Annex A

A. Gas Drainage Layout Plans

bhpbilliton
Carbon Steel Materials
Illawarra Coal Holdings Pty Ltd
Asset Development
Gas & Ventilation

Lot 4 Pipes Removed
Lot 21 Downcast Borehole Removed
Lot 3 Well Relocated
MRD Well Trajectories Shown

0 50 100 200 Metres

Appin Area 7
AREA 7 GOAF DRAINAGE PROJECT
703 & 704 WELLS & PIPELINES

Date: FEB, 2009
Author: Mick Loney
Signed Off:

NTS
Horizontal Datum
MGA - Zone 56

GV-A7-03
Version 3

Lot 4 Pipes Removed

bhpbilliton
Carbon Steel Materials
Illawarra Coal Holdings Pty Ltd
Asset Development
Gas & Ventilation

Appin Area 7
AREA 7 GOAF DRAINAGE PROJECT
DETAIL VIEW - LOT3

Date: FEB, 2009
Author: Mick Loney
Signed Off:

NTS
Horizontal Datum
MGA - Zone 56

GV-A7-02f
Version 3

0 50 100 200 Metres

292000

291000

6216000

6216000

291000

bhpbilliton

Carbon Steel Materials

Illawarra Coal Holdings Pty Ltd
Asset Development
Gas & Ventilation

Lot 4 Pipes Removed
Lot 21 Downcast Borehole Removed
Lot 3 Well Relocated

0 50 100 200 Metres

Appin Area 7
AREA 7 GOAF DRAINAGE PROJECT
703 & 704 GOAF PLANT LOCNS

Date: FEB, 2009
Author: Mick Loney
Signed Off:

NTS
Horizontal Datum
MGA - Zone 56

GV-A7-02
Version 2

Annex B

B. Methodology

1. Methodology

All methodology used in this assessment for the estimation of GHG emissions have been in accord with the *National Greenhouse Accounts (NGA) Factors (2008)* document in the first instance and/or in accord with sound scientific and engineering principles where NGA Factors have proved inadequate for the required calculations. The specific methodologies used in each calculation are given in the following sections. To ensure emissions were not underestimated, all calculations were conservative in nature.

1.2 Source Data

All source data used in this assessment was obtained from stable and reliable sources where possible or estimated based on engineering experience and reasonable assumptions where sound reference data was not available.

A list of source data used in the assessment is provided in **Section 3.5.1** of the GGA report.

1.3 Baseline Emissions

Baseline emissions were calculated using the NGA Factors (2008) methodology for estimating fugitive emissions from underground coal mining. This methodology accounts for release of methane and carbon dioxide during the mining process due to the fracturing of coal seams, overburden and underburden strata. The methodology can be found on page 19 of the NGA Factors (2008), and is described briefly below:

GHG emissions (t CO_2-e) = (Q x EF) / 1000

Where,

Q is the quantity of run of mine (ROM) coal extracted in tonnes; and

EF is the relevant emission factor expressed in t CO_2-e/t ROM coal, obtained from the *NGA Factors (2008)* document;

The EF for Gassy underground mines was used for the estimation of baseline emissions (NGA 2008, Table 6).

The mass of coal to be mined was calculated based on the plan view area of the longwall layout (refer Annex A), using an average coal seam thickness of 3m and a coal density of 1.5 t/m^3.

1.4 Emissions from Onsite Ventilation of Extracted Gas

Emissions were from onsite ventilation of extracted gas were estimated by converting the likely quantity of gas to be vented from a volume (in m^3) to a mass (in tonnes) using the ideal gas equation (i.e., $PV = NRT$). The mass of CH_4 was then converted to CO_2-e using the GWP for CH_4 (i.e., 21).

1.5 Emissions from Onsite Flaring and EDL Power Generation

Emissions from the onsite flaring and EDL combustion of extracted goaf gas were estimated using the NGA Factors (2008) methodology for fuel combustion of gaseous fuels, which can be found on page 12 of the NGA Factors (2008) booklet.

Emissions were calculated using the following formula:

GHG emissions (t CO_2-e) = (Q x EC x EF) / 1000

Where,

Q is the quantity of fuel consumed expressed by volume (m^3);

EF is the relevant emission factor expressed in kg CO_2-e/GJ, obtained from the *NGA Factors (2008)* document; and

EC is the energy content factor of the fuel type, expressed in GJ/m^3 (if Q is measured in GJ, EC=1), obtained from NGA Factors (2008).

An EC value of 37.7 x 10^{-3} GJ/t, and the emission factors for coal seam methane that is captured for combustion (NGA 2008, Table 2) were used in the calculations.

1.6 Fuel (Petrol and Diesel) Consumption Calculations

Emissions from the combustion of fuels (incl. diesel consumption during setup / installation works, materials haulage, employee transportation, and operational power supply to the goaf gas plants) during transportation was obtained from the NGA Factors (2008), were estimated using the NGA Factors (2008) methodology for fuel combustion of liquid fuels, which can be found on page 14 of the NGA Factors (2008) booklet.

Emissions were calculated using the following formula:

GHG emissions (t CO_2-e) = (Q x EF x EC) / 1000

Where,

Q is the quantity of fuel consumed expressed by volume (kL or GJ);

EF is the relevant emission factor expressed in kg CO_2-e/GJ, obtained from the *NGA Factors (2008)* document; and

EC is the energy content factor of the fuel type, expressed in GJ/kL (if Q is measured in GJ, EC=1), obtained from NGA Factors (2008).

Emissions associated with the combustion of fuel include both Scope 1 and Scope 3 emissions. Scope 1 emissions account for the point source onsite combustion of the fuel (within the organisation) and Scope 3 emissions account for extraction and transportation of the fuel (outside the organisation). The emission factors for each fuel are different.

The relevant emission factors for diesel and petrol were used in the calculations (refer NGA 2008, Table 3).

A copy of the calculations used in the assessment is provided in **Annex C**.

Annex C

C. Calculations

GHG EMISSION CALCULATIONS

1	**Baseline Emissions** **(without implementation of Goaf Gas Drainage and Utilisation Project)**		
	NOTE: Assumes all gas is vented to atmosphere without any utilisation for EDL power generation or flaring		
	Average Coal Seam Thickness	3	m
	Plan View Area of Longwall 703	713500	m^2
	Plan View Area of Longwall 704	630000	m^2
	Volume of ROM Coal in Longwall 703	2354550	m^3
	Volume of ROM Coal in Longwall 704	2079000	m^3
	Assumed density of coal	1.50	t/m^3
	Mass of Coal in Longwall 703	3531825	t
	Mass of Coal in Longwall 704	3118500	t
	Total Mass of Coal	6650325	t ROM coal
	Emission Factor for Fugitive Emissions (Gassy Underground Mines [NGA, 2008])	0.305	t CO_2-e/t ROM coal
	Total Baseline GHG Emissions (Scope 1)	**2028349**	**t CO_2-e**
2	**Project Emissions (Construction / Setup / Installation Works)** **(with implimentation of Goaf Gas Drainage and Utilisation Project)**		
2.1	**Diesel Combustion During Construction / Setup / Installation Works**		
	(NOTE: Includes drilling of boreholes, installation of surface goaf extraction pipeline, construction / relocation / installation of extraction plant, and reticulation to underground EDL connection)		
	Fuel type = "Diesel Oil"		
	(refer NGA Factors (2008), p16, Table 4)		
	Total Volume of Fuel Consumed (Q_i)	29.2	kL
	Energy Content Factor (ECi)	38.6	GJ/kL
	Energy Content	1125	GJ
	Scope 1		
	CO_2 Emission Factor (EF_{ijoxec})	69.2	kg CO_2-e / GJ
	CH_4 Emission Factor (EF_{ijoxec})	0.1	kg CO_2-e / GJ
	N_2O Emission Factor (EF_{ijoxec})	0.2	kg CO_2-e / GJ
	Total Emission Factor (EF_{ijoxec})	69.5	kg CO_2-e / GJ
	Total Scope 1 CO_{2-e} emissions (E_{ij})	**78.2**	**t CO_2-e**
	Scope 3		
	Scope 3 CO_2-e Emission Factor (EF_{ijoxec})	5.3	kg CO_2-e / GJ
	(NGA Factors [2008], page 58,Table 38)		
	Total Scope 3 CO_{2-e} emissions (E_{ij})	**6.0**	**t CO_2-e**
	Total Diesel Fuel Combustion GHG Emission (Scope 1 + Scope 3)	**84.2**	**t CO_2-e**
2.2	**Petrol Fuel Consumption from Employee Travel**		
	Fuel type = "Gasoline (other than for use as fuel in an aircraft)"		
	(refer NGA Factors (2008), p16, Table 4)		
	Total Volume of Fuel Consumed (Q_i)	2.7	kL
	Energy Content Factor (ECi)	34.2	GJ/kL
	Energy Content	92	GJ
	Scope 1		
	CO_2 Emission Factor (EF_{ijoxec})	66.7	kg CO_2-e / GJ
	CH_4 Emission Factor (EF_{ijoxec})	0.2	kg CO_2-e / GJ
	N_2O Emission Factor (EF_{ijoxec})	0.2	kg CO_2-e / GJ
	Total Emission Factor (EF_{ijoxec})	67.1	kg CO_2-e / GJ
	Total Scope 1 CO_{2-e} emissions (E_{ij})	**6.2**	**t CO_2-e**
	Scope 3		
	Scope 3 CO_2-e Emission Factor (EF_{ijoxec})	5.3	kg CO_2-e / GJ
	(NGA Factors [2008], page 58,Table 38)		
	Total Scope 3 CO_{2-e} emissions (E_{ij})	**0.5**	**t CO_2-e**
	Total Petrol Fuel Combustion GHG Emission (Scope 1 + Scope 3)	**6.7**	**t CO_2-e**

2.3	**PROJECT EMISSION TOTALS for Construction / Setup / Installation Works (Scope 1 & Scope 3)**		
	Scope 1	84	t CO_2-e
	Scope 2	NA	t CO_2-e
	Scope 3	6	t CO_2-e
	TOTAL (Scope 1 + Scope 2)	**84**	**t CO_2-e**
	TOTAL (Scope 1 + Scope 2 + Scope 3)	**91**	**t CO_2-e**
3	**Project Emissions (Operational)** **(with implimentation of Goaf Gas Drainage and Utilisation Project)**		
3.1	**Goaf Gas Drainage Emissions**		
	Gas Extraction Data		
	Goaf Extraction Flow Rate	800	L/s
	Total Goaf Extraction Duration	89	weeks
	Total Volume of Gas Extracted via Goaf Bores	43061760	m3
	Seam Gas Composition	86.9	% CH_4
		7.76	% CO_2
		0.56	% O_2
		3.06	% N2
		1.73	% C_2H_6
		0.54	% C_3H_8
		0.28	% C_4H_{10}
		0.19	% H_2
		0.03	% Ar
	Consideration of MVA Dilution of Seam Gas in Goaf Gas		
	MVA Portion of Goaf Gas (ie, air from mine ventilation system)	30	%
	Seam Gas Portion of Goaf Gas (ie, gas from coal seam)	70	%
	Total Effective Volume of Coal Seam Gas Goaf Gas Drainage Air	30143232	m3
	Goaf Drainage Flow Distribution		
	Portion of Gas to EDL	99	%
	Portion of Gas Vented to atmosphere	1	%
	Goaf Gas Drainage Emissions		
	Goaf Gas Emissions from EDL Power Generation (Scope 3)	57748	t CO_2-e
	Goaf Gas Emissions from Venting (Scope 1)	3973	t CO_2-e
	Total Goaf Gas Drainage Emissionss (Scope 1 + Scope 3)	**61721**	**t CO_2-e**
	Baseline Goaf Gas Emissions	397263	t CO_2-e
	(NOTE: Baseline goaf gas emissions have been calculated as the total amount of CO2-e contained in the extracted goaf gas. This number represents the emissions that would occur via the goaf drainage project if all drained gas was vented with no utilisation.)		
	Total Reduction due to EDL Power Generation and/or Flaring of Drained Goaf Gas	**-335543**	**t CO_2-e**
	(calculated as Baseline Goaf Gas Emissions minus Total Goaf Gas Drainage Emissions)		
3.3	**Extraction Plant Power Supply (Diesel Combustion)**		
	Duration of Extraction Operation for Goaf Drainage (as per Section 3.1)	89	Weeks
	Diesel Fuel Consumption per Week (assumes 175 kVA generator)	3500	L/week
	Fuel type = "Diesel Oil"		
	(refer NGA Factors (2008), p16, Table 4)		
	Total Volume of Fuel Consumed (Q_i)	311.5	kL
	Energy Content Factor (ECi)	38.6	GJ/kL
	Energy Content	12024	GJ
	Scope 1		
	CO_2 Emission Factor (EF_{ijoxec})	69.2	kg CO_2-e / GJ
	CH_4 Emission Factor (EF_{ijoxec})	0.1	kg CO_2-e / GJ
	N_2O Emission Factor (EF_{ijoxec})	0.2	kg CO_2-e / GJ
	Total Emission Factor (EF_{ijoxec})	69.5	kg CO_2-e / GJ
	Total Scope 1 CO_{2-e} emissions (E_{ij})	**836**	**t CO_2-e**

