitive receptors

Site no.	Site name	Potential visual impact of the proposed power station[1]
3	Keston Homestead	▪ Top third of the exhaust stacks would be expected to be visible from some locations on the veranda. ▪ During summer, this view would be diluted by vines. ▪ Mitigation measures proposed for the Keston Rose Garden Café would minimise this visual impact.
4	Keston Log Cabin	▪ All four exhaust stacks would be expected to be visible from the front of the cabin. ▪ Mitigation measures proposed for the Keston Rose Garden Café would minimise this visual impact.
5	Mount Nanima	▪ All four exhaust stacks would be visible from the entrance driveway leading to the homestead. ▪ Proposed power station would not be visible from the homestead due to the mature garden and solid fence to the north.

Site no.	Site name	Potential visual impact of the proposed power station[1]
7	One Tree Hill subdivision	▪ Glimpses of the proposed power station would be possible from this location. However, given that residential development is yet to occur, mitigation measures would not be necessary.
8	Falls, Maxwell and Warne roads	▪ One or two exhaust stacks would be expected to be visible from this location. ▪ Visual impact would be minimal given the considerable distance to the site and the absorption of the proposed power station within the landscape.
10	Cadia Cottage	▪ The top half of at least one exhaust stack would be visible above the mature Eucalyptus trees. ▪ The cottage is oriented away from, and down slope of, the proposed power station, so visual impacts would be minimal and manageable.
11	Hermitage Hill	▪ The proposed power station would not be visible from most buildings within this site. ▪ The north-facing balcony of the main building would have views of the top half of at least one exhaust stack. The visual impact would be minimal given the considerable distance to the site.

Note: 1. See Figure 3-15 for sensitive receptor locations

9.4.3 Compressor station

Skyline and tree line

The proposed compressor station would be situated at a similar or lower elevation than the surrounding landscape, in an area vegetated with remnant mature trees. As such, the impact on the skyline would be relatively minimal. When viewing the proposed compressor station site from the south, two rises in topography (to 340 metres Australian height datum (AHD)) that are located directly behind the proposed compressor station site would dominate the skyline.

At a distance, the tree line appears as a solid line of canopy. When closer, however, the individual trees are more noticeable. From this closer distance, the impact of the proposed compressor station would more likely be at trunk level, rather than canopy level, due to the relatively low height (4–5 metres) of the proposed infrastructure.

Sensitive receptors

Table 9-18 provides a summary of the potential visual impact of the proposed compressor station on the four sensitive receptors identified in Section 3.10.2.

Table 9-18 Visual impact of the proposed compressor station on four sensitive receptors

Site no.	Site name	Potential visual impact of the proposed compressor station
1	Property A	▪ The proposed compressor station would not be visible.
2	Property B	▪ Mature vegetation around this property would effectively screen the proposed compressor station such that it would not be visible.
3	Myalls	▪ The grain and silo complex would block most views of the proposed compressor station.
4	Mountain View	▪ Scattered vegetation would be visible between this site and the proposed compressor station site. ▪ The proposed compressor station would be visible.

9.4.4 Mitigation measures

General

Endemic species that are hardy to the local environment would be used for all on-site visual screening plantings and are strongly recommended for all off-site visual screening plantings (recommended species are listed in Appendix 1 of Technical Paper No. 5).

Power station

The mitigation measures listed below are illustrated in the landscape concept plan shown in Figure 9-13.

On-site

The following mitigation measures would be implemented within the proposed power station site:

- The CEMP would include measures to ensure that all due care would be taken to avoid the clearing of vegetation for temporary features of the proposed power station (i.e. construction car park and laydown area) as much as possible.
- Vegetation would be planted within the proposed power station site to aid in ameliorating the visual impact at a broad visual catchment scale.
- Neutral colours with low reflective quality would be used for the power station infrastructure. Dark colours generally blend in well with the landscape, particularly from a distance. As such, the Colorbond® colours Ironstone Blue and Matt Grey would be considered for use on the features and bulk of the power station respectively.
- A minimalist approach would be taken to the provision of external lighting for safety and security to minimise off-site impacts.

Off-site

The type and style of off-site planting and other mitigation measures would be determined in consultation with the residents/owners of the sensitive receptors. Similar consultation would be undertaken with TransGrid and Wellington Council, and any other third party owners. The following mitigation measures would be considered.

- Additional mid-storey vegetation, with mature heights of 3–8 metres, would be planted along Gulgong Road fronting the existing TransGrid substation.
- An additional grouping of vegetation would be planted in the north-eastern corner of TransGrid's land, between Gulgong Road and the driveway to Mount Nanima. This would mitigate potential sightings of the proposed power station from the Cadonia Drive/Cadia Place and One Tree Hill subdivisions.

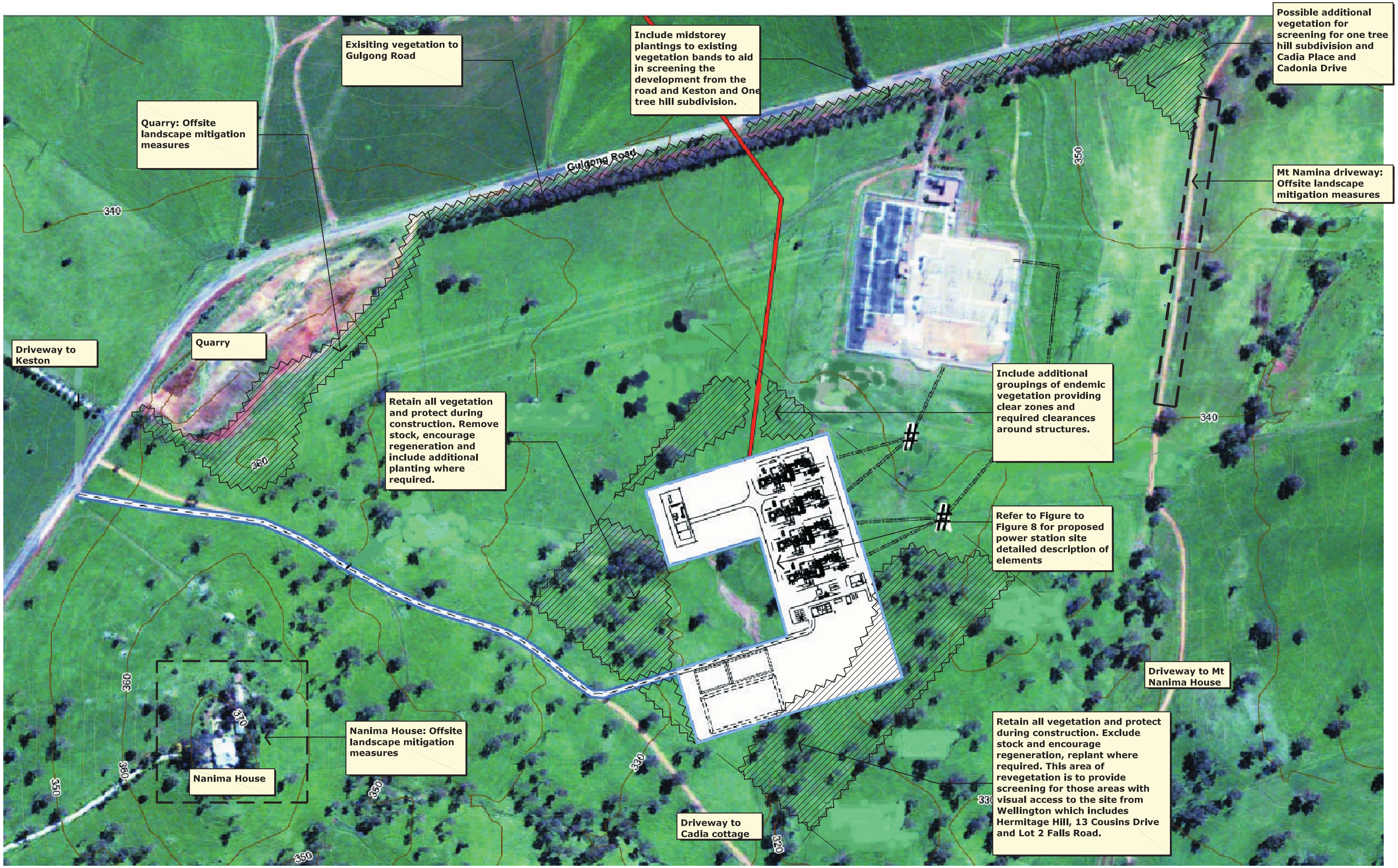


Figure 9-13 Landscape plan to mitigate visual impact of proposed power station

Scale: NTS
Date: 15-02-08

- Liaison would be undertaken with Wellington Council regarding the future of the quarry and use of the site for vegetation planting to visually screen the proposed power station. The area directly behind the quarry, which includes a small hill, would be included in this planting.

Site 1 — Nanima House

- Growth of the existing *Pyracantha* species hedging would be encouraged to the eastern side of Nanima House, to a mature height of 3–5 metres.
- Scattered trees would be strategically planted in the paddock between the house and the proposed power station site.

Site 2 — Keston Rose Garden Café

- A minimum of three rows of vegetation would be planted on the western side of the council quarry and on land immediately behind (south-east) of the quarry (which is at a higher elevation than the café).

Sites 3 and 4 — Keston Homestead and Keston Log Cabin

- Individual plantings of evergreen trees would be undertaken in the location where there is currently an Ash tree.