	Scope 3		
	Scope 3 CO_2-e Emission Factor (EF_{ijoxec})	5.3	kg CO_2-e / GJ
	(NGA Factors [2008], page 58, Table 38)		
	Total Scope 3 CO_{2-e} emissions (E_{ij})	**64**	**t CO_2-e**
	Total Emissions for Operational Power Supply (Scope 1 + Scope 3)	**899**	**t CO_2-e**
3.5	**PROJECT EMISSION TOTALS for Operation of Goaf Gas Drainage and Utilisation Project (Scope 1 & Scope 3)**		
	Scope 1	4808	t CO_2-e
	Scope 2	N/A	t CO_2-e
	Scope 3	57812	t CO_2-e
	TOTAL (Scope 1 + Scope 2)	**4808**	**t CO_2-e**
	TOTAL (Scope 1 + Scope 2 + Scope 3)	**62620**	**t CO_2-e**
4	**Post-Project Appin Mine MVA (Fugitive Emissions)** **(<u>with</u> implimentation of Goaf Gas Drainage and Utilisation Project)**		
	Baseline Emissions (as calculated in **Section 1**)	2028349	t CO_2-e
	<u>Minus</u> baseline goaf gas emissions (as calculated in **Section 3.1**)	397263	t CO_2-e
	(NOTE: Baseline goaf gas emissions have been calculated as the total amount of CO2-e contained in the extracted goaf gas. This number represents the emissions that <u>would</u> occur via the goaf drainage project if all drained gas was vented with no utilisation.)		
	Total Fugitive Emissions via Appin Mine MVA (Scope 1)	**1631086**	**t CO_2-e**
5	**POST-PROECT EMISSION TOTALS** **(<u>with</u> implimentation of Goaf Gas Drainage and Utilisation Project)**		
	Scope 1	1635894	t CO_2-e
	Scope 2	N/A	t CO_2-e
	Scope 3	57812	t CO_2-e
	TOTAL (Scope 1 + Scope 2)	**1635894**	**t CO_2-e**
	TOTAL (Scope 1 + Scope 2 + Scope 3)	**1693706**	**t CO_2-e**

Pre and Post Project Emissions Summary Table

Operation	Scope 1 Emission Total (kt CO2-e)	Scope 3 Emission Total (kt CO2-e)	TOTAL EMISSIONS (kt CO2-e)	Equivilent Annual Average Emission (kt CO2-e/yr)
Baseline Emissions (ie, without implimentation of Goaf Gas Drainage and Utilisation Project)				
Total Baseline Emissions	2028		2028	1193
Post-Project Emissions (ie, with implimentation of Goaf Gas Drainage and Utilisation Project)				
Project Emissions (Construction / Setup / Installation Works)				
Diesel Combustion During Construction / Setup / Installation Works	0.078	0.006	0.084	0.049
Petrol Fuel Consumption from Employee Travel	0.0062	0.0005	0.0067	0.0039
Project Emissions (Operational)				
Goaf Gas Drainage Emissions	4.0	58.0	62.0	36.5
Extraction Plant Power Supply (Diesel Combustion)	0.8	0.1	0.9	0.5
Post-Project Appin Mine MVA (Fugitive Emissions)	1631.0		1631.0	959.4
Total Post-Project Emissions	1636	58	1694	996

Emission Reduction Summary Table

Operation	Total Emission (kt CO2-e)	Equivilent Annual Average Emission (kt CO2-e/yr)
Baseline Emissions (ie, without implimentation of Goaf Gas Drainage and Utilisation Project) [a]	2028	1193
Post-Project Emissions (ie, with implimentation of Goaf Gas Drainage and Utilisation Project)	1694	996
Total Reduction in Emissions due to Goaf Gas Drainage and Utilisation Project	**334**	**196**

Annex D

D. Flora & Fauna Assessment

BIOSIS
RESEARCH

Flora and Fauna Impact Assessment: Appin Area 7 Goaf Gas Drainage Project

May 2009

Natural & Cultural Heritage Consultants 8 Tate St Wollongong NSW 2500

BIOSIS
RESEARCH

Report for

Cardno Forbes Rigby

Flora and Fauna Impact Assessment: Appin Area 7 Goaf Gas Drainage Project

Final Report

May 2009

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ACKNOWLEDGMENTS

Biosis Research acknowledges the contribution of the following people and organisations in preparing this report:

- Ashleigh Pritchard (GIS Operator, Biosis Research)
- Peter Chudleigh (Cardno Forbes Rigby)
- Terri English (Senior Zoologist, Biosis Research Pty. Ltd.)

ABBREVIATIONS

DBH	Diameter at Breast Height
DECC	NSW Department of Environment and Climate Change
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts
EP&A Act	NSW *Environmental Planning and Assessment Act* 1979
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
LGA	Local Government Area
NPWS	NSW National Parks and Wildlife Service (now part of DECC)
ROTAP	Rare or Threatened Australian Plant as listed by Briggs and Leigh (1995)
SEPP	NSW State Environmental Planning Policy
TSC Act	NSW *Threatened Species Conservation Act* 1995
sp.	Species (singular)
spp.	Species (plural)
ssp.	Subspecies
var.	Variety

CONTENTS

TABLES

FIGURES

Plates

1.0 SUMMARY

Biosis Research was commissioned by Cardno Forbes Rigby to conduct a terrestrial flora and fauna assessment for the proposed goaf gas drainage project for Longwalls 703-704 at Appin Mines' Area 7. The proposed project will involve the installation of goaf gas extraction plants, eight boreholes for extracting goaf gas from the mine, one downhole to convey the extracted goaf gas to the Energy developments Limited (EDL) Power Stations for re-use and associated pipelines.

The preferred location of the goaf gas extraction plant is on the property described as Lot 2 DP 576136 and is represented as Option 1 in this report. A contingency or back up extraction plant, proposed to be located on the property described as Lot 7 DP 250231 is also proposed as part of the project and is represented as Option 2 in this report (refer Figure 2).

This assessment has been carried out for determination under Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act).

The Study Area supports mostly cleared paddocks with scattered trees. The only exception to this is the proposed location of Goaf Gas Extraction Plant Option 2, which supports Cumberland Plain Woodland, an Endangered Ecological Community on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

The proposal may involve clearing or modifying approximately:

- 0.16 ha of Cumberland Plain Woodland
- 1.2 ha of cleared paddocks.

No threatened plant species were recorded within the Study Area, nor is there considered to be potential habitat for any threatened flora.

The Project may involve the removal of a small area of Cumberland Plain Woodland, supporting potential foraging habitat for 14 threatened animal species listed on the TSC and/or EPBC Acts (Grey-headed Flying Fox *Pteropus poliocephalus*, Greater Broad-nosed Bat *Scoteanax rueppellii* , Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Eastern Freetail-bat *Mormopterus norfolkensis*, Large-footed Myotis *Myotis macropus*, Regent Honeyeater *Anthochaera phrygia*, Swift Parrot *Lathamus discolor*, Black-chinned Honeyeater, Turquoise Parrot *Neophema pulchella*, Powerful Owl *Ninox strenua*, Barking Owl *Ninox connivens*, White-bellied Sea-eagle *Haliaeetus leucogaster*, Cattle Egret *Ardea ibis* and Rainbow Bee-eater *Merops ornatus*), however the impacts to these species are likely to be negligible.

Impact Assessments following the Part 3A Guidelines under the EP&A Act were carried out for the threatened biota listed on the TSC Act occurring or with potential habitat in the Study Area. These assessments concluded that the proposal would have a minor impact, given that a relatively small area of potential habitat would be impacted and none of the threatened species were recorded during surveys of the Study Area. Further, impact assessments following the EPBC Act Significant Impact Guidelines have been prepared for threatened biota listed under the EPBC Act with potential habitat in the Study Area. It was found that the proposed project would not have a significant impact on threatened biota. A Referral for Matters of National Significance (EPBC Act) is not considered necessary for any threatened biota within the Study Area.

The following mitigation measures are proposed to minimise any potential disturbances from the proposal on the ecological values of the Study Area:

- adjustment of the location of access tracks to avoid native trees and significant habitat features such as trees with hollows, where required;
- trees with hollows should be retained and protected, with no drilling within the critical root zone (extending to 2 m beyond the drip line) of the trees;
- where possible, proposed boreholes, pipelines and access tracks have been located within existing cleared areas;
- sediment and erosion control measures should be implemented on all sites to prevent erosion during and after construction;
- any chemicals used on site will be taken off site after use and disposed of appropriately;
- machinery and vehicles should be washed down prior to use on site to avoid the transmission of weed seed or disease into intact areas of native vegetation;
- Goaf Gas Extraction Plant Option 1 located on the property described as Lot 2 DP 576136 is the preferred option, as this location supports cleared paddocks and would not result in impacts to flora and fauna habitats. The development of Goaf Gas Extraction Plant Option 2 located on the property described as Lot 7 DP 250231 will result in the removal of approximately 0.16 ha of Cumberland Plain Woodland, an EEC on the EPBC and TSC Acts, and habitat for a number of threatened fauna species.
- A suitably qualified ecologist should be on site during the construction of Goaf Gas Extraction Plant Option 2 (if this option is utilised) and/or the drilling of the MRD borehole from this location, to ensure impacts to significant habitat features are minimised.

- The site of Option 2 (if this option is utilised) should be rehabilitated with Cumberland Plain Woodland after the cessation of goaf gas drainage to replace any cleared vegetation.

2.0 INTRODUCTION

Biosis Research was commissioned by Cardno Forbes Rigby to conduct a terrestrial flora and fauna assessment for the proposed goaf gas drainage project for Longwalls 703-704 at Appin Mines' Area 7 (Figure 1). The project will involve the installation of goaf gas extraction plants (of which there are two options), eight boreholes to extract the goaf gas from the mine, one downhole to convey the extracted goaf gas to the EDL Power Stations for re-use and associated pipelines (Figure 2).

The preferred location of the goaf gas extraction plant is on the property described as Lot 2 DP 576136 and is represented as Option 1 in this report. A contingency or back up extraction plant, proposed to be located on the property described as Lot 7 DP 250231 is also proposed as part of the project and is represented as Option 2 in this report (refer Figure 2).

This assessment has been carried out for determination under Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) with reference to threatened biota listed on the NSW *Threatened Species Conservation Act* 1995 (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).

2.1 Aims

The specific aims of this assessment are to:

- conduct a literature review and database search for the locality;
- undertake targeted field surveys for habitat of threatened terrestrial flora and fauna, populations or ecological communities that are listed on the TSC Act and the EPBC Act and have been identified as potentially occurring in the locality;
- provide an assessment of the habitat values of the site;
- undertake impact assessments for threatened biota listed on the TSC and/or EPBC Acts following the guidelines for threatened species assessment under Part 3A of the EP&A Act (DEC & DPI 2005) and the EPBC Act Significant Impact Guidelines (DEH 2006); and,
- Provide recommendations to minimise the environmental impacts of the proposal.