Site 5 —Mount Nanima

- A single row of trees and shrubs would be planted along the western side of the Mount Nanima driveway along the section of the driveway from which the proposed power station would be clearly visible. These plantings would be undertaken as per the landscape concept plan shown in Figure 22 of Technical Paper No. 5.

Sites 6 and 7 — Cadonia Drive and Cadia Place, and One Tree Hill subdivision

- Strategically placed plantings would be located between these locations and the proposed power station site, as deemed necessary following construction of the proposed power station.

Sites 8 and 9 — Falls Road, Maxwell Road and Warne Road, and 13 Cousin Drive

- For a period of 3 years following construction of the proposed power station, trees and shrubs would be offered for visual screening to residents who have views of the proposed power station site, where such screen plantings would mitigate this visual impact.

Site 10 — Cadia Cottage

- Strategic paddock trees would be planted in the short to middle distance between the house and the proposed power station, as deemed necessary following construction of the proposed power station.

Site 11 — Hermitage Hill

- Individual trees would be strategically planted in the area north of the site if it is determined that such screen plantings would mitigate visual impacts (and if permissible by land owners).

Compressor station

The proposed compressor station site would have minimal visual impact on nearby receptors. The following mitigation measures would be implemented, however, to further minimise the impacts:

- Vegetation of varying height would be planted on all sides of the proposed compressor station site. Endemic plant species have been recommended in Appendix 1 of Technical Paper No. 5.
- Stock-proof fencing would be installed to minimise loss of vegetation by grazing.
- A minimalist approach would be taken to the provision of external lighting for safety and security to minimise off-site impacts.
- Neutral colours with low reflective quality would be used for the compressor station infrastructure.

9.5 Biodiversity

Section 3.6 provided a description of the existing biodiversity in the area of the project. This section summarises potential impacts of the project on this biodiversity and outlines management measures to address these impacts.

Flora and fauna were identified as key issues for assessment in the DGRs (see Appendix A). Detailed assessment of these issues is included in Technical Paper No. 1 – *Biodiversity Assessment*. The outcomes of the assessment are summarised in this section.

Construction and operation of the power station and gas pipeline are likely to result in a range of direct and indirect impacts on the biodiversity identified in the area or considered likely to occur, including threatened species and ecological communities. These impacts include:

- clearing of native vegetation and disturbance of habitats
- habitat fragmentation and edge effects
- direct mortality of plants and less mobile animals
- weed and pest species
- noise
- cumulative impacts.

A 200-metre wide buffer around the proposed pipeline route was surveyed and assessed as part of this assessment to account for any minor deviations of the pipeline route that may occur as a result of geotechnical or other assessments during the detailed design phase.

9.5.1 Power station

Construction

Construction of the power station would involve clearing of up to approximately 4.2 hectares of scattered paddock trees (around 20 trees). This clearance is likely to result in a minor reduction of fauna habitat for species recorded or likely to occur at the power station site. However, removal of these trees is unlikely to increase habitat fragmentation and/or edge effects, result in changes to the abundance or distribution of weeds and pest species, or impact species sensitive to noise.

The clearing of vegetation may, however, result in the direct mortality of plants and less mobile animals. These impacts are discussed in more detail in reference to construction of the gas pipeline below; however, they would also apply to construction of the power station.

Operation

Operation of the power station is unlikely to result in further impacts to biodiversity.

9.5.2 Gas pipeline

Construction

Clearing of native vegetation

Clearing of native vegetation would be the major direct impact of construction of the proposed gas pipeline on biodiversity. Clearing of native vegetation is known to affect threatened species of flora and fauna, and is recognised as a key threatening process under the *Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), under the following final determination titles:

- clearing of native vegetation (TSC Act)
- land clearance (EPBC Act).

The need to clear native vegetation has been avoided as far as possible through the route selection and design process of the gas pipeline. Nonetheless, total avoidance of vegetation clearing is not achievable, and an estimated 37.2 hectares of woodland vegetation and associated fauna habitat would be cleared as a result of construction of the gas pipeline (a total of 41.4 hectares, including the worst-case clearance of 4.2 hectares of scattered paddock trees at the power station site). Table 9-19 indicates that the loss of vegetation and associated habitats represents approximately 1% of the available woodland vegetation identified within the study area (see Section 3.6.3 for a description of these woodland communities). Of the vegetation that would be cleared as a result of the project, 44% would be scattered paddock trees that no longer represent a native vegetation community.

Table 9-19 Potential loss of vegetation associated with construction of the proposed gas pipeline

Vegetation community	Extent within footprint (hectares)	Extent within study area (hectares)	Percent clearing within study area
Fuzzy Box Woodland	0.5	49.2	1%
Ironbark / Black Cyprus Pine Woodland	7.7	1,220.4	1%
Red Stringybark Woodland	2.3	46.2	5%
River Red Gum Woodland	3.1	283.0	1%
Scattered paddock trees including some areas of former Gum Woodland)	14.0	1,023.6	2%
Tumbledown Red Gum and Dwyers Red Gum Woodland	6.4	470.1	1%

Vegetation community	Extent within footprint (hectares)	Extent within study area (hectares)	Percent clearing within study area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland	3.3	949.3	0%
Other vegetation (plantings)	0.0	9.0	0%
Total vegetation	**37.2**	**4,050.9**	**1%**

Removal of fauna habitat elements

Clearing of native vegetation would result in the removal of fauna habitat elements, including direct and indirect feeding resources, dead trees (fallen and standing), tree hollows (often limited to small hollows only suitable for woodland birds), bushrock, dead wood (fallen) and leaf litter layers. Fauna use these habitat elements for shelter, to hide from predators, find food, to avoid extreme weather conditions and for breeding.

The removal of certain fauna habitat elements is recognised as a key threatening process under the TSC Act under the following final determination or preliminary listing titles:

- bush rock removal
- removal of dead wood and dead trees
- loss of hollow-bearing trees.

These fauna habitat elements are limited resources, especially in modified landscapes, and are generally slow to develop following disturbance. Many threatened species of animal are dependent on one or more of these habitat elements to complete their life cycle (e.g. tree hollows for breeding).

Habitat fragmentation and edge effects

Clearing of native vegetation also has the potential to result in habitat fragmentation and edge effects to the remaining patches of native vegetation surrounding the gas pipeline. Habitat fragmentation is the division of a single area of habitat into two or more smaller areas, with the occurrence of a new habitat type in the area between the fragments. Edge effects are where a zone of changed environmental conditions (i.e. altered light levels, wind speed and/or temperatures) occurs along the edges of habitat fragments.

The gas pipeline route traverses landscapes that are already highly fragmented as a result of past land uses. The species that occur in these habitats are generally tolerant to habitat fragmentation and are unlikely to be further disturbed by additional habitat fragmentation resulting from the project. These fragmented patches of habitat are also already subject to edge effects.

The potential for habitat fragmentation and introduction of new edge effects is higher where the project would bisect large patches of native vegetation. This has been avoided where possible through the route selection and design process. Nonetheless, the gas pipeline would traverse a large patch of Open Forest and Woodland habitat along Herveys Range. At this location, the project would following existing forest tracks and trails to minimise potential for fragmentation or the introduction of new edge effects.

Direct mortality of plants and less mobile animals

Clearing of native vegetation results in direct mortality of plants and less mobile animals in the areas being cleared, including potentially threatened species. This would directly impact any threatened species occurring in the areas cleared. Fauna injury and/or death have the greatest potential to occur during the construction phase, when vegetation and habitats are being cleared. While some mobile species, such as birds, may be able to move away from the path of clearing, other species that are less mobile, or those that are nocturnal and restricted to tree hollows may find it difficult to move rapidly to adjoining areas of suitable habitat. There is also potential for animals to enter the pipeline trench during construction and become trapped. This would be a particular risk for ground-dwelling fauna, including reptiles and small mammals.

Weeds

Construction of the gas pipeline and power station has the potential to disperse weeds into areas of remnant vegetation where weed species do not currently occur. Five of the key threatening processes under the TSC Act and EPBC Act relate to invasion of native vegetation communities by weeds. Two of these key threatening processes relate to the weeds identified or likely to occur in along the gas pipeline route:

- invasion of native plant communities by exotic perennial grasses
- invasion and establishment of Scotch Broom.

The most likely causes of weed dispersal associated with the project would include earthworks, movement of soil, and attachment of seed (and other propagules) to vehicles and machinery. This may, in turn, reduce the condition of vegetation communities and habitat quality for threatened species. However, the majority of the vegetation within the study area contains weeds, such that the overall extent of habitat modification associated with the project is not likely to significantly increase existing weeds populations.

Pest species

Thirteen of the key threatening processes under the TSC Act and EPBC Act relate to invasion and establishment of, predation by, competition from, and change in habitat resulting from feral animal species. Five of these key threatening processes relate to the feral animal species identified or likely to occur along the gas pipeline route:

- predation by the European Red Fox *Vulpes vulpes* (Linnaeus 1758)
- predation by the Feral Cat *Felis catus* (Linnaeus 1758)
- competition and grazing by the feral European Rabbit *Oryctolagus cuniculus*
- competition and habitat degradation by the Feral Goat *Capra hircus* (Linnaeus 1758)
- predation, habitat degradation, competition and disease transmission by the Feral Pig *Sus scrofa* (Linnaeus 1758).

These pest species are likely to be already established and affecting native fauna populations in the locality. These species are all relatively mobile and are likely to flee vegetation and habitats being cleared during construction. This could increase their abundance and distribute individuals to surrounding fragments that may not have initially been affected.