2.2 Definitions

The following terms are used frequently throughout the report:

- ***The proposal*** is the development, activity or action proposed. In this case the proposal is the installation of eight goaf gas extraction boreholes, one downhole to convey the extracted goaf gas to the EDL Power Stations for reuse in electricity generation and the installation of a preferred goaf gas extraction plant on the property described as Lot 2 DP 576136 and a contingency or back up extraction plant on the property described as Lot 7 DP250231 if this is required.

- ***Subject site*** is defined in *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC 2004b) and means the area directly affected by the proposal. In this case, the subject site is the combination of the eight boreholes, one downhole, the easements of the surface pipeline reticulation system and both goaf gas extraction plant locations (refer Figure 2).

- ***Study Area*** is defined in DECC (2004b) as the subject site and any additional areas that are likely to be affected by the proposal, either directly or indirectly.

- ***Abundance*** means a quantification of the population of the species or community.

- ***Regional*** means the area defined within the applicable IBRA Bioregion (Thackway and Cresswell 1995), i.e., The Sydney Basin Bioregion.

- ***Local population*** is defined in DECC (2004b) as the population of a species within the Study Area.

- ***Local occurrence*** is used in reference to endangered ecological communities and is defined in (DEWHA 2004) as the community that occurs within the Study Area.

- ***Locality*** is the area within a 10 kilometre radius of the Study Area.

- ***Threatened biota*** refers to threatened species, populations and ecological communities as listed on the TSC Act and EPBC Act.

2.3 The Proposal

BHPBIC proposes to drain the goaf gas from Longwalls 703-704 within Appin Area 7, west of the township of Appin (Figure 1). Goaf gas is the accumulation of coal seam methane in the area of collapsed rock strata associated with the extraction of coal by the longwall mining method (Cardno Forbes Rigby 2008). If unmanaged this gas could enter the ventilation system within the mine and cause operational and safety issues underground. As such BHPBIC will use the proposed plant to draw the goaf gas to the surface and resolve these issues (Cardno Forbes Rigby 2008).

BHPBIC propose to drain the goaf gas by installing a series of boreholes between the goaf and the surface. The goaf gas will be drawn up the boreholes by extraction plant/s drawing goaf gas from multiple boreholes connected by a pipeline reticulation system located on the surface (refer Figure 2) (Cardno Forbes Rigby 2008).

2.3.1 Potential Impacts of the Proposal

The disturbance footprint of each borehole drilling site comprises of approximately 30 x 40 metre compound. Installation of the surface pipeline reticulation system will involve a 650 mm wide trench dug to a depth of approximately 1400 mm. The goaf gas extraction plants may require disturbance to approximately 0.16 ha of Cumberland Plain Woodland, which represents approximately 0.01% of the occurrence of this plant community in the locality.

Direct impacts that may apply to this proposal and will therefore be considered in this assessment include:

- vegetation clearance; and,
- the removal of potential habitat.

Indirect impacts that may apply to this proposal include:

- the potential for erosion; and,
- increased human activity within or adjacent to sensitive habitat areas.

Section 5.0 discusses the specific potential impacts associated with the proposal and the proposed amelioration measures. Direct impacts are usually unavoidable while indirect impacts are usually mitigated through amelioration measures.

2.4 The Study Area

The study area is located south west of Sydney between Douglas Park and Menangle (refer Figure 1) within the Wollondilly Local Government Area (LGA).

The Study Area generally supports cleared paddocks, with scattered patches of native vegetation in varying condition, mostly along road edges and creeklines. The current land use is agricultural, with cattle, goats and ponies grazing within the cleared paddocks.

2.4.1 Geology, Soils and Topography

The soil landscape of the study area is mapped at a 1:100,000 scale by (Hazelton *et al.* 1990) as Blacktown (map unit bt), which is described as gently undulating rises on Wianamatta Group Shale.

2.5 Planning Approvals

The proposal has been declared as a Major Project under Part 3A of the NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act) and State Environmental Planning Policy (Major Projects) 2005.

The EP&A Act was amended in June 2005 to reform the land-use planning and development assessment and approval system, particularly as it relates to major infrastructure and other significant development. In the new Part 3A, the Act provides a single assessment and approval regime for all major infrastructure and other projects previously undertaken under Part 4 and/or Division 4 of Part 5 of the EP&A Act. The new Part applies to major State government infrastructure projects, development that was previously classified as State significant development and other projects, plans or programs declared by the Minister for Planning.

3.0 METHODS

3.1 Taxonomy

The plant taxonomy (method of classification) used in this report follows Harden (1992, 1993, 2000, 2002), Fairley and Moore (2000), Robinson (2003) and subsequent advice from the National Herbarium of NSW. In the body of this report plants are referred to by their scientific names only. Common names where available have been included in the Appendices.

Names of vertebrates follow the Census of Australian Vertebrates maintained by Department of Environment, Heritage, Water Resources and the Arts (DEWHA). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

3.2 Legislation

Federal and State Acts and Policies that haven been considered in this report with regard to terrestrial flora and fauna are listed below:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act);
- NSW *Threatened Species Conservation Act* 1995 (TSC Act);
- NSW *Environmental Planning and Assessment Act* 1979 (EP&A Act); and,
- State Environmental Planning Policy (SEPP) 44 – Koala Habitat.

3.3 Literature and Database Review

A list of documents used to prepare this report is located in *References*. Records of threatened species, populations and communities were obtained from the Department of Environment and Climate Change (DECC) *Atlas of NSW Wildlife* within a 10 km radius of the Study Area.

Potential occurrences of threatened species, populations and communities listed on the EPBC Act were obtained from the Department of the Environment, Water, Heritage and the Arts (DEWHA) *EPBC Online Database* within a 10 km radius of the Study Area. Database searches were conducted in September 2008.

3.4 Field Survey

The Study Area was inspected on the 8 April 2009. The general condition of the site was assessed and observations of flora and fauna and plant communities were made (as detailed below). During the site visit the weather was warm and sunny.

This study was by design a habitat assessment, therefore does not include trapping, spotlighting, active searching, call playback techniques or vegetation quadrat sampling.

3.4.1 Flora

Information recorded during the flora survey included: location (GPS), photograph, community structure and composition, the presence of threatened plants and ecological communities (or their potential habitat), fire history, condition (Section 3.4.2), plant species list and habitat description.

A compiled plant species list for the Study Area was entered into the NSW Flora Information System (Viridans 2003) and is included in Appendix 1.

3.4.2 Vegetation Condition Assessment

Vegetation condition was assessed according to the degree to which it resembles relatively natural, undisturbed vegetation. Vegetation was assessed as being in Good, Moderate or Poor condition or Disturbed according to the following criteria:

- **species composition** (species richness, degree of weed invasion);
- **vegetation structure** (representation of each of the original layers of vegetation); and,
- **resilience** (This is the capacity of a site for natural regeneration. This is primarily linked to the degree to which the natural soil profile of the area has been disturbed).

The categories of vegetation conditions are as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges and track margins; vegetation community contains original layers of vegetation; vegetation layers (ground, shrub, canopy etc.) are intact, or if modified, natural soil profile remains intact;

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout;

one or more of original layers of vegetation are modified; vegetation layers (ground, shrub, canopy etc.) are largely intact, or if modified, natural soil profile remains intact; able to be regenerated to Good condition with minimal level of management;

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation are highly modified; one or more original vegetation layers (ground, shrub, canopy etc.) are modified or missing, but natural soil profile intact; able to be regenerated to Moderate or Good condition with substantial management; and,

Disturbed: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition; requires a high input of resources to achieve restoration goals.

3.4.3 Fauna

The fauna survey was undertaken as a habitat based assessment. Animal species using the site were surveyed by undertaking active searching and listening, as well as recording incidental observations.

3.4.4 Fauna Habitat Assessment

The three categories used to evaluate habitat value were Good, Moderate or Poor, as detailed below:

Good: ground flora containing a high number of indigenous species; vegetation community structure, ground, log and litter layer intact and undisturbed; a high level of breeding, nesting, feeding and roosting resources available; a high richness and diversity of native animal species.

Moderate: ground flora containing a moderate number of indigenous species; vegetation community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna.

Poor: ground flora containing a low number of indigenous species, vegetation community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native fauna.

Other habitat features such as the value of the study area as a habitat corridor, the presence of remnant communities or unusual ecological plant community structure were also used to assess habitat quality.

3.5 Limitations

Some plant species that occur in the locality are annuals (completing their life cycle within a single season) and are present only in the seed bank for much of the year. Other plant species are perennial but are inconspicuous unless flowering. Further, some animal species are migratory and therefore may not be present during the certain seasons. However, as the assessment of impact is based on the presence or absence of suitable habitat for threatened flora and fauna (which is adequate to satisfy the requirements of the EP&A Act), such species are taken into account during the assessment even though they may not be conspicuous during the survey.

4.0 RESULTS

4.1 Plant Communities

The vegetation of the region has been mapped by NPWS (2002b). The majority of the study area is mapped as cleared. Shale Sandstone Transition Forest (High and Low Sandstone Influence) is mapped as adjoining the study area.

Field surveys revealed most of the study area to support cleared paddocks, with scattered remnant trees occurring in some areas and a small patch of regrowth Cumberland Plain Woodland occurring at the proposed Goaf Gas Extraction Plant Option 2 Location. A description of the cleared paddocks and Cumberland Plain Woodland based on the field surveys of the study area is provided below. Shale Sandstone Transition Forest was not surveyed as part of the field assessment, as it was not recorded in the study area and will not be impacted by the proposal. Therefore this plant community is not included in the descriptions below.

4.1.1 Cleared Paddocks

The majority of the study area supported cleared paddocks with little or no resilience, having been pasture improved and grazed for many years (Plate 1). The cleared paddocks within the study area supported grazing animals such as cattle, goats and Welsh ponies. A series of boreholes, pipelines and the Goaf Gas Extraction Plant Option 1 Location occurs within the cleared paddocks of the study area.

Dominant species recorded in cleared paddocks include pasture grasses such as *Paspalum dilatatum, Pennisetum clandestinum* and *Setaria gracilis.* Weed species recorded within the paddock areas included *Chloris gayana*, *Verbena bonariensis, Sida rhombifolia, Senecio madagascariensis, Cynodon dactylon* and *Plantago lanceolata.* Scattered exotic shrubs were also recorded in the cleared paddocks including *Olea europaea* subsp. *cuspidata* and *Rubus fruticosus.* Native species such as the canopy trees *Eucalyptus moluccana, E. tereticornis,* the small tree *Acacia parramattensis* and the shrub *Bursaria spinosa* were also recorded in scattered patches within the cleared paddocks in the study area (Plate 2). Planted trees along fence lines within cleared paddock areas included *Allocasuarina littoralis* and *Lophostemon confertus*.

Cleared paddocks within the study area were considered to be in a Disturbed condition, given the extensive ongoing disturbances such as grazing, weed invasion, vegetation clearance and rubbish dumping. The absence of all natural structural layers and heavily reduced native species diversity suggests a lack of natural resilience in the cleared paddocks of the study area.

4.1.2 Cumberland Plain Woodland

A small patch of regrowth Cumberland Plain Woodland was recorded in the area proposed for the Goaf Gas Extraction Plant Option 2 Location (Plate 3). This area supported mostly canopy trees of *Eucalyptus tereticornis* and *E. moluccana*, most of which were relatively young regrowth to a maximum of 15 m in height. Two larger remnant trees of *Eucalyptus tereticornis* to 25 m in height and approximately 75 m DBH were recorded in this area (Plate 4). The small tree layer was sparse, supporting scattered young regrowth *Eucalyptus tereticornis.* The shrub layer was also sparse, supporting few scattered *Bursaria spinosa*, with *Olea europaea* subsp. *cuspidata* and *Ligustrum lucidum* also occurring. The ground layer was dominated by exotic grasses such as *Paspalum dilatatum*, *Setaria gracilis*, with native species *Dichondra repens*, *Themeda australis* and *Aristida ramosa* also occurring.