Disturbance to aquatic habitats

Without careful management, run-off from the construction corridor during the construction and operation phases of the proposed gas pipeline has the potential to modify water quality, and as such, adversely affect aquatic flora and fauna in the surrounding aquatic habitats, including threatened and migratory aquatic species.

Surface run-off from the corridor during construction has the potential to carry increased sediment loads, in addition to other contamination from accidental spillage/leakage of road construction materials, fuels, lubricants and hydraulic oils from construction equipment.

Management measures are detailed in Section 9.5.3.

Noise and dust

During construction of the proposed gas pipeline and power station, there would be increased noise in the local area for a short period of time (see Section 9.3). This may cause disturbance to fauna in the area, although given the proximity of the pipeline to existing roads, this impact is expected to be minor. Access for maintenance vehicles may cause intermittent disturbance; however, any impacts are likely to be minor.

Cumulative impacts

The potential biodiversity impacts of the project have been considered as a consequence of the construction and operation of the project within the existing environment. The incremental effect of multiple sources of impact (past, present and future) is referred to as a ‘cumulative impact’ and provides an opportunity to consider the project in a strategic context. This is necessary so the impacts associated with the project and other activities within the region are examined collectively.

The proposed gas pipeline route is located in a highly developed landscape dominated by agricultural activity in which the remaining areas of remnant vegetation and associated habitat are fragmented and isolated. The gas pipeline would traverse some areas within the footprint of an existing electricity easement, access tracks and cleared areas for agriculture. Due to its location in a highly developed landscape, the gas pipeline would be one of many developments and pressures on biodiversity in the local area.

The significance of the biodiversity impacts of the current project is likely to be increased by biodiversity impacts from surrounding projects and agricultural activities.

Operation

Operation of the gas pipeline is unlikely to result in further impacts to biodiversity.

Significance of impacts

The significance of the aforementioned impacts to endangered ecological communities and threatened species of state conservation significance was assessed in accordance with the *Draft Guidelines for Threatened Species Assessment under Part 3A* (National Parks and Wildlife Service 2002a). The significance of these impacts to endangered ecological communities and threatened species of national conservation significance was assessed in accordance with *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment and Heritage 2006). These significance assessments are summarised in Table 9-20. The assessments concluded that the proposed power station and gas pipeline are unlikely to result in a significant impact to any ecological community or species.

Table 9-20 Summary of threatened biodiversity for which significance assessments were undertaken and the likelihood of significant effects

Name	TSC Act[1]	EPBC Act[2]	Likely to be significantly affected?	Reason for the outcome
Threatened ecological communities				
White Box, Yellow Box, Blakely's Red Gum Woodland	E	EC[3]	No	Impacts would be small across the extent of the project and restricted to several small, modified and isolated patches.
White Box, Yellow Box, Blakely's Red Gum Woodland and derived Grassland	E	EC	No	As above
Fuzzy Box Woodland	E	EC[3]	No	As above
Threatened flora				
Tylophora linearis	E	E	No	As above
Swainsona recta	E	E	No	As above
Swainsona sericea	V	-	No	As above
Threatened fauna				
Birds				
Blue-billed Duck	V	-	No	Appropriate mitigation measures (directional drilling) would reduce impact on aquatic habitats in the study area.
Brown Treecreeper	V	-	No	Greater habitat resources are available adjacent to the study area and no important habitat resources would be removed.
Hooded Robin	V	-	No	As above
Black-chinned Honeyeater	V	-	No	As above
Gilbert's Whistler	V	-	No	As above
Grey Crowned Babbler	V	-	No	As above
Speckled Warbler	V	-	No	As above
Diamond Firetail	V	-	No	As above
Turquoise Parrot	V	-	No	As above
Regent Honeyeater	E1	EM	No	Loss of foraging habitat is not considered significant considering availability in wider locality.
Superb Parrot	V	V	No	As above
Bush-stone Curlew	E1	-	No	As above
Glossy Black-cockatoo	V	-	No	Study area only provides marginal habitat for this species with no nesting habitat and only limited foraging habitat available.
Powerful Owl	V	-	No	Loss of foraging habitat is not considered significant considering availability in wider locality.
Masked Owl	V	-	No	As above
Barking Owl	V	-	No	As above
Grey Falcon	V	-	No	As above

Name	TSC Act[1]	EPBC Act[2]	Likely to be significantly affected?	Reason for the outcome
Mammals				
Greater Long-eared Bat	V	V	No	Greater habitat resources are available adjacent to the study area and no important habitat resources would be removed.
Yellow-bellied Sheathtail Bat	V	-	No	As above
Little Pied Bat	V	-	No	As above
Squirrel Glider	V	-	No	As above
Koala	V	-	No	As above
Fish				
Trout Cod	E	E	No	Appropriate mitigation measures (directional drilling) would reduce impact on aquatic habitats in the study area.

Notes: 1: V = Vulnerable, E1 = Endangered (TSC Act); 2: V = Vulnerable, E = Endangered, CE = Critically Endangered (EPBC Act); 3: The equivalent EPBC Act listing for White Box, Yellow Box, Blakely's Red Gum Woodland and Fuzzy Box Woodland only applies to those patches that qualify as White Box, Yellow Box, Blakely's Red Gum Woodland and derived Grassland under the EPBC definition.

9.5.3 Mitigation measures

A general principle of environmental management is to, in order of preference:

- avoid environmental impacts
- minimise impacts
- mitigate impacts
- as a last resort, once the above options have been investigated, compensate for residual impacts.

In order to further minimise and mitigate impacts on the ecological values of the site, the following mitigation measures would be implemented:

- During the detailed design phase the pipeline route would be confirmed following assessment by geotechnical specialists, and consultation with biodiversity specialists, land owners and relevant authorities. Any variations to the route alignment would be carefully determined to avoid significant habitat features, such as large mature trees or habitat for threatened species, where possible. Should previously unsurveyed areas be traversed by the pipeline, biodiversity specialists would provide on-site assessment, if necessary.
- Suitable fencing, colour tape or 'parawebbing' would be used to delineate the maximum width of work area permitted in sensitive areas. This would be implemented prior to any work commencing on-site. If any tape is disturbed, it would be immediately replaced along the appropriate alignment. Construction work outside this area would constitute a non-conformance with the contract terms.
- Except for trenching and at the proposed gas-fired power station, vegetation clearing would involve only the removal of above-ground plant parts, with root systems and the soil profile left undisturbed.

- Any dead logs within the development footprint would be moved to an adjacent area outside the construction footprint and returned to the disturbed site following construction, thus minimising loss of habitat.
- Directional drilling launch and receiving pad areas would be carefully planned in order to avoid removal of mature trees. If this is not possible, the number of trees to be affected would be minimised. It is envisaged, however, that any directional drilling would take place from within cleared areas.
- Clearance of paddock trees at the proposed power station site would be minimised as far as possible within the construction car park and laydown area.
- For any habitat trees to be removed, clearing protocols would be put in place. These protocols would include:
  - All habitat trees in the area to be cleared would be identified (by survey) and marked.
  - Marked habitat trees and corridors of retained trees linking marked habitat trees with the nearest uncleared (secure) habitat areas would be left standing after initial vegetation clearing for a period of at least 24 hours (to encourage animals to disperse into adjacent uncleared habitat).
  - After the 24-hour waiting period, standing habitat trees and corridors may be felled, commencing with the most distant trees from secure habitat.
  - If habitat trees are in short supply, artificial nest sites (nest boxes) would be installed in adjacent (secure) habitat before clearing.
  - All contractors would have the contact numbers of wildlife rescue groups should animals be injured during clearing.
- Areas not necessary for operation of the pipeline would be rehabilitated in a progressive manner as construction proceeds. This would include:
  - Planting of a range of locally occurring and sourced native shrubs, trees and groundcover plants (Discussion would be held with the DECC regarding the choice of species, particularly in areas where revegetation would be adjacent to existing patches of native vegetation, including endangered ecological communities.).
  - Inclusion of logs, dead trees and stumps in the landscaping works.
  - Inclusion of foraging species, such as *Allocasuarina* for Glossy Black-cockatoos.
  - Incorporation of existing natural vegetation where possible.
  - Maintenance of plantings through a revegetation plan included in the CEMP.
- Soil that may contain seeds of exotic species would be stockpiled away from drainage lines, and vegetated areas and weed-free soil stockpiles. Weed-infested stockpiles would be covered to eliminate spread of the soil and seed during rainfall and high wind events.
- Where possible, branches overhanging the easement that are in the way of construction activities would be tied back for the duration of construction rather than being cut.
- No materials, spoil or machinery would be stored or parked within the drip-line of any trees.

- Topsoil removed during trenching would be stockpiled nearby within the easement and replaced once the pipe has been laid. Care would be taken not to transfer topsoil between areas.
- Vehicles and other equipment (including boots) would be thoroughly cleaned of soil, seeds and plant material before entering or leaving the site. This would help to prevent the spread of weed species or pathogens within the site or into the surrounding bushland.
- The amount of open cut trenching would be generally limited to 100 metres per crew at any one time.
- Trenches would be backfilled so as to cover as much open trench as practicable by the end of each day's work. If this is not possible, the ends of the open trenches would be graded to allow escape for any animals that may venture into the trench.
- Excavated material would not be placed within 20 metres of any drainage line.
- When accessing construction sites, contractors would use only designated access tracks.
- Directional drilling would be used to drill and install the gas pipeline across significant waterways and environmentally sensitive areas. Launch and retrieval sites at either end of the directional drill would be located in cleared areas to reduce vegetation disturbance and clearing outside the construction footprint (25–30 metres).
- Trenching and directional drilling would only occur in dry weather adjacent to waterways.
- The OEMP prepared for the project would include management measures and monitoring programs to ensure operation of the project does not affect biodiversity. The plan would include:
  - Ongoing monitoring of the impacts.
  - Rehabilitation.
  - Ongoing management of weed invasion in the easement to ensure weeds do not spread.

Offsets of residual impacts

Many of the potential biodiversity impacts of the project have either been avoided or minimised through design decisions or can be adequately mitigated or managed. The project would, however, require the removal of an estimated 41.4 hectares of woodland and open forest vegetation communities, including the removal of habitat for a variety of native species and secondary habitat for threatened species of plant and animal.

To address the residual impacts of the project, an offset strategy would be implemented prior to construction to contribute to the long-term conservation of biodiversity.

An offset is one or more appropriate actions that are put in place to counterbalance specific impacts on biodiversity. Appropriate actions are long-term management activities to improve biodiversity conservation. These can include legal protection of land to ensure security as well as direct management actions (Department of Environment and Conservation 2006).

9.6 Aboriginal heritage

Australian Museum Business Services (AMBS) was commissioned by PB to undertake an assessment of potential impacts to Aboriginal and historic cultural heritage that may arise from the project.

Section 3.8 provided a description of the existing environment as it relates to Aboriginal heritage in the area. This section summarises potential impacts of the project on this heritage and other areas/items of significance identified during the assessment, and outlines management measures to address these impacts.

Aboriginal heritage was identified as a key issue for assessment in the DGRs (see Appendix A). Detailed assessment of this issue is included in Technical Paper No. 2 – *Heritage Assessment*. The outcomes of the assessment are summarised in this section.

9.6.1 Methodology

The Aboriginal heritage assessment was consistent with the principles and guidelines of the Burra Charter and was undertaken in accordance with current heritage best practice guidelines.

The key heritage requirements addressed in this assessment were:

- consultation and liaison with representatives of the local Aboriginal community, in line with the DECC *Interim Community Consultation Guidelines*
- location and assessment of the significance of Aboriginal and historic heritage sites and places within the study area and surroundings
- investigation of the Aboriginal and historic heritage significance of the study area
- identification of any potential constraints or opportunities arising from consideration of the study area's heritage
- determination of the cultural significance of the study area by integrating the results of archaeological survey and consultation with relevant Aboriginal groups
- provision of advice regarding potential constraints and opportunities for future development resulting from consideration of Aboriginal heritage.

Aboriginal community consultation was undertaken in accordance with DECC guidelines. Expressions of interest for participation were sought via advertisements in The Western Magazine and The National Indigenous Times, and via letters to the relevant groups/individuals. Representatives of the Bogan River Peak Hill Wiradjuri Aboriginal Corporation and the Gallanggabang Aboriginal Corporation participated in the field survey for the heritage assessment, which aimed to:

- record physical evidence of past Aboriginal occupation
- investigate the likelihood for potential archaeological deposits to be present within the study area.

A 200 metre buffer around the proposed pipeline route was surveyed and assessed as part of this assessment to account for any minor deviations of the pipeline route that may occur as a result of geotechnical or other assessments during the detailed design phase.

Site prediction modelling

On the basis of archaeological sites registered in the region and reviews of previous archaeological studies, conclusions were drawn regarding the potential presence and location of Aboriginal heritage sites within the landscapes of the study area (see Table 9-21). This prediction model enabled a targeted field survey to be undertaken, which increased the efficiency of the survey and the likelihood that any sites or objects of Aboriginal heritage significance would be identified.

Table 9-21 Potential presence and location of Aboriginal heritage sites

Site type	Potential presence	Potential location
Open artefact scatters/open campsites	High to moderate	Flat, open areas associated with creeks
Isolated artefacts	High	Landforms associated with past Aboriginal activities (i.e. ridgelines, level areas with access to water)
Scarred/carved trees	Moderate	Old tree growth occurrences associated with Goobang National Park, Macquarie, Bell and Little Rivers and tributaries
Burial mounds, carved tree	Moderate to low	-
Bora ground	Low	-
Grinding grooves	Moderate to low	Areas north of Macquarie River in association with sandstone and/or granite formations
Stone arrangements and cairns	Low	-
Quarries	Moderate to low	-

9.6.2 Survey results

A total of four Aboriginal heritage sites were identified during the field survey. These sites comprised three small artefact scatters and one culturally scarred tree. These are summarised in Table 9-22, presented in Figure 9-14 and discussed below.

Table 9-22 Identified Aboriginal heritage sites summary

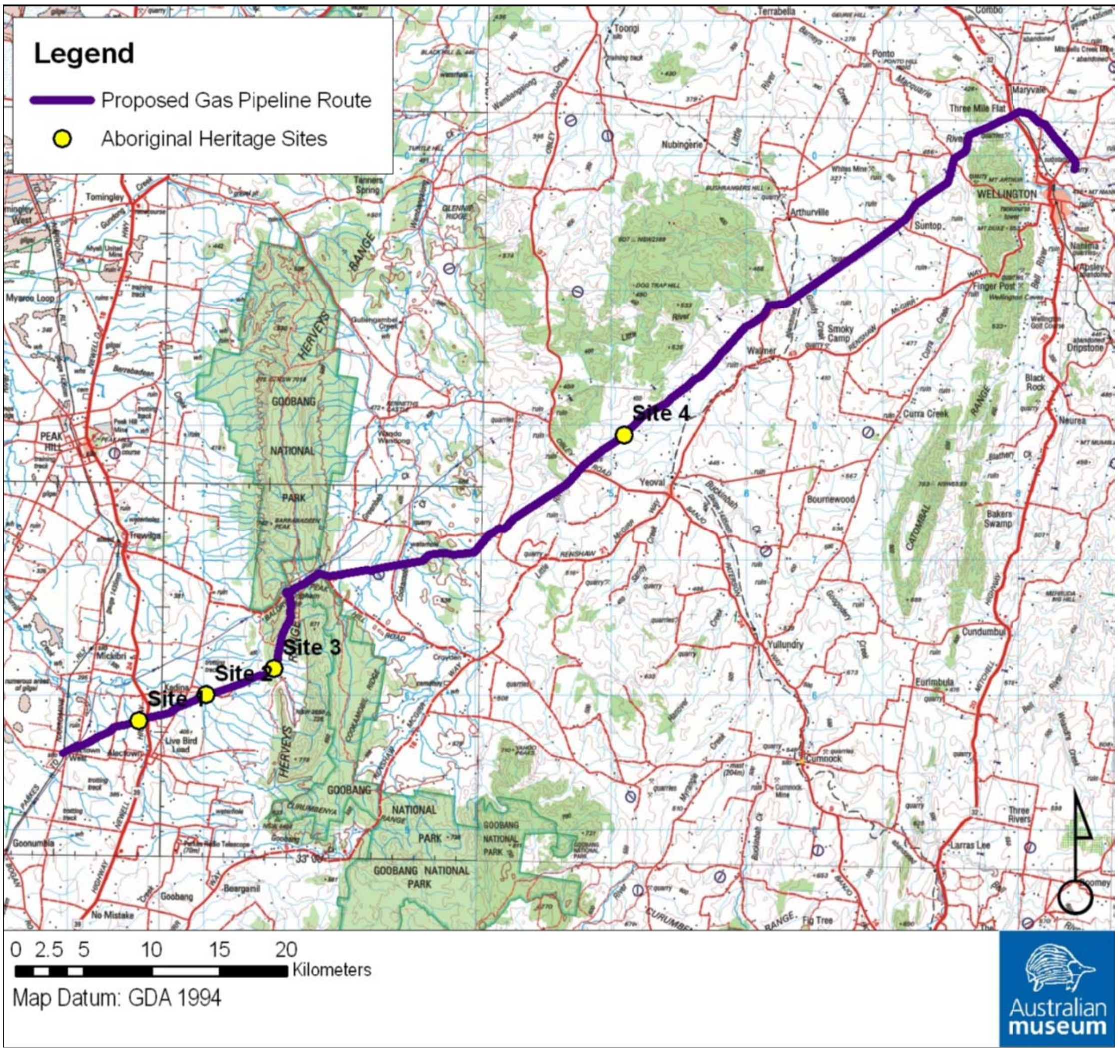
Site	Type	Landform	Number of artefacts	Details
1	Artefact scatter	Waning lower slope	2	Chert flakes — one red and one black
2	Artefact scatter	Flat	11	4 chert flakes 4 silcrete flakes 3 quartz bipolar flakes
3	Scarred tree	Waning lower slope	-	50 x 40 centimetre scar
4	Artefact scatter	Maximal lower slope	2	Chert flakes

Sites 1, 2 and 3 were identified along the proposed pipeline route to the west of Goobang National Park. The chert flakes identified at Site 1 were located approximately 15 metres apart on the base of a low hill, within the adjacent flood zone of an adjacent creek. The site showed no indication of subsurface deposit.

The artefact scatter at Site 2 was situated within a large erosional area on the eastern bank of a creek. The creekline itself was heavily overgrown with zero ground visibility, and the site is already affected by extensive erosion and flooding from the adjacent creekline. Furthermore, agricultural activities adjacent to the site would be creating disturbance to any scatter that may extend into the paddock. Recent tree plantings had been established directly adjacent to Site 2 in an attempt to stabilise the creek bank and prevent further erosion. The alignment of the proposed gas pipeline would run approximately 30 metres to the south of this site. As such, it would not directly affect the identified artefact scatter.