The Cumberland Plain Woodland in the study area was considered to be in Poor condition given the altered structure and low native species diversity. This area is, however, likely to have some natural resilience given the presence of a tree canopy and native species in the shrub and ground layers persisting despite the overall dominance of exotics.

Cumberland Plain Woodland is listed as an Endangered Ecological Community on both the TSC and EPBC Acts. There is also a preliminary determination (listed January 23 2009) to list Cumberland Plain Woodland as a critically endangered ecological community on the TSC Act.

4.2 Flora

A total of 45 plant species were recorded in the Study Area, including 18 (40%) native species and 27 (60%) exotic species. A list of plant species recorded in the Study Area is provided in Appendix 1.

4.2.1 Noxious Weeds

The following exotic species recorded in the study area are listed as Noxious Weeds on the Noxious Weeds Act 1993:

- *Rubus fruticosus* - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority

- *Opuntia* sp. - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

4.2.2 Threatened Flora

A total of 23 threatened plant species listed on the TSC and/or the EPBC Acts have been either previously recorded or have potential habitat within the locality (Table 1). The distribution of threatened plants derived from DECC Atlas of NSW Wildlife are illustrated in Figure 4.

No threatened plant species were recorded within the Study Area, nor is there considered to be potential habitat for any threatened flora.

Table 1: Threatened flora within 10 km of the Study Area

Key: 1) Listed on the EPBC Act as Critically Endangered (CE), Endangered (E) or Vulnerable (V)
2) Listed on the TSC Act as Endangered (E1) or Vulnerable (V)
3) For explanation of ROTAP codes see Appendix 2.

Species	EPBC Act[1]	TSC Act[2]	ROTAP[3]	Habitat	Potential Habitat
Acacia bynoeana Bynoe's Wattle	V	E1	3V	*Acacia bynoeana* is found in central eastern NSW, in the following catchment regions – Hawkesbury/Nepean, Hunter/Central Rivers, Southern Rivers, and Sydney Metropolitan. More specifically it is found from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra (DEC 2005a). It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and recently burnt patches (DEC 2005a). It grows in sandy clay soils often containing ironstone gravels (Fairley 2004). Main vegetation types include heath or dry sclerophyll forest on sandy soils (DEC 2005a). Associated overstorey species include C*orymbia gummifera, Corymbia maculata, Eucalyptus parramattensis, Banksia serrata* and *Angophora bakeri* (DEC 2005a). Flowering period is mainly summer.	No
Caladenia tessellata Tessellated Spider Orchid	V	E1	3V	*Caladenia tessellata* is found in the following Catchment Management Regions Sydney Metropolitan, Southern Rivers, Hawkesbury/Nepean, and Hunter/Central Rivers. Currently known from three disjunct areas: Braidwood on southern tablelands, Ulladulla on the south coast and three populations in Wyong area on the Central Coast (DEC 2005c). It is generally found in grassy, dry sclerophyll forests/woodland, particularly those associated with clay loam, or sandy soils. However, there is one population at Braidwood in lowland on stony soil (DEC 2005c). This species only grows in very dense shrubbery in coastal areas (Bishop 1996). Flowers appear between September and November, but generally late September or early October in extant southern populations (DEC 2005c).	No
Callistemon linearifolius	-	V	2Ri	Occurs chiefly from Georges River to the Hawkesbury River where it grows in dry sclerophyll forest (Harden 2002), open forest, scrubland (Fairley and Moore 2000) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in Spring.	No
Cryptostylis hunteriana	V	V	3V	This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop	No

Species	EPBC Act[1]	TSC Act[2]	ROTAP[3]	Habitat	Potential Habitat
Leafless Tongue Orchid				1996). This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla, E. sieberi, Corymbia gummifera* and *Allocasuarina littoralis;* appears to prefer open areas in the understorey of this community and is often found in association with the *Cryptostylis subulata* (DEC 2005d). It occurs in the following Catchment Management Regions Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers and Southern Rivers.	
Cynanchum elegans White-flowered Wax Plant	E	E1	3Ei	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean , Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005v). *Cynanchum elegans* usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest*; Leptospermum laevigatum, Banksia integrifolia* subsp. *integrifolia; Eucalyptus tereticornis* open forest and woodland; *Corymbia maculata* open forest and woodland; and *Melaleuca armillaris* scrub to open scrub (DEC 2005v). Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific (DEC 2005v).	No
Diuris lanceolata Snake Orchid	E	-	-	Grows in moist grassy areas, among shrubs in sclerophyll forest and heath; coast and tablelands (Harden 1993).	No
Epacris purpurascens var. *purpurascens*	-	V	2K	Located in the Hawkesbury/Nepean, Hunter/Central Rivers/and Sydney Metropolitan catchment authority region - from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South (DEC 2005e). *Epacris purpurascens* var. *purpurascens* grows in Dry Sclerophyll forests, scrub and swamps (Harden 1992). Specifically this species is thought to require wet heath vegetation (T. James pers. comm.). Characteristically found in a range of habitat types, most of which have a strong shale soil influence. These include ridge top drainage depressions supporting wet heath within or adjoining shale cap communities (including Shale Sandstone Transition Forest, Turpentine Ironbark Margin Forest, Stringybark/Scribbly Gum Woodland and Scribbly Gum/Grey Gum/Red Bloodwood Woodland). Also occurs in riparian zones draining into Sydney Sandstone Gully Forest, shale lenses within sandstone habitats and colluvial areas overlying or adjoining sandstone or tertiary alluvium (NPWS 2002d).	No
Eucalyptus benthamii Nepean River Gum	V	V	2Vi	Known from two main locations: Bents Basin and Kedumba Valley. A few scattered individuals are recorded from other sites on the sandy alluvial flats of the Kedumba/Cox/Nepean River system. Occurs only in wet open forest on sandy alluvial soils along valley floors at an elevation of 140-750 m. The soils are shallow to moderately deep and are well drained alluvial	No

Species	EPBC Act[1]	TSC Act[2]	ROTAP[3]	Habitat	Potential Habitat
				sands and gravels along stream channels, small terraces and alluvial flats (NPWS 2000a). Restricted but locally abundant (Harden 1991). ROTAP; 2Vi	
Grevillea parviflora ssp. *parviflora* Small-flower Grevillea	V	V	-	Located in Hawkesbury/Nepean, Hunter/Central Rivers and Sydney Metropolitan Catchment. Sporadically distributed throughout the Sydney Basin with the main occurrence centred in Picton, Appin, Wedderburn and Bargo. Northern populations are found in the Lower Hunter Valley. To the west of Sydney, small populations occur at Kemps Creek & Voyager Point (DEC 2005f). *Grevillea parviflora* ssp. *parviflora* grows on sandy clay loam soils, often with ironstone gravels. Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong Formation with alternating bands of shale and fine-grained sandstones (NPWS 2002a). Grevillea parviflora subsp. parviflora is found on crests, upper slopes or flat plains in both low-lying areas and on higher topography. The plant prefers open habitat conditions with the largest populations in open woodland and along exposed roadside areas (NPWS 2002a). *G. parviflora* subsp. *parviflora* has been recorded in a range of vegetation types from heath and shrubby woodland to open forest. Canopy species vary greatly with community type but generally are species that favour soils with a strong lateritic influence including *Eucalyptus fibrosa, E. parramattensis, Angophora bakeri* and *Eucalyptus sclerophylla* (NPWS 2002a).. Flowering has been recorded between July to December as well as April-May (NPWS 2002a).	No
Gyrostemon thesioides	-	E1	2K	Within NSW, has only ever been recorded at three sites, to the west and south of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River within Wollemi National Park. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively, despite searches. Also occurs also in Western Australia, South Australia, Victoria and Tasmania. Grows on hillsides and riverbanks and may be restricted to fine sandy soils (DEC 2005g).	No
Leucopogon exolasius Woronora Beard-heath	V	V	2V	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment (DEC 2005w), restricted to the Woronora and Grose Rivers (Harden 1991). The plant occurs in woodland on sandy alluvium and rocky sandstone hillsides near creeks, and on low nutrient soils (Powell 2007). Flowering occurs in August and September (Harden 1991). Associated species include *Eucalyptus piperita* and *E. sieberi* and the shrubs *Pultenaea flexilis*, *Leptospermum trinervium* and *Dillwynia retorta* (Powell 2007).	No
Melaleuca deanei Dean's Melaleuca	V	V	3R	Melaleuca deanei occurs in Catchment Management Regions Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan. Distinctly it occurs in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas (DEC 2005i). The species grows in wet heath on sandstone (Harden 1991) and Dry Sclerophyll Forests.	No

Species	EPBC Act[1]	TSC Act[2]	ROTAP[3]	Habitat	Potential Habitat
				Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate(DEC 2005i).	
Persicaria elatior Tall Knotweed	V	V	3V	Tall Knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace and the Grafton area (Cherry Tree and Gibberagee State Forests). The species also occurs in Queensland. This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance (DEC 2005j).	No
Persoonia bargoensis Bargo Geebung	V	E1	2V	Found in the Sydney Metropolitan and Hawkesbury/Nepean Catchment Authority Regions. Restricted to a small area south-west of Sydney on the western edge of the Woronora Plateau. Its entire range falls between Picton, Douglas Park, Yanderra, Cataract River and Thirlmere (DEC 2005k). *P. bargoensis* grows in woodland to dry sclerophyll forest on sandstone and clayey laterite on heavier, well drained, loamy, gravelly soils of the Hawkesbury Sandstone and Wianamatta Shale (NPWS 2000b). More specifically, *P. bargoensis* seems to prefer the interfaces between shale-derived soils such as the Blacktown Soil Landscape, the complex soils of the Mittagong Formation (Lucas Heights Soil Landscape), and the underlying sandstone (Hawkesbury and Gymea Soil Landscapes). Some of the vegetation in which *P. bargoensis* occurs can be recognised as the endangered Shale/Sandstone Transition Forest (NPWS 2000b). This species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC 2005k). Flowering occurs mainly in summer but can extend into autumn (NPWS 2000b).	No
Persoonia hirsuta Hairy Geebung	E	E1	3Ki	Occurs from Gosford to Royal NP and in the Putty district from Hill Top to Glen Davis where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) or rarely on shale (NSW Scientific Committee 1998). Two subspecies are recognised, *P. hirsuta* ssp. *hirsuta* (Gosford to Berowra and Manly to Royal NP) and *P. hirsuta* ssp. *evoluta* (Blue Mountains, Woronora Plateau and Southern Highlands). Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone and shale-sandstone transition areas (DEC 2005l).	No
Persoonia nutans Nodding Geebung	E	E1	2Ei	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment. Restricted to the Cumberland Plain between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith LGA, and to a lesser extent, Hawkesbury LGA. Small populations also occur in the Liverpool, Campbelltown, Bankstown and Blacktown LGAs (DEC 2005m). Confined to aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland (DEC 2005m). *P. nutans* also occurs on Shale/Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (Conservation 2005).	No