The scarred tree identified at Site 3 is currently less than 1 metre from the road and is on the edge of a scrubbed area encompassing a hill to the west. The scar measures approximately 50 centimetres by 40 centimetres and is located approximately 4 metres from the ground (see Photograph 9-1). The proposed pipeline route would not affect Site 3, nor would it encroach closer than approximately 30 metres east of the tree.

The artefact scatter at Site 4 is located north-east of Yeoval. The artefacts within this site are located in an eroded area that is heavily disturbed by water erosion, land clearing and stock grazing activity. The site is at the base of two hills within a natural drainage slope into a creek.



Source: Technical Paper No. 2

Figure 9-14 Aboriginal heritage sites identified during field survey

Source: Technical Paper No. 2

Photograph 9-1 Scarred tree identified at Site 3

9.6.3 Assessment of significance

Assessment criteria

Professional guidelines for the assessment of significance of Aboriginal sites, objects and places discuss two types of significance:

- *cultural significance* — the value(s) of a site or feature to a particular community group
- *archaeological/scientific significance* — archaeological research potential, representativeness and rarity (National Parks and Wildlife Service 1997).

Assessment of Aboriginal cultural significance

This area of assessment concerns the value(s) of a site or feature to a particular community group – in this case the local Aboriginal community or communities. Aspects of social significance are relevant to sites, items and landscapes that are important, or have become important, to the local Aboriginal community. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for sites and landscapes generally and their continued protection. Aboriginal cultural significance may include social, spiritual, historic and archaeological values. Aboriginal cultural significance assessments can only be made by the relevant Aboriginal communities.

Aboriginal communities consulted with throughout the Environmental Assessment have indicated that, while the Aboriginal culturally scarred tree (Site 3) is considered to be highly culturally significant, and all Aboriginal heritage sites recorded contain intrinsic cultural significance, there are no further specific cultural significances attached to the identified sites.

Assessment of scientific significance

Table 9-23 summarises the assessment of scientific significance undertaken for the four Aboriginal sites identified.

Table 9-23 Assessment of archaeological significance for the identified Aboriginal sites

Site(s)	Assessment/comment(s)
Archaeological research potential	
1, 2 and 4	Low research potential. Creeklines within the region are likely to contain evidence of past Aboriginal activity. However, the high level of disturbance observed at Sites 1, 2 and 4 indicates that the landform is unlikely to contain undisturbed *in situ* archaeological deposits. In addition, the number and type of artefacts recorded at these sites is not suggestive of complex archaeological deposits. As such, the sites are likely to represent incidental, background Aboriginal activity within the region.
3	High research potential. Given the good condition of this site, and the relatively low level of disturbance in its vicinity, the site is a clear, intact example of Aboriginal tree scarring practices.
Representativeness	
1, 2 and 4	The artefact scatters recorded at Sites 1, 2 and 4 are the most common site type previously recorded within the local region. They represent a continuity of use of water resources across the region, and it is likely that a background scatter of such artefacts is present throughout similar landforms in the region.
3	Aboriginal scarred trees are the second most common site type in the local region, and as such this site is representative of the archaeology of the area.
Rarity	
1, 2 and 4	No archaeological rarity. The complex of artefact scatter sites present within the study area may be regarded as relatively common within the local region. Such sites are the most common site type both locally and regionally.
3	High archaeological rarity. Aboriginal scarred trees are relatively rare throughout Australia, due to past land clearing practices. Although this site type is the second most common in the local region, it is considered to retain high archaeological rarity for its place in the wider Australian archaeological landscape.

Summary

The archaeological significance of the Aboriginal heritage sites is summarised in Table 9-24.

Table 9-24 Summary of archaeological assessment

Site	Type	Archaeological significance
1	Aboriginal stone tool scatter sites	Low
2	Aboriginal stone tool scatter sites	Low
3	Scarred tree	High

Site	Type	Archaeological significance
4	Aboriginal stone tool scatter sites	Low

9.6.4 Mitigation measures

Further archaeological ground survey and further Aboriginal heritage assessment of the project area would not be required for the current project footprint.

Based on the results of the Aboriginal background research, community consultation and archaeological field survey, the following mitigation measures would be implemented.

General

- Appropriate Aboriginal heritage specialists would be consulted if the detailed design phase determined that the gas pipeline corridor was to be realigned beyond the surveyed corridor buffer.
- Representatives of Aboriginal groups consulted during the assessment would be provided the opportunity to participate in a one-day drive-by survey of the finalised, pegged gas pipeline route to allow confirmation of the final development impact area.
- Vehicle access during construction of the proposed gas pipeline would be guided by the CEMP, which would outline any constraints and issues to access and construction activities arising from considerations of Aboriginal heritage.

Site 1

- Although the proposed pipeline route would impact on Site 1, this highly disturbed site with low significance should not be avoided (to prevent potential disturbance of other unidentified sites).

Site 2

- The proposed pipeline construction route would seek to avoid Site 2 and the associated erosion stabilisation area.

Site 3

- A buffer zone of at least 10 metres surrounding the scarred tree would be maintained during the pipeline construction works to ensure the safety of this sensitive site. All impacts to this site and its immediate surrounds would be avoided. The buffer zone would be clearly demarcated during construction to prevent accidental impacts (e.g. using temporary fencing).

Site 4

- Although the proposed pipeline route would impact on Site 4, this highly disturbed site with low significance should not be avoided (to prevent potential disturbance of other unidentified sites).

9.7 Hazard and risk

Sherpa Consulting undertook a hazard and risk assessment for the project. The objectives of the study were to undertake a preliminary hazard analysis (PHA) of the project and, in particular, to meet the requirements of the DGRs in terms of hazard and risk impacts (see Appendix A).

The detailed objectives of the study were to:

- identify hazards that could result from operation of the proposed power station and pipeline facilities (including the compressor station)
- identify whether the proposed design and operational measures would be adequate to minimise the hazards and manage the residual risks
- identify, where required, additional safeguards to further minimise the risk to personnel, people and property
- prepare a report summarising the analysis and findings in a form suitable for use by the client and the regulatory authorities.

The complete hazard and risk assessment is provided in Technical Paper No. 6 – *Preliminary Hazard Analysis*. The following sections summarise the key findings of the assessment.

9.7.1 Methodology

The assessment was based on preliminary design details and the scope included the following:

- power station site and facilities (gas receival station, gas-fired turbines, transmission connection to substation)
- gas pipeline
- compressor station.

The safeguards assumed for the assessment were based on typical safeguards for similar facilities. The methodology undertaken for the risk assessment followed guidelines in the documents identified in Chapter 4 of Technical Paper No. 6.

The hazard analysis process required the identification of potential hazardous incidents that could occur as a result of the operation of the facility. This included the identification of causes or failure mechanisms that could initiate a hazardous event and proposed safeguards that would reduce the consequence or likelihood of the incident.

The outcome of the hazard identification was a number of scenarios that could potentially affect land uses adjacent to the facility. These scenarios were carried forward to quantitative risk assessment. This involved the following steps:

- consequence assessment — an estimate of the magnitude of impact of the hazardous incident scenarios
- frequency analysis — an estimate the frequency of the incident occurring
- quantitative risk assessment — combining the results of the consequence and frequency assessments
- comparison of risk assessment results with relevant criteria for acceptable risk
- identification of risk reduction measures where the assessed risk levels exceed the criteria for acceptable risk.

Consequence assessment

Different scenarios were modelled for the proposed power station and gas pipeline. These varied in regard to the size of leakage holes and gas release rates. Those estimated to have off-site jet fire or flash fire consequences were carried forward to the quantitative risk analysis.

Quantitative risk analysis

Quantitative risk levels for facilities like power stations are usually presented as risk contours. Contours of equal risk level around each site indicate the risk level at any point around the facility.

The risk resulting from operation of linear infrastructure such as gas pipelines is commonly presented as risk transects (i.e. a graph of estimated risk level versus the lateral distance from the centreline of the pipe). The transect shows the risk level that a receiver would be exposed to at any lateral distance from the pipe. The graph can also be used to estimate the distance to the relevant risk criteria and to show whether there is adequate separation distance from the pipeline to adjacent land uses.

Individual risk

The calculation of risk is assessed by combining the consequence of the event (in this case the distance to heat radiation levels) with the frequency of occurrence. The risk for all incidents is accumulated to show the total risk to an individual at any point near the pipeline and facilities.

Societal risk

Societal risk is a measure of society's concerns for risks which result in multiple fatalities. For example, people may be concerned with the risks of aircraft crashes, based on reporting of incidents with high casualty figures. By comparison, people may be less concerned with the risks of motor vehicle accidents, which occur on a daily basis and do not receive the same level of public attention.

Societal risk is calculated by assessing the impact to the entire population around the facility and, therefore, depends on the population density in the area.

Escalation

The potential for escalation (i.e. transfer of a hazard or risk) between facilities was assessed by considering the consequence distances for heat radiation levels of 23 kilowatts per square metre (kW/m^2) (impact on structures) resulting from jet fire incidents. Flash fire incidents have a very short duration and do not result in significant potential for escalation to on-site equipment. Two escalation incidents were considered:

- A maximum hole size of 25 millimetres was assumed for assessing escalation, as larger hole sizes would have a very low likelihood of occurrence.
- For gas releases from equipment at a pressure of 12 megapascals (MPa), the distance to a heat radiation level was shown to be about 40 metres.