Species	EPBC Act[1]	TSC Act[2]	ROTAP[3]	Habitat	Potential Habitat
				In Castlereagh Scribbly Gum Woodlands it is found in open woodland with dominant overstorey species being *Angophora bakeri, Eucalyptus sclerophylla* and *Melaleuca decora*. The Agnes Banks Woodlands have a similar array of tree species, with the addition of *Banksia serrata* and *Banksia aemula* (Conservation 2005). *Persoonia nutans* is found on the Agnes Banks and Berkshire Park soil landscapes. Drainage appears to influence the distribution of P. nutans as the species is more common on the deeper sands at Agnes Banks. At other locations on the Cumberland Plain it occurs on low rises as opposed to swales or other low lying areas (Conservation 2005).	
Pomaderris brunnea Rufous Pomaderris	V	V	2V	*Pomaderris brunnea* is found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. Occurs in the Central West, Hawkesbury/Nepean, Hunter/Central Rivers Catchments. Occurs on clay & alluvial soils (Fairley and Moore 1995), in moist woodland or forest of flood plains and creek lines (DEC 2005n). In the Hawkesbury/Nepean region, the species is known to be associated with Dry sclerophyll forests (Cumberland, Upper Riverina, Sydney Coastal, Sydney Hinterland, Sydney Sand Flats), Coastal Floodplain Wetlands and Coastal Valley Grassy Woodlands (DEC 2005n). Flowers appear in September and October.	No
Pterostylis saxicola Sydney Plains Greenhood	E	E1	2E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south (Hawkesbury/Nepean and Sydney Metropolitan Catchment) (DEC 2005x). Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The plant communities above the shelves where Pterostylis saxicola occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils (DEC 2005x). All species of Pterostylis are deciduous and die back to fleshy, rounded underground tuberoids. The time of emergence and withering has not been recorded for this species, however flowering occurs from October to December and may vary due to climatic conditions. The above ground parts of the plant whither and die following seed dispersal and the plant persists as a tuberoid until the next year (DEC 2005x).	No
Pultenaea aristata Prickly Bush-pea	V	V	2V	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Keira above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring (DEC 2005p).	No
Pultenaea pedunculata Matted Bush-pea	-	E1	-	Restricted to the Cumberland Plain and near Merimbula where it grows in dry sclerophyll forest and disturbed sites (Harden 2002). In western Sydney it occurs in three locations: within industrial and residential areas at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel No. 2(NPWS 2002c). Associated with Hawkesbury/Nepean, Southern Rivers and Sydney Metropolitan Catchment areas.	No

Species	EPBC Act[1]	TSC Act[2]	ROTAP[3]	Habitat	Potential Habitat
				It occurs in clay or sandy clay soils (Blacktown soil landscape) on Wianamatta shale, close to localised patches of Tertiary alluvium (Liverpool) or the shale/sandstone influence (west of Appin) (DEC 2005q). At all sites there is a lateritic influence in the soil with characteristic ironstone gravels present (DEC 2005q). This species is known to occur in remnants of Cooks River Clay Plain Scrub Forest (James *et al.* 1999).	
Syzygium paniculatum Magenta Lilly Pilly	V	V	3Ri	Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea (Harden 1991). Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DEC 2005t). The species occurs in the following Catchment Authority Regions - Hunter/Central Rivers, Hawkesbury/Nepean, Sydney Metropolitan, and Southern Rivers.	No
Thelymitra sp. Kangaloon	CE	-	-	*Thelymitra* sp. Kangaloon is a terrestrial orchid endemic to New South Wales, and is known from three locations near Robertson in the Southern Highlands. The swamp habitat in which the species occurs has an extent of occurrence of 300 km2 and an area of occupancy of 10 km^2. The three swamps are Butlers Swamp, Stockyard Swamp and Wildes Meadow Swamp, and are all located above what is known as the Kangaloon aquifer. It flowers in late October and early November. The species grows amongst tall sedges and rushes in seasonally swampy sedgeland on grey silty clay loam at 600-700 m above sea level (Threatened Species Listing Advice 2008).	No
Thesium australe Austral Toad-flax	V	V	3Vi	Found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. *Thesium australe* is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005u). It is often found in damp sites in association with *Themeda australe*, but also found on other grass species at inland sites (G. Leonard pers. obs.). Occurs on clay soils in grassy woodlands or coastal headlands (James *et al.* 1999).	No

4.3 Fauna Habitats

Woodland

Woodland occurred in the vicinity of the Goaf Gas Extraction Plant Option 2 location to the east of the Hume Highway. Regenerating *Eucalyptus tereticornis*, dominates the upper canopy in this area and supply direct (foliage, nectar, exudates) and indirect food (arthropods) for a range of vertebrates. Two large *E. tereticornis* which are likely to contain hollows were observed in this area adjacent to a fence line. These potentially provide nesting and roosting habitat for a range of common birds, microbats and arboreal mammals. The understorey and shrub vegetation are relatively open and dominated by grasses with a poor layer of leaf litter and fallen branches.

The Woodland habitat is considered to be in poor - moderate condition within the study area. Threatened fauna that may utilise these habitats include nomadic nectivorous species such as the Grey-headed Flying-fox *Pteropus poliocephalus* Swift Parrot *Lathamus discolor* and Regent Honeyeater *Xanthomyza Phrygia* and highly mobile species that may forage in the vicinity of the area such as threatened microbats and birds of prey.

Cleared Areas

The majority of the study area has been previously cleared for grazing, and dominated by exotic pasture grasses. Generally these areas would provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals and natives tolerant of disturbance or favouring edge/ecotone habitat. A few scattered trees were present in the vicinity of the study area providing foraging resources for common native birds.

Cleared areas are considered to be in Poor condition, with the ground flora containing a low number of indigenous species and little woodland structure and few resources available for native fauna.

Waterbodies (Dams)

A number of farm dams were observed in the vicinity of the proposed surface pipeline reticulation system, none of which will be directly impacted, however; the dams near the western sections of the surface pipeline reticulation system are downslope of the proposed pipeline. These dams lack dense vegetation on the banks, nevertheless they may provide habitat for common native amphibians, waterfowl and insects.

4.4 Fauna

4.4.1 Significant Fauna

A total of 50 threatened and/or migratory animal species or their habitat have been previously recorded within the locality (DECC Atlas of NSW Wildlife (Figure 5) and DEWHA EPBC Online Database (Table 2).

No threatened fauna were recorded during the current survey. However, the Study Area contains potential habitat for 14 threatened or migratory species listed on the TSC or EPBC Acts.

Table 2: Terrestrial fauna listed on the TSC Act or EPBC Act that may occur in the locality

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Amphibians					
Litoria aurea	Green and Golden Bell Frog	V	E1	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC (NSW Government 2008). The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spikerushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999c; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 6 weeks to develop, feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DECC 2005a).	No
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.	No
Litoria raniformis	Southern Bell Frog	V	E1	In NSW the species is known to exist only in isolated populations in the Coleambally Irrigation Area, the Lowbidgee floodplain and around Lake Victoria. Usually found in or around permanent or ephemeral swamps or billabongs with an abundance of bulrushes and other emergent vegetation along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat. Outside the breeding season animals disperse away from the water and take shelter beneath ground debris such as fallen timber and bark, rocks, grass clumps and in deep soil cracks (Robinson 1993; DEC 2005s).	No, unlikely to occur this far north.
Heleioporus australiacus	Giant Burrowing Frog	V	V	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996; Recsei 1996). Can also occur within shale outcrops within sandstone formations. In the southern part of its range can occur in wet and dry forests, montane sclerophyll woodland and montane riparian woodland (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995).	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Mixophyes balbus	Stuttering Frog	V	E1	This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker *et al.* 1995). It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker *et al.* 1995).	No
Pseudophryne australis	Red-crowned Toadlet	-	V	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks that feed into larger semi-perennial streams. After rain these creeks are characterised by a series of shallow pools lined by dense grasses, ferns and low shrubs (Thumm and Mahony 1997).	No
Birds					
Haliaeetus leucogaster	White-bellied Sea-eagle	M	-	A migratory species that is generally sedentary in Australia, although immatures and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees (Marchant and Higgins 1993).	Yes
Apus pacificus	Fork-tailed Swift	M	-	Almost exclusively aerial (foraging and roosting). Breed in Asia (Higgins 1999).	No, overfly only
Hirundapus caudacutus	White-throated Needletail	M	-	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breed in Asia (Pizzey and Knight 1997).	No, overfly only
Ardea alba	Great Egret	M	-	Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	No
Ardea ibis	Cattle Egret	M	-	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).	Yes
Burhinus grallarius	Bush Stone-curlew	-	E1	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993).	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Callocephalon fimbriatum	Gang-gang Cockatoo	-	V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	No
Calyptorhynchus lathami	Glossy Black-cockatoo	-	V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999b). Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	No, no preferred foraging trees were observed in the study area.
Ephippiorhynchus asiaticus	Black-necked Stork	-	E1	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997).	No
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	-	V	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	No
Monarcha melanopsis	Black-faced Monarch	M	-	A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).	No
Myiagra cyanoleuca	Satin Flycatcher	M	-	Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).	No
Rhipidura rufifrons	Rufous Fantail	M	-	Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Anthochaera phrygia	Regent Honeyeater	E	E1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999d; Pizzey and Knight 1997). Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises : *E. microcarpa, E. punctata, E. polyanthemos, E. moluccana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata, E. mckieana, E. macrorhyncha, E. laevopinea* and *Angophora floribunda.* Nectar and fruit from the mistletoes A. miquelii, A. pendula, A. cambagei are also eaten during the breeding season (DECC 2005b). Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DECC 2005b).	Yes
Grantiella picta	Painted Honeyeater	-	V	Found mainly in dry open woodlands and forests, where it is strongly associated with mistletoe (Higgins *et al.* 2001). Often found on plains with scattered eucalypts and remnant trees on farmlands.	No
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	-	V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarely recorded east of the Great Dividing Range (Higgins *et al.* 2001).	Yes
Merops ornatus	Rainbow Bee-eater	M	-	Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999).	Yes
Pyrrholaemus sagittatus	Speckled Warbler	-	V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984; NSW Scientific Committee 2008a). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984; NSW Scientific Committee 2008a). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2008a).	No
Stagonopleura guttata	Diamond Firetail	-	V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins *et al.* 2006).	No
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	-	V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Lathamus discolor	Swift Parrot	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	Yes
Neophema pulchella	Turquoise Parrot	-	V	Occurs in open woodlands and eucalypt forests with a ground cover of grasses and understorey of low shrubs (Morris 1980). Generally found in the foothills of the Great Divide, including steep rocky ridges and gullies (Higgins 1999). Nest in hollow-bearing trees, either dead or alive; also in hollows in tree stumps. Prefer to breed in open grassy forests and woodlands, and gullies that are moist (Higgins 1999).	Yes
Rostratula australis	Australian Painted Snipe	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	No
Gallinago hardwickii	Latham's Snipe	M	-	Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	No
Ninox connivens	Barking Owl	-	V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997). Territories range from 30 to 200 ha (DEC 2005b).	Yes
Ninox strenua	Powerful Owl	-	V	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). Has a large home range of between 450 and 1450 hectares (DEC 2005o).	Yes
Invertebrates					
Meridolum corneovirens	Cumberland Plain Land Snail	-	E1	Most likely restricted to Cumberland Plain, Castlereagh Woodlands and boundaries between River-flat Forest and Cumberland Plain Woodland. It is normally found beneath logs, debris and amongst accumulated leaf and bark particularly at the base of trees. May also use soil cracks for refuge (NPWS 1999a).	No, ground cover contains insufficient leaf litter
Mammals					

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Cercartetus nanus	Eastern Pygmy-possum	-	V	Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5 month period (Ward 1990).	No
Dasyurus maculatus maculatus	Spotted-tailed Quoll (southeastern mainland)	E	V	Occurs along the east coast of Australia and the Great Dividing Range (Belcher *et al.* 2008). Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999k). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995). 70% of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999e). The home range of a female is between 180 – 1000 ha, while males have larger home ranges of between 2000 – 5000 ha. Breeding occurs from May to August (Belcher *et al.* 2008).	No
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2-30 ha (Eldridge and Close 1995).	No
Mormopterus norfolkensis	Eastern Freetail Bat	-	V	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoye *et al.* 2008).	Yes
Isoodon obesulus obesulus	Southern Brown Bandicoot	E	E1	Prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burn from time to time (Braithwaite 1995). A mosaic of post fire vegetation is important for this species (Maxwell *et al.* 1996).	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Petaurus australis	Yellow-bellied Glider	-	E2	Restricted to tall native forests in regions of high rainfall along the coast of NSW. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows. Critical elements of habitat include sap-site trees, winter flowering eucalypts, mature trees suitable for den sites and a mosaic of different forest types (NPWS 1999f). Live in family groups of 2-6 individuals which commonly share a number of tree hollows. Family groups are territorial with exclusive home ranges of 30-60 ha. Very large expanses of forest (>15,000ha) are required to conserve viable populations (Goldingay 2008)	No
Petaurus norfolcensis	Squirrel Glider	-	V	Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran (DEC 1999) in the northern part of the state and as far west as Tocumwal along the southern border of the state (NSW Government 2008). Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Require abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Van der Ree and Suckling 2008). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988). They live in family groups of 2-10 individuals and maintain home ranges of 0.65 and 10.5 hectares, varying according to habitat quality and food resource availability (Quin 1995; Goldingay and Jackson 2004).	No
Phascolarctos cinereus	Koala	-	V	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005h). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin *et al.* 2008). Primary feed trees include *Eucalyptus robusta, E. tereticornis, E. punctata, E. haemastoma* and *E. signata* (Department of Planning 1995). They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100ha (Martin *et al.* 2008).	No
Potorous tridactylus	Long-nosed Potoroo	V	V	Occurs from Queensland to Victoria, normally within 50km of the coast (Claridge *et al.* 2007). Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue. It is solitary and sedentary, buts tends to aggregate in small groups. It has two breeding seasons, one in late winter-early spring and the other in late summer. (Johnston 2008). This species appears to benefit from a lack of recent disturbance (Claridge *et al.* 2007).	No