Level of assessment

The (then) Department of Urban Affairs and Planning's 1999 *Multi-Level Risk Assessment* provides guidelines for the level of analysis required for risk assessments. The assessment showed that there is potential for significant off-site consequences near the proposed power station and pipeline facilities as a result of gas explosion. As the expected frequency of incidents indicates that risk levels may exceed DoP criteria, a Level 3 assessment was undertaken.

9.7.2 Power station

Hazard identification

Releases in power station

The PHA identified that the main potential hazard associated with operation of the proposed power station is the loss of containment, possibly caused by the following incidents:

- loss of containment from station pipe work and equipment due to corrosion, mechanical damage, flange, gasket and fitting leaks, etc
- loss of containment during pigging operations
- releases due to venting operations
- dispersion of natural gas from the stack during venting operations with the potential for ignition
- external events including earthquakes, flooding, lightning and bushfires
- failure of temperature and pressure control.

Ignited gas release from the power station could result in:

- jet fires
- flash fires
- vapour cloud explosions.

Gas release would result in a jet fire if ignited immediately, resulting in a jet flame. Heat radiation from the jet fire would affect people within the vicinity of the release. If ignition was delayed, a vapour cloud could form; however, as natural gas is buoyant, the potential for a significant cloud build-up is low. If the vapour cloud reached an ignition source, a flash fire or a vapour cloud explosion could result.

In the event of a flash fire, the vapour cloud would burn rapidly without a blast wave and would then continue to burn as a jet flame from the release point. In the event of a flash fire, there would be a high (100%) chance of a fatality within the vapour cloud, but due to the short duration of the flame, there would be a low chance of significant impact outside the vapour cloud radius. However, the impact from the jet fire that continues after the flash fire would remain.

A vapour cloud explosion could occur if there is a potential for build-up of natural gas in congested areas, which would restrict the flame front and result in an explosive overpressure, which would affect people in the area.

There is potential for gas build up in the enclosures for the gas-fired turbines to result in an explosion, should gas ignition occur. The enclosures would be provided with appropriate gas detection, as per industry practice, and fire detectors to detect lube fires. The gas turbine unit would be designed to minimise the number of potential leak sources in the enclosure. The risk from the turbine equipment would, therefore, be minimal.

Bushfire risk

The proposed power station site has been identified as bushfire-prone land. However, given the sparse distribution of paddock trees within the site, and the proposal to clear some of these trees for development of the proposed power station, the risk of external bushfires affecting the station is low.

The preliminary power station layout (see Figure 7-4) already includes firewater storage and fire booster stations. This, coupled with the mitigation measures discussed in Section 9.7.5, would ensure that any impacts caused by a bushfire on the power station would be low.

Transport risk

No transportation of significant quantities of flammable materials would be required for the power station as the gas-fired turbines would only operate with natural gas fuel and no bulk storage of liquid fuel would be required. Approximately 4 tonnes (in total) of sulfuric acid and caustic soda would be delivered to site each year.

Sulphuric acid and caustic soda would be delivered to the power station site in intermediate bulk containers by an accredited carrier in accredited packaging. These hazardous substances would be handled in accordance with the *Australian Code for the Transportation of Dangerous Goods by Road and Rail*. The two substances (sulfuric acid and caustic soda) would be carried in separate vehicles at different times, as they are not compatible with each other. Specific handling procedures would be identified in a risk management and emergency response plan to be developed for the site.

The storage on-site would meet the requirements of *AS3780-1994 The Storage and Handling of Corrosive Substances* and the NSW Occupational Health and Safety Amendment (Dangerous Goods) Regulation 2005. Given the small quantities stored on-site, there would not be a significant risk from storage of sulfuric acid and caustic soda.

Only minor quantities of other chemicals and dangerous goods would be stored at the power station site. These substances would generally be associated with day-to-day maintenance and house keeping activities, and would comprise small quantities of lubricant oils and cleaning chemicals. These substances would be stored within a designated bunded area within the administration building. It is envisaged that the maintenance contractor would bring any materials required during major maintenance activities onto the facility and any waste materials would be taken off-site when the works were completed.

Aviation risk

The Civil Aviation Safety Regulation 1998 states that if a physical structure is greater than 110 metres, or if gaseous efflux is greater than 4.3 metres per second at 110 metres above ground level, the Civil Aviation Safety Authority (CASA) would need to assess the object to determine whether it should be considered an obstacle.

Should the object be considered an obstacle, CASA would regulate mitigation measures, such as lighting, restricted air access, depiction on charts and notification.

As the project is within 15 kilometres of Bodangora Airstrip, and the gaseous efflux from the exhaust stacks is likely to be greater than 4.3 metres per second at 110 metres above ground level, CASA would be notified of the project for assessment, once approved.

Transmission line connection

Transmission lines would connect the turbine power output to an existing TransGrid substation located north of the proposed power station. The following potential hazards could result:

- environmental impact to local flora and fauna and soil run-off during transmission construction
- construction equipment and personnel contacting live powerlines and equipment near the substation
- high voltage induction effects on construction personnel and equipment near live powerlines.

These hazards are typical of construction and operation of transmission lines. Environmental impacts would be managed through implementation of the mitigation measures identified in Sections 9.5, 10.5 and 10.6. Safety aspects of construction near live transmission lines would be included in construction safety plans for the project.

Environmental risk analysis

Table 9-25 lists the type of environmental risks identified for the project and a cross-reference to the section of this document in which they are further discussed.

Table 9-25 Environmental risks identified for the project

Type of risk	Section in EA where addressed
Environmental impact on flora and fauna	Section 9.5
Noise generation during operation of compressors and turbines	Section 9.3
Emissions of natural gas from station venting operations	Sections 9.1 and 9.2
Emissions from turbine exhausts	Section 9.1 and 9.2

Consequence assessment

The Hazard Identification Table in Appendix 1 of Technical Paper No. 6 was reviewed to select a set of credible release scenarios and hole sizes to be carried forward to the quantitative risk assessment. Table 9-26 identifies the scenarios subjected to the quantitative risk analysis for the proposed power station.

Table 9-26 Power station scenarios subjected to quantitative risk analysis

Release scenario	Hole size (millimetres)	Release rate (kilograms per second)
12 MPa, horizontal		
Gasket leak	3	0.16
Valve/gland leak	10	1.75
Fitting failure	25	11.0
4 MPa, horizontal		
Gasket leak	3	0.05
Valve/gland leak	10	0.51
Fitting failure	25	3.2

Quantitative risk assessment

Individual risk

Risk contours for power station releases were generated and assessed for the proposed power station site (see Figure 9-15), the results for which are summarised below:

- The risk contour for an individual risk of fatality of 1 x 10^{-6} per year (residential areas) extends past the northern boundary by a maximum of 70 metres and does not extend to any residences.
- The risk contour for an individual risk of fatality of 10 x 10^{-6} per year (active open spaces) extends past the northern boundary by a maximum of 20 metres and does not extend to any active open spaces.
- No individual risk of fatality of 50 x 10^{-6} per year (industrial areas) was generated for the power station.
- There are no sensitive or commercial land uses near the power station.

The risk resulting from the operation of the power station would, therefore, meet the DoP criteria for individual risk.

Societal risk

Due to the low population in the area of the power station and the low individual risk levels shown, the societal risk level would be negligible and, therefore, has not been quantified.

Escalation

The gas-fired turbine units would be located about 100 metres from the inlet facilities at the power station. In the event of an incident at the turbines, individual turbines would be shut down and isolated via the shutdown valves. If the incident was serious enough, the station would be isolated by shutdown valves on the gas receival unit. The risk of escalation from gas-fired turbine units to the shutdown valves at the station inlet is unlikely to impede shutdown of the proposed power station.

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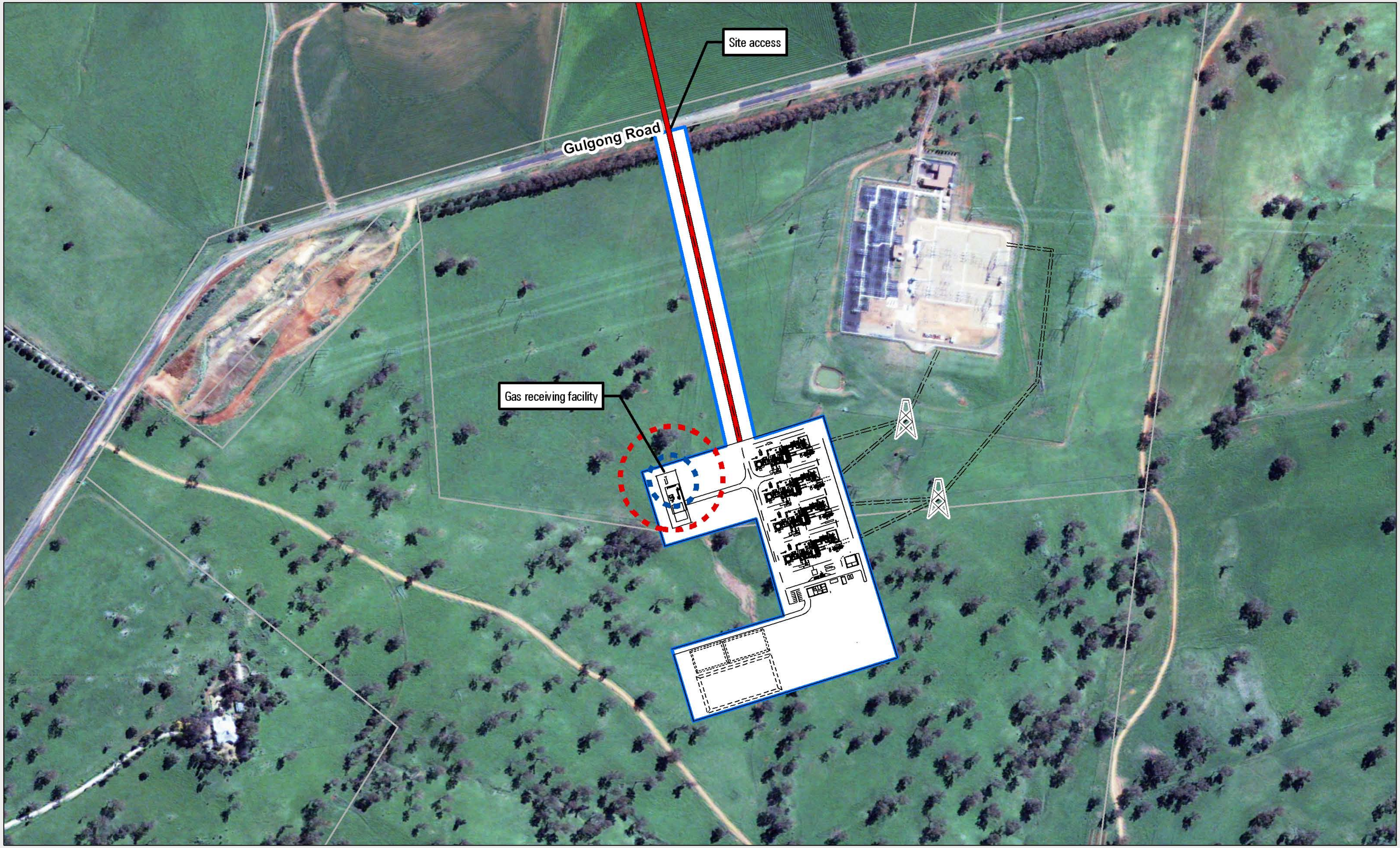