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	Yes
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley. Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands. Roosts include rock overhangs, caves, Fairy Martin nests and mines, in colonies of between three and 40. Forages on small, flying insects below the forest canopy. Likely that it hibernates during the cooler months. Females give birth in November, and young are independent by late February (Churchill 2008; Hoye and Schulz 2008).	No, no roosting habitat present
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	V	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet high-altitude forests. Apparently hibernates in winter. Roosts in tree hollows and sometimes in buildings and caves, in colonies of between 3 and 80. Often change roosts every night. Forages for beetles, bugs and moths below or near the canopy in forests with an open structure, or along trails. Has a large foraging range, up to 136 ha (Churchill 2008; Law *et al.* 2008). Records show movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).	Yes
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	-	V	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometers to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008).	No, no roosting habitat present
Myotis macropus (adversus)	Large-footed Myotis	-	V	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects ((Richards *et al.* 2008)).	Yes

Scientific Name	Common Name	EPBC Act	TSC Act (NSW)	Habitat	Potential habitat
Scoteanax rueppellii	Greater Broad-nosed Bat	-	V	Occurs along the Great Dividing Range, up to 1200m, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches (Churchill 2008; Richards *et al.* 2008).	Yes
Reptiles					
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998).	No
Varanus rosenbergi	Rosenberg's Goanna	-	V	This species is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington and Wells 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger 1992).	No

Key: 1) Listed on the TSC Act as Endangered (E), Vulnerable (V); 2) Listed on the EPBC Act as Endangered (E) or Vulnerable (V) or covered under migratory provisions (M) on the EPBC Act

Table 3: Species that are proposed to be listed on the TSC Act as vulnerable which may occur in the locality

Scientific Name	Common Name	Habitat	Potential habitat
Glossopsitta pusilla	Little Lorikeet	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008b).	Yes
Daphoenositta chrysoptera	Varied Sitella	Inhabit a wide variety of dry Eucalypt forests and woodlands, usually with either shrubby understorey or grassy ground cover or both, in all climatic zones of Australia (Higgins and Peter 2002). Usually inhabit areas with rough-barked trees, such as stringybarks or ironbarks, but also in paperbarks or mature Eucalypts with hollows.	No
Petroica boodang	Scarlet Robin	In NSW this species inhabits open forests and woodlands from the coast to the inland slopes(Higgins and Peter 2002). Breeding occurs in ridges or slopes of drier eucalypt forests and woodlands with an open grassy or shrubby understorey (NSW Scientific	No

Scientific Name	Common Name	Habitat	Potential habitat
		Committee 2009b).	
Hieraaetus morphnoides	Little Eagle	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees [Marchant, 1993 #165].	Yes
Petroica phoenicia	Flame Robin	In NSW this species breeds in upland moist forests and woodlands often on ridges or slopes with an open understorey. In winter migrates to lowland habitats of the inland slopes and plains. (NSW Scientific Committee 2009a)	No

5.0 IMPACT ASSESSMENT

5.1 Predicted Impacts

Generally the impacts of the proposal would result in disturbance to a highly modified landscape, which provides limited habitat potential for native flora and fauna. Cleared, pasture improved paddocks with scattered trees are the dominant habitat type that will be impacted by the proposal. Scattered trees in the landscape will be avoided by the proposed works.

The exception to this is the proposed location of Goaf Gas Extraction Plant Option 2, which would have the greatest impact of the overall proposal. The potential installation of an extraction plant and the drilling of the MRD borehole from this location would require the clearing of approximately 0.16 ha of Cumberland Plain Woodland in Poor condition. In terms of impacts to flora and fauna, Goaf Gas Extraction Plant Option 1 would be the preferred option, as this Plant is located within a cleared paddock area dominated by exotic pasture grasses and *Rubus fruticosus*, and would not require clearing of any areas of native vegetation.

The disturbance footprint of each borehole drilling site comprises a 30 m x 40 m compound. Further, disturbance for the surface pipeline reticulation system will require disturbance to 650 mm width due to the pipeline easements. Given that the boreholes and pipelines are located within cleared paddocks, there are not likely to be any indirect impacts on any flora or fauna habitats.

Impacts associated with the proposal include:

- Disturbance to 0.16 ha of Cumberland Plain Woodland at the Goaf Gas Extraction Plant Option 2 location.
- Disturbance to 1.2 ha of cleared paddocks, identified as an unnatural landscape, at the Goaf Gas Extraction Plant Option 1 location and all boreholes and pipelines.

Indirect impacts are likely to be minor, as the patch impacted is small and isolated and already completely impacted by edge affects. The potential indirect impacts associated with the proposal include (in the absence of adequate amelioration measures):

- the potential for erosion during and after construction at all sites; and,
- increased human activity.

5.2 Proposed Amelioration Measures

The following measures have been recommended in order to ameliorate the impacts of the proposal:

- adjustment of the location of sections of the surface pipeline reticulation system to avoid native trees and significant habitat features such as trees with hollows, where required;
- trees with hollows should be retained and protected, with no drilling within the critical root zone (extending to 2 m beyond the drip line) of the trees;
- where possible, proposed boreholes, pipelines and access tracks have been located within existing cleared areas;
- sediment and erosion control measures should be implemented on all sites to prevent erosion during and after construction;
- any chemicals used on site will be taken off site after use and disposed of appropriately;
- machinery and vehicles should be washed down prior to use on site to avoid the transmission of weed seed or disease into intact areas of native vegetation;
- the location of Goaf Gas Extraction Plant Option 1 is the preferred option, as this location supports cleared paddocks and would not result in impacts to flora and fauna habitats. The development of Goaf Gas Extraction Plant Option 2 and the drilling of the MRD borehole from this location would result in the removal of approximately 0.16 ha of Cumberland Plain Woodland, an EEC on the EPBC and TSC Acts, and habitat for a number of threatened animal species.
- a suitably qualified ecologist should be on site during the construction of Goaf Gas Extraction Plant Option 2 if this option is utilised, to minimised impacts to significant habitat features;
- The site of Option 2 (if this option is utilised) should be rehabilitated with local native species characteristic of Cumberland Plain Woodland after the cessation of goaf gas drainage to replace any cleared vegetation.

5.3 Part 3A Guidelines for Threatened Species Assessment (EP&A Act)

The impacts of the proposal on threatened biota listed under the TSC Act have been undertaken following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DEC & DPI 2005). Where threatened biota **is recorded** within a Study Area, an impact assessment is required under the EP&A Act. When threatened biota **is not recorded** during a survey, the presence of potential habitat for this species is used to determine the need to undertake an impact assessment under the EP&A Act. Where there is no potential habitat in the Study Area for threatened biota, there is unlikely to be any impact on these species and therefore they are not required to be considered further.

The impact assessments included in Appendix 4 incorporate a consideration of the predicted impacts and amelioration measures as outlined in Sections 5.1 and 5.2 respectively.

5.3.1 Endangered Ecological Communities

The Study Area supports one Endangered Ecological Community listed under the TSC Act, Cumberland Plain Woodland. Impacts to this plant community would occur if Goaf Gas Extraction Plant Option 2 and the drilling of the MRD borehole from this location were undertaken and would involve clearing of a small, isolated regrowth patch in poor condition. Approximately 0.16 ha of Cumberland Plain Woodland would need to be cleared for the construction of Goaf Gas Extraction Plant Option 2 and the drilling of the MRD borehole, if this option is utilised.

An assessment of impact under Part 3A of the EP&A Act has been undertaken for Cumberland Plain Woodland (Appendix 4).

5.3.2 Flora

No threatened flora were recorded in the study area. Further, the habitats in the study area are not considered to provide potential habitat for any threatened plant species listed on the TSC Act. Therefore, impact assessments under Part 3A of the EP&A Act are not considered necessary for threatened plant species.

5.3.3 Fauna

No threatened fauna were recorded during the current survey. However, there is potential habitat (mostly opportunistic foraging resources) for 11 species listed under the TSC Act and two species that are preliminary determinations to be listed under Schedule 2 of the TSC Act. Where there is potential habitat (foraging or breeding resources) for a threatened species in the Study Area, further consideration must be given to the potential impact of the proposal on these species.

The proposal may significantly impact threatened species by causing any of the following situations to arise:

- death or injury of individuals;
- loss or disturbance of limiting foraging resources; and
- loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However for some species, limiting resources include specialised foraging habitats that have a restricted distribution.

Impact assessments have been carried out for 13 species in Appendix 4. The impacts described are specific to the proposed location of Goaf Gas Extraction Plant Option 2, which would involve clearing of a small area of Cumberland Plain Woodland, which may provide some opportunistic forging habitat for threatened species. Given the highly disturbed nature of the study area, it is not considered to contain potential habitat for the remaining species, therefore, impact assessments have not been carried out for these species. No threatened animal species have potential habitat within the remainder of the study area and as such, if the Goaf Gas Extraction Plant Option 1 is developed then the impacts are likely to be less than stated.

5.3.4 Conclusions of the Impact Assessments

The impact assessments (Appendix 4) concluded that the proposal is likely to have a minor impact on threatened biota, as listed on the TSC Act, provided recommended ameliorative measures are adhered to.

5.3.5 Key Thresholds

The Part 3A Guidelines of the EP&A Act (DEC & DPI 2005) set out a number of key thresholds which need to be addressed to justify the impacts of the proposal on threatened species, populations or ecological communities. The key thresholds are (DEC & DPI 2005):

- whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values;

- whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;

- whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and,

- whether or not the proposal will adversely affect critical habitat.

Based on the impact assessments following the Part 3A Guidelines of the EP&A Act for Threatened Species Assessment (Appendix 4), the proposal is unlikely to reduce the long-term viability of, accelerate the extinction of and/or adversely affect critical habitat for threatened species and/or populations within the Study Area (Table 4).

Maintenance of Biodiversity Values

Given that a total of 0.16 ha of highly degraded regrowth native vegetation, that provides limited potential habitat for a number of threatened species, may be impacted by the proposal, some biodiversity values of the locality will be lost. The loss of biodiversity values can be minimised by incorporating the proposed amelioration measures detailed in Section 5.2, particularly measures to avoid and protect significant habitat features and to include suitable rehabilitation for any impacts to Cumberland Plain Woodland and fauna habitat after the removal of the Project infrastructure. Provided that the amelioration measures detailed in Section 5.2 are implemented, the proposal is likely to maintain the biodiversity values of the locality.

Table 4: Assessment of Key Thresholds

Threatened Biota	Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values.	Will the proposal reduce the long-term viability of a local population of the species, population or EEC?	Will the proposal accelerate the extinction of the species, population or EEC or place it at risk of extinction?	Will the proposal adversely affect critical habitat?
Endangered Ecological Communities				
Cumberland Plain Woodland	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Threatened Fauna				
Grey-headed Flying Fox	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Microchiropteran Bats (Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat, Large-footed Myotis)	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Regent Honeyeater and Swift Parrot	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Black-chinned honeyeater, Turquoise Parrot, Little Lorikeet, Little Eagle	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Forest Owls (Powerful Owl and Barking Owl)	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Migratory bird species (White-bellied Sea-eagle, Cattle Egret and Rainbow Bee-eater.	Likely to maintain biodiversity values	Unlikely	Unlikely	No

5.4 Commonwealth Significance Impact Criteria (EPBC Act)

Under the Commonwealth EPBC Act, if the proposal has the potential to have an adverse impact on threatened biota listed on the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration. The Significant Impact Criteria (DEH 2006) are used to assess the likelihood of impact.

The address of Significant Impact Criteria included in Appendix 5 incorporates a consideration of the predicted impacts and amelioration measures as outlined in Sections 5.1 and 5.2 respectively.

5.4.1 Endangered Ecological Communities

The Study Area supports one Endangered Ecological Community listed under the EPBC Act, Cumberland Plain Woodland. Impacts to this plant community would occur if Goaf Gas Extraction Plant Option 2 were to be developed and this would involve clearing of a small, isolated regrowth patch in poor condition. Approximately 0.16 ha of Cumberland Plain Woodland would need to be cleared for the construction of Goaf Gas Extraction Plant Option 2.

An assessment of impact under the EPBC Act has been undertaken for Cumberland Plain Woodland (Appendix 5).

5.4.2 Flora

No threatened plant species, or their habitat, are considered to occur within the Study Area. Therefore, impact assessments under the EPBC Act are not required for any threatened plant species.

5.4.3 Fauna

The Study Area contains potential habitat for three threatened species and three migratory species listed on the EPBC Act.

Assessments of the Significance Impact Criteria have been prepared for these species in Appendix 5 and have concluded that the proposal is unlikely to have a significant impact on any matter of National environmental significance. Thus a referral under the EPBC Act is not recommended. Potential habitat for the remaining species does not occur within the Study Area therefore Assessments of Significance are not required for these species.

5.4.4 Conclusions of the Significant Impact Criteria Assessments

The proposal may result in impact to approximately 0.16 ha of Cumberland Plain Woodland and habitat for threatened fauna. This represents approximately 0.01% of the local distribution of this plant community.

The Significant Impact Criteria Assessments under the EPBC Act (Appendix 5) found that the proposal is not likely to have a significant impact on threatened species, endangered ecological communities or their habitats, as listed on the EPBC Act, provided recommended ameliorative measures are adhered to.

6.0 CONCLUSION

The proposal may involve clearing or modifying approximately 0.16 ha of poor condition Cumberland Plain Woodland and 1.2 ha of Cleared Paddocks. Cumberland Plain Woodland is an EEC, listed on the TSC Act and EPBC Act. No threatened plant species or their potential habitats were recorded within the Study Area.

The proposal may remove or modify a small area of potential foraging habitat for 14 threatened or migratory species listed on the TSC Act and/or the EPBC Act, and two species preliminary listed under Schedule 2 of the TSC Act.

Impact Assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act (DEC & DPI 2005) and Significant Impact Guidelines under the EPBC Act (DEH 2006) were carried out for threatened biota occurring or with potential habitat in the Study Area. It was found the impacts of the proposal are likely to be minor.

A number of amelioration measures are recommended in Section 5.2 to reduce the potential impacts of the proposal on flora and fauna of the locality.

PLATES

Plate 1: Cleared paddocks

Plate 2: Regrowth *Acacia parramattensis* within cleared paddock

Plate 3: Regrowth Cumberland Plain Woodland in Poor Condition

Plate 4: Large remnant *Eucalyptus tereticornis* with hollows within Cumberland Plain Woodland

FIGURES

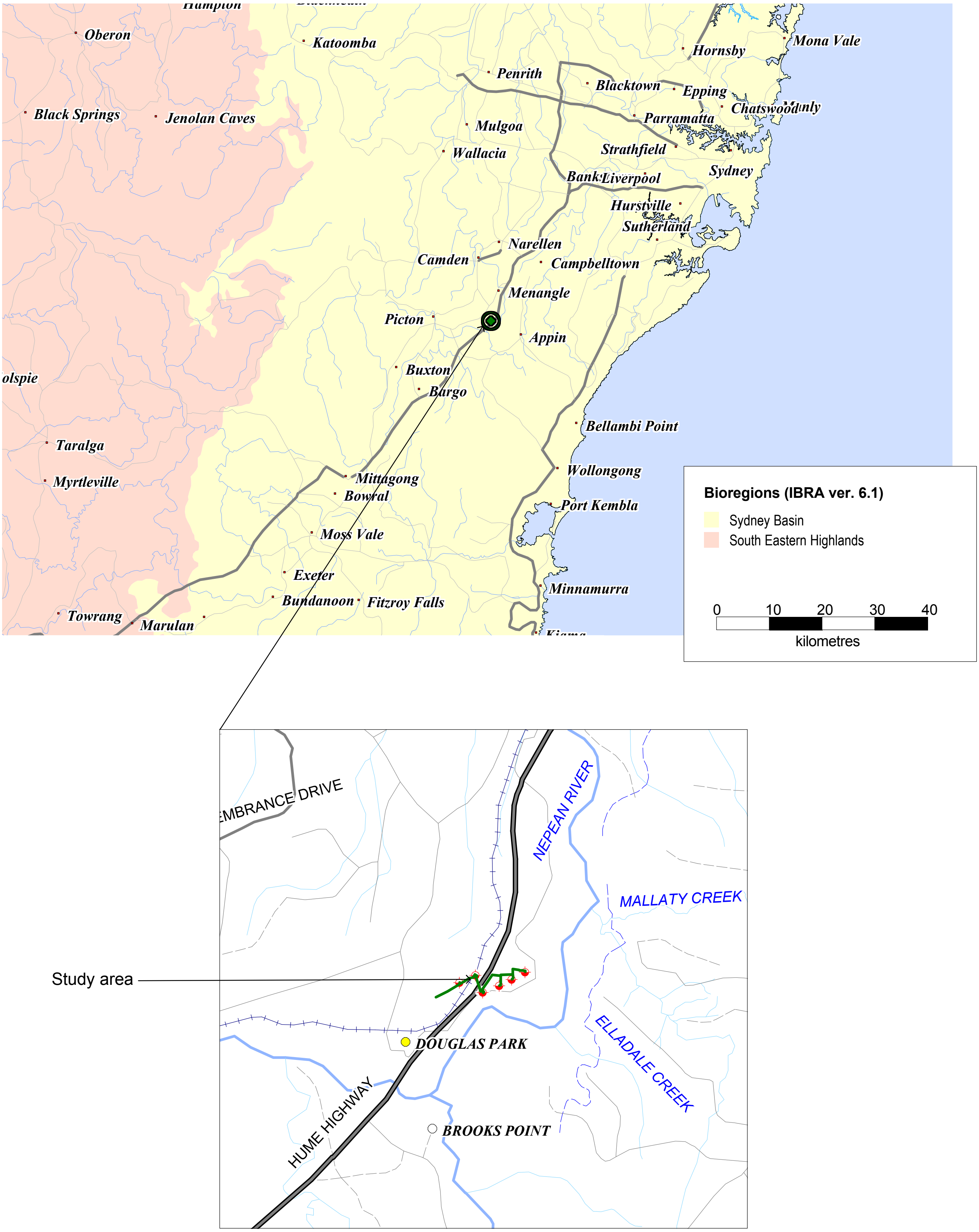

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Figure 1: Location of the Study Area in a regional context.