Access road
Operational boundary
Power lines
Proposed pipeline route
2 m contours
10 m contours
Transmission line towers

Figure 9-15 Individual fatality risk at the power station

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9.7.3 Gas pipeline

Hazard identification

Releases from the gas pipeline

The hazardous incidents associated with operation of the proposed gas pipeline identified during the PHA include the following:

- loss of containment from the pipeline due to corrosion, third party impact, earth movement, subsidence, etc.
- exposure of the pipeline due to erosion from flooding
- vehicle loading
- AC induction effects from HV power lines enhancing corrosion
- fatigue due to pressure cycling (discussed further below)
- stress corrosion cracking (discussed further below)
- weld and material defects
- overpressure/ over-temperature.

The main incident of concern that could result from operation of the pipeline is a loss of containment, release of high pressure natural gas to the atmosphere and subsequent ignition. The range of release sizes could range from a small leak to a full bore rupture.

The results of ignited gas release from the pipeline would be the same as those from the power station. As there are no major structures near the pipeline route, there would be a very low likelihood of congestion and resulting vapour cloud explosion.

Fatigue

The peak demand operation of the power station could result in pressure cycling from static to dynamic conditions as gas flow to the power station is turned on. As part of the detailed design, a fatigue assessment would be undertaken to ensure that the design of the pipeline is capable of meeting the cycling demand as per the requirements of Australian Standard *AS 2885-2007 Pipelines: Gas and Liquid Petroleum*.

Fatigue can result in fracture failure, leading to a pipeline rupture in the worst case. The potential for fatigue would be readily detected from the records of the operating history and maintenance inspections during the lifetime of the pipeline. If problems were detected, mitigation measures such as pressure restriction or reducing the design life of the pipeline would be implemented. Given the effectiveness of the proposed safeguards and the conservative approach used for the assessment, no increase in the failure rate for the effect of fatigue was included in the analysis.

Stress corrosion cracking

Another potential effect, which could result from pressure cycling, is stress corrosion cracking. Stress corrosion cracking is a phenomenon which can occur in pipelines that are subject to pressure cycles under high operating temperatures and in soil conditions which are conducive to corrosion. If detected, stress corrosion cracking can require pipeline repairs or de-rating of the pipeline. If undetected, stress corrosion cracking can lead to pipeline failure.

Pipeline designers make allowance to minimise the impact of stress corrosion cracking by selecting an appropriate pipeline coating that minimises the impact of external corrosion, and by selecting an appropriate design for the cathodic protection system. The protocols of the Pipeline Research Council International (1998) for assessment of the likelihood of stress corrosion cracking would also be followed in the detailed design.

Due to the proposed safeguards and the low likelihood of stress corrosion cracking impact, no increase in the failure rate for stress corrosion cracking was included in the frequency analysis.

Environmental risk analysis

The environmental risks associated with construction and operation of the gas pipeline would be similar to those of the power station (see Table 9-24).

Consequence assessment

The Hazard Identification Table in Appendix 1 of Technical Paper No. 6 was reviewed to select a set of credible release scenarios and hole sizes to be carried forward to the quantitative risk assessment. Table 9-27 identifies the scenarios subjected to the quantitative risk analysis for the proposed gas pipeline.

Table 9-27 Gas pipeline scenarios subjected to quantitative risk analysis

Release scenario	Hole size (millimetres)	Release rate (kilograms per second)
Lateral		
Pinhole (corrosion)	6	0.63
Medium (puncture)	25	11
Rupture followed by isolation	355	862
Unisolated rupture	355	2,210
Vertical		
Pinhole (corrosion)	6	0.63
Medium (puncture)	25	11
Rupture followed by isolation	355	862
Unisolated rupture	355	2,210

Quantitative risk assessment

Individual risk

Risk transects, showing individual risk of fatality versus the distance from the centreline of the proposed gas pipeline, were produced for the proposed gas pipeline. The following sensitivity cases were assessed with different levels of safeguards:

- Case 1 (Base Case) — 750 millimetre depth of cover (DoC); 6.3 millimetre wall thickness; marker tape
- Case 2 — 900 millimetre DoC; 6.3 millimetre wall thickness; marker tape
- Case 3 — 1,200 millimetre DoC; 6.3 millimetre wall thickness; marker tape
- Case 4 — 750 millimetre DoC; 9.5 millimetre wall thickness; marker tape

- Case 5 — 900 millimetre DoC; 9.5 millimetre wall thickness; marker tape
- Case 6 — 1,200 millimetre DoC; 9.5 millimetre wall thickness; marker tape.

The risk transects indicate that for Case 1 (Base Case) the resulting risk reaches an individual risk of fatality of 1 x 10^{-6} per year (the criteria for residential areas) at a distance of 110 metres from the pipeline. The complete results of the assessment, including the distances to the risk criteria levels required for other land uses, are summarised in Table 9-28.

Table 9-28 Separation distances required for land uses near the pipeline route

Case (pipeline safeguards)	Distance to individual risk of fatality (HIPAP No. 4) at nearby land uses (metres)				
	Sensitive land uses (0.5 x 10^{-7} per year)	Residential (1 x 10^{-6} per year)	Commercial (5 x 10^{-6} per year)	Active open spaces (10 x 10^{-6} per year)	Industrial (10 x 10^{-6} per year)
1	141	118	NR	NR	NR
2	140	115	NR	NR	NR
3	135	110	NR	NR	NR
4	124	75	NR	NR	NR
5	121	65	NR	NR	NR
6	117	8	NR	NR	NR

Note: NR = Not reached at any distance from the pipeline

Table 9-27 shows the separation distances required for land uses near the pipeline route. Given that the nearest residential building is at least 300 metres from the proposed pipeline, the DoP criteria for residential areas would be met. An appropriate level of safeguards may be selected, depending on the separation distance to nearby land uses to meet the DoP risk criteria.

Risk contours were not generated for the mainline valves (see Section 7.2.2) as the locations of these have not been identified. The risk for these stations would generally be less than for the compressor and delivery stations, as there would be less equipment at the mainline valves. Therefore, the extent of the risk contours for the mainline valve stations would be less than the other aboveground stations.

Societal risk

Due to the low population in the area of the pipeline and the low individual risk levels shown, the societal risk level would be negligible and has not been quantified.

9.7.4 Compressor station

Hazard identification

Releases in compressor station

The incidents identified for the proposed compressor station would be the same as those for the proposed power station. Assuming that the appropriate mitigation measures are applied, the risk from the proposed compressor station would be minimal.

Environmental risk analysis

The environmental risks identified for the proposed compressor station would be the same as those for the proposed power station (see Table 9-24).

Quantitative risk assessment

Individual risk

Risk contours were generated and assessed for the compressor station (see Figure 9-16), the results for which are summarised below:

- The risk contour for an individual risk of fatality of 1 x 10^{-6} per year (residential areas) extends past the southern boundary by 42 metres, at most, and does not extend to any residences.
- The risk contour for an individual risk of fatality of 10 x 10^{-6} per year (active open spaces) extends beyond the southern boundary by approximately 16 metres.
- No individual risk of fatality of 50 x 10^{-6} per year (industrial areas) was generated for the site.
- There are no sensitive or commercial land uses near the delivery facility.

Therefore, the risk resulting from the operation of the proposed compressor station would meet the DoP criteria for individual risk.

Societal risk

Due to the low population in the area of the compressor station and the low individual risk levels shown, the societal risk level would be negligible and has not been quantified.

Escalation

The compressor units would be located approximately 50 metres from the inlet to the compressor station. In the event of a major incident at the compressor station, the compressors would be shut down and the compressor station isolated via the shutdown valves. Therefore, the risk of escalation to the compressor station inlet is unlikely to impede shutdown of the station.