Date: 08 May 2009

Checked by: RBR | File number: S5310

Location: 5000\5300s\5310\Mapping\S5310 F1 Locality.WOR

Scale: 0 1 2 3 4 kilometres

N W E S

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NEW SOUTH WALES 2500

Figure 2: The Proposal

Figure 2: The Proposal

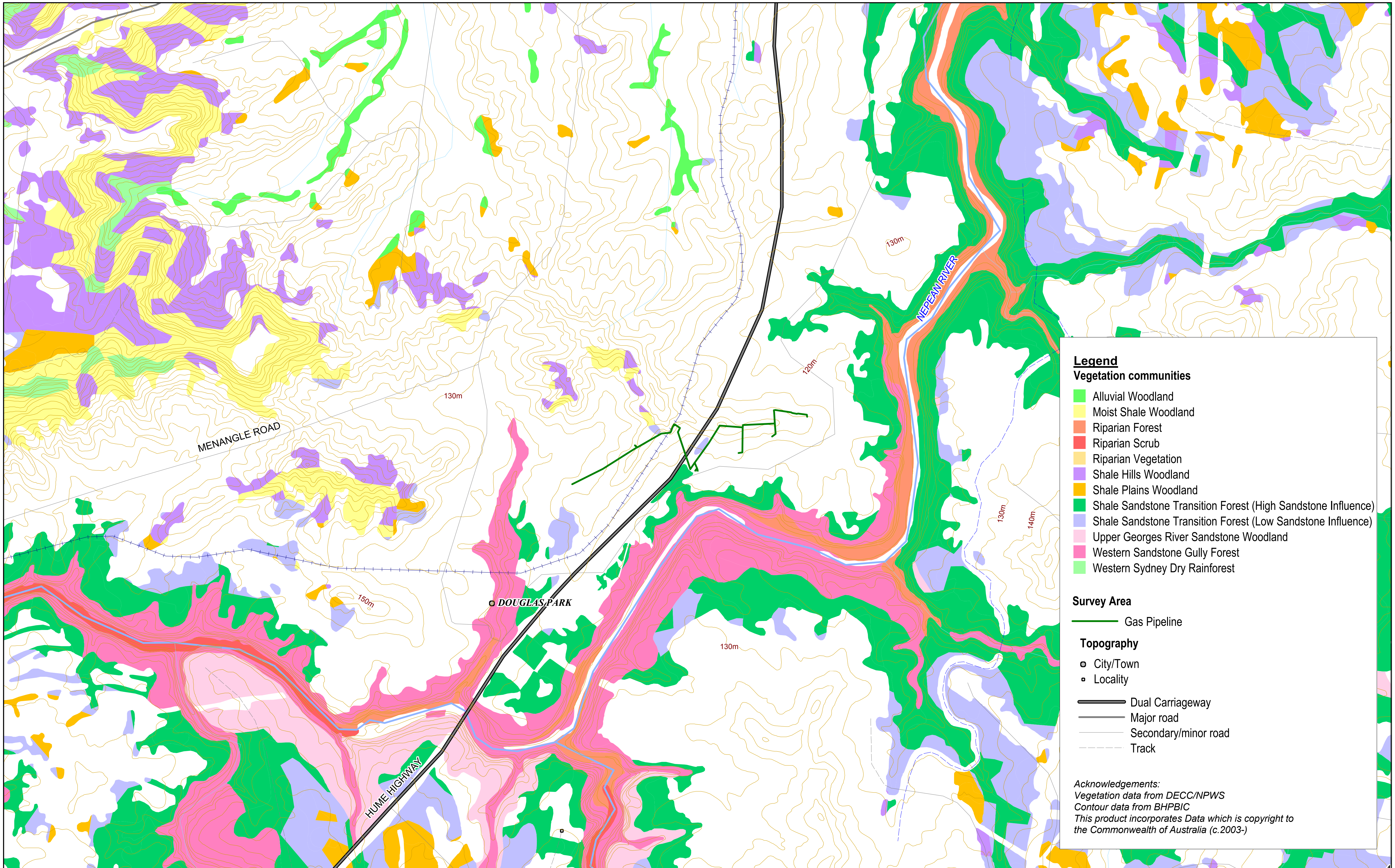
Date: 15 May 2009

Checked by: SEW | File number: S5309

Location:-..5000\5300s\5309\Mapping\S5309 F2 Proposal.WOR

Scale: 0 50 100 150 200 250 Metres

N W E S



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BIOSIS RESEARCH

Figure 3: Plant communities within the vicinity of the study area

Figure 3: Plant communities within the vicinity of the study area

Date: 08 May 2009

Checked by: SEW | File number: S5309

Location: P:\5000\5300s\5309\Mapping\S5309 F3 Veg.WOR

Scale: 0 .25 .50 .75 1 1.25 kilometres

N W E S

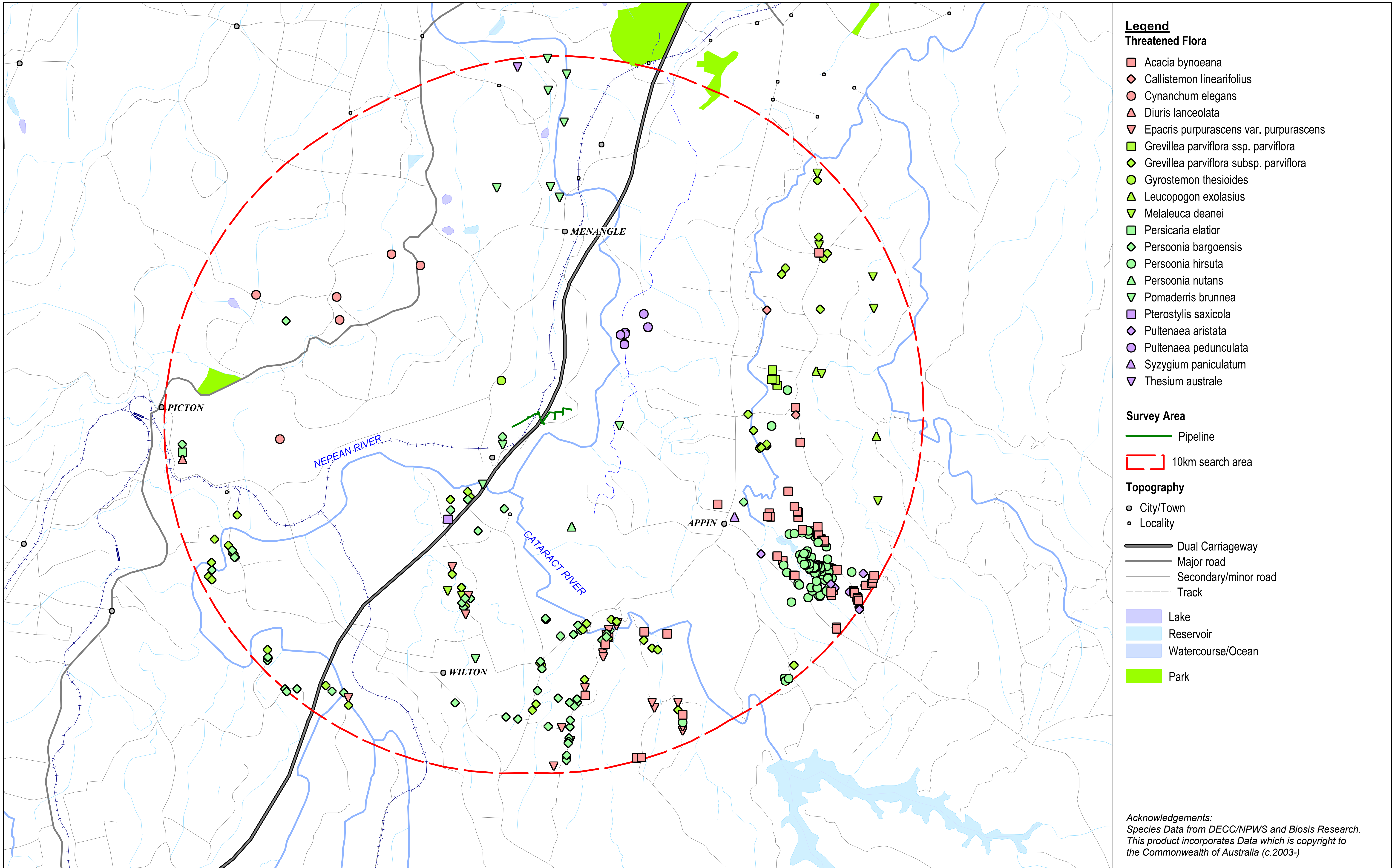

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Figure 4 : Threatened flora, listed on the TSC and EPBC Act, within 10km of the Study Area

Date: 08 May 2009

Checked by: SEW

File number: S5309

Location: P:\5000\5300s\5309\Mapping\S5309 F4 Flora.WOR

Figure 4 : Threatened flora, listed on the TSC and EPBC Act, within 10km of the Study Area

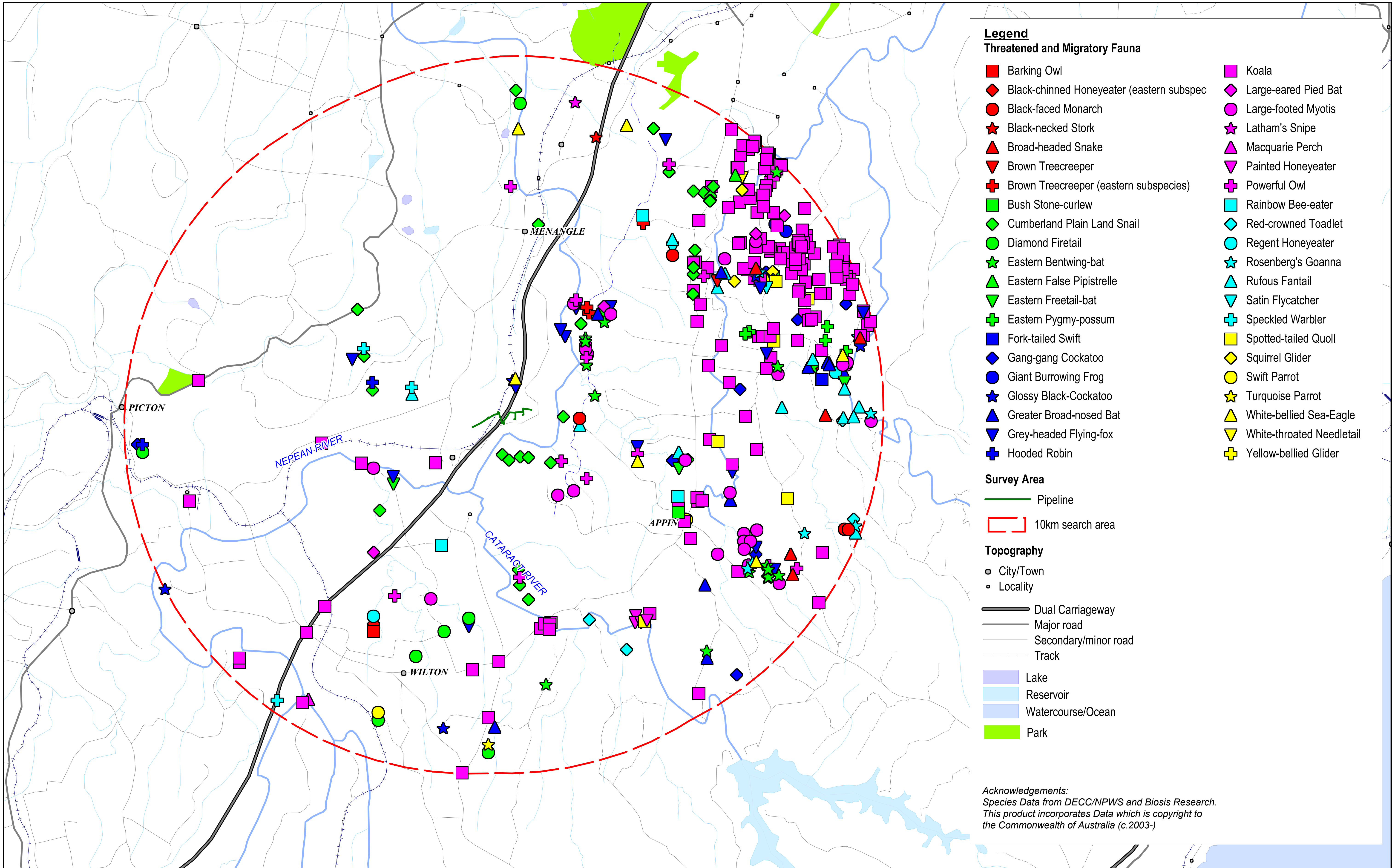

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Figure 5: Threatened fauna within 10km of the study Area

Figure 5: Threatened fauna within 10km of the study Area

Date: 08 May 2009

Checked by: SEW | File number: S5309

Location: P:\5000\5300s\5309\Mapping\S5309 F5 Threatened Fauna.WOR

Scale: 0 1 2 3 4 5 kilometres

N W E S

APPENDICES

APPENDIX 1

Flora Results

Plant species recorded in the study area

Family		Scientific Name	Common Name
Monocotyledons			
Cyperaceae			
	*	*Cyperus spp.*	
Poaceae			
		Aristida ramosa var. ramosa	
		Austrodanthonia spp.	
		Bothriochloa spp.	
	*	*Chloris gayana*	Rhodes Grass
	*	*Cynodon dactylon*	Common Couch
		Eragrostis leptostachya	Paddock Lovegrass
		Microlaena stipoides var. stipoides	Weeping Grass
	*	*Paspalum dilatatum*	Paspalum
	*	*Pennisetum clandestinum*	Kikuyu Grass
	*	*Phalaris spp.*	
	*	*Setaria gracilis*	Slender Pigeon Grass
	*	*Sporobolus indicus var. capensis*	Parramatta Grass
		Themeda australis	Kangaroo Grass
Dicotyledons			
Apiaceae			
	*	*Foeniculum vulgare*	Fennel
Asclepiadaceae			
	*	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush
Asteraceae			
		Calotis cuneifolia	Purple Burr-Daisy
	*	*Cirsium vulgare*	Spear Thistle
	*	*Conyza spp.*	
	*	*Hypochaeris radicata*	Catsear
	*	*Senecio madagascariensis*	Fireweed
	*	*Sonchus oleraceus*	Common Sowthistle
Brassicaceae			
	*	*Brassica spp.*	
Cactaceae			
	*	*Opuntia spp.*	
Campanulaceae			
		Wahlenbergia gracilis	Sprawling or Australian Bluebell
		Wahlenbergia stricta ssp. stricta	
Casuarinaceae			
		Allocasuarina littoralis	Black Sheoak
Convolvulaceae			
		Dichondra repens	Kidney Weed
Euphorbiaceae			
	*	*Ricinus communis*	Castor Oil Plant
Fabaceae (Mimosoideae)			
		Acacia parramattensis	Parramatta Wattle
		Acacia saligna	Golden Wreath Wattle
Fabaceae (Faboideae)			
	*	*Trifolium repens*	White Clover

Family		Scientific Name	Common Name
Malvaceae			
	*	*Modiola caroliniana*	Red-flowered Mallow
	*	*Sida rhombifolia*	Paddy's Lucerne
Myrtaceae			
		Eucalyptus moluccana	Grey Box
		Eucalyptus spp.	
		Eucalyptus tereticornis	Forest Red Gum
		Lophostemon confertus	Brush Box
Oleaceae			
	*	*Ligustrum lucidum*	Large-leaved Privet
	*	*Olea europaea ssp. africana*	
Phytolaccaceae			
	*	*Phytolacca octandra*	Inkweed
Pittosporaceae			
		Bursaria spinosa ssp. spinosa	Sweet Bursaria
Plantaginaceae			
	*	*Plantago lanceolata*	Lamb's Tongues
Rosaceae			
	*	*Rubus fruticosus*	Blackberry complex
Verbenaceae			
	*	*Verbena bonariensis*	Purpletop

Note - * signifies exotic species

APPENDIX 2

Conservation Rating According to Briggs and Leigh (1995)

Conservation Rating According to Briggs and Leigh (1996)

Briggs and Leigh (1996) list over 5,031 species, subspecies and varieties of plants (5% of native vascular flora of Australia) that have been ranked according to their conservation status. While many of these species are contained within the schedules of various state and federal threatened species legislation (e.g. TSC Act and *EPBC