The station buildings (office, control room, etc.) would also be located approximately 50 metres from the compressors. Therefore, the risk of escalation to the control room is unlikely to impede remote operation and local control in the event of an emergency.

The compressor station would be located approximately 100 metres from the offtake. Therefore, there would be a low risk of compressor station incidents escalating to impede controlled shutdown of the gas supply offtake to the proposed gas pipeline.

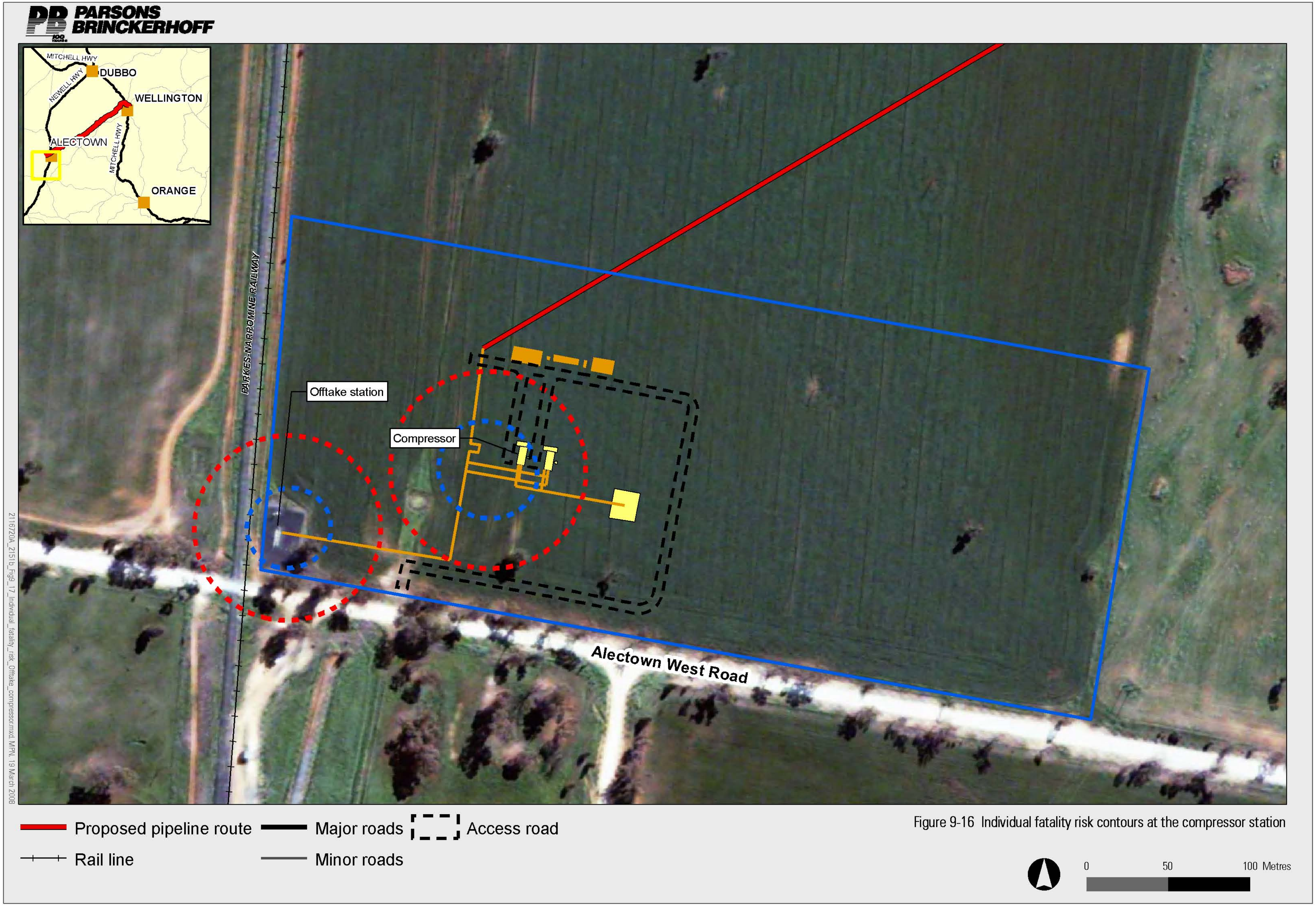

Figure 9-16 Individual fatality risk contours at the compressor station

9.7.5 Mitigation measures

Prior to the commencement of operation, the PHA would be updated to a final hazard analysis (FHA), where necessary. In the event of significant design changes occurring during the detailed design phase, this revision of the PHA would occur prior to the commencement of construction. This would be a likely requirement for the proposed gas pipeline and compressor station, as only preliminary designs were available at the time of the PHA, and the locations of the pipeline mainline stations were not known.

Power station

In order to control and mitigate fire incidents at the power station, the following safeguards have been included in the design of the proposed power station:

- A separation distance would be provided between the release point and site boundary (minimum 15 metres as per AS 2885:2007).
- Enclosures for turbine/compressor units would be provided with appropriate gas detection and fire detectors to detect lube oil fires.

Emergency response procedures would also be implemented.

Leak prevention/minimisation

The following measures would be implemented to prevent/minimise leaks from the proposed power station:

- No free oxygen would be present in the natural gas (reducing the effect of corrosion).
- Aboveground pipe work would be painted.
- Maintenance/inspection would be undertaken regularly.
- Spiral-wound gaskets would be used on HP flanged equipment.
- Pressure control and slam-shut valves would be used on the pressure regulating skid.
- High fracture tough steel would be used.
- A permit to work system would be implemented.
- Security fencing would be installed.
- Vehicle barriers would be erected.
- Hydrostatic testing of equipment would be undertaken.
- 100% radiography of all circumferential welds would be undertaken.
- A security fence would be placed around the station outside the hazardous area classified by AS 2430 to minimise the risk of ignition sources.
- A gravel or hardstand area would be built inside the fenced site around gas-filled equipment to minimise the risk of grass fires.
- Lightning protection would be constructed.
- Maintenance procedures would be implemented.
- Operating procedures would be implemented.

Control

The following control measures would be implemented:

- Pressure would be monitored via a SCADA system.
- A remotely-operated ESD valve would be placed at the station inlet.
- Ignition control would be implemented as per AS 2430.
- Slam shut valves would operate if pressure increases above the set point.

Bushfire prevention

The following mitigation measures would be implemented to prevent/minimise the risk of a bushfire:

- The area around the site fence, as well as within the fenced area, would be cleared.
- The area around gas-filled equipment would be either hardstand or gravel with open spaces within the boundary comprising grassed areas only.
- There would be a minimum separation distance of 15 metres between fencing and turbine/compressor units to minimise the impact of external fires.
- Open space would be provided around the site for fire fighting purposes (as per AS 2885:2007).
- There would be a minimum separation distance of 4 metres between buildings.
- At least one site access point would be wide enough for access for fire fighting equipment.
- Firewater storage and fire booster stations would be present.
- Liquid fuel storage would be present.
- Appropriate Australian Standards (e.g. *AS 3959-1999 Construction of Buildings in Bush Fire-prone Areas*) and the Building Code of Australia would be referred to in the detailed design for the power station.
- A fire safety study would be prepared for the detailed design prior to construction.
- The development would meet the requirements of the NSW Rural Fire Service document *Planning for Bush Fire Protection* (2006).

Hazardous substances

The following mitigation measures would be implemented to prevent/minimise risks associated with hazardous substances.

- Hazardous substances (e.g. small amounts of sulfuric acid and caustic soda) being delivered to the power station site would be transported in intermediate bulk containers by an accredited carrier in accredited packaging.
- Hazardous substances would be handled in accordance with the *Australian Code for the Transportation of Dangerous Goods by Road and Rail* and would be carried in separate vehicles at separate times.
- Specific handling procedures would be identified in a risk management and emergency response plan to be developed for the site.

- The site would meet the requirements of *AS 3780-1994 The Storage and Handling of Corrosive Substances* and the NSW Occupational Health and Safety Amendment (Dangerous Goods) Regulation 2005.

Escalation

In order to minimise the risk of escalation, the control room/office, workshop/store and fire booster station would be located a minimum of 40 metres from the nearest turbine and gas receival area. Alternatively, the spacing requirements in AS 2885-2007 for station equipment would be followed.

Gas pipeline

Protection against external damage

Protection against external damage would be ensured via the following mitigation measures:

- depth of cover
- ‘one-call’ or ‘dial before you dig’
- pipeline controls
- mainline valve stations to isolate and limit release
- marker tape
- warning signs.

Corrosion protection

The gas pipeline would be protected against corrosion by:

- following the protocols of the Pipeline Research Council International (1998) for the assessment of likelihood of stress corrosion cracking in the detailed design
- external coating of the pipeline
- ‘holiday’ detection (testing of coating integrity) prior to burial
- impressed current cathodic protection system
- intelligent pigging (i.e. passing a device through the pipeline) to assess pipeline condition.

Ground movements/subsidence

In order to minimise hazards due to ground movement or subsidence, the pipeline would be regularly patrolled to facilitate detection of any ground movement or land subsidence so that investigations can be carried out. Should significant ground movement be detected and stresses are determined to be high, the ground around the pipeline would be dug up to relieve the stresses on the pipe as an additional precautionary measure to mitigate the effect of subsidence prior to reburial.

Compressor station

Measures to mitigate hazards and risks associated with the proposed compressor station would be similar to that for the proposed power station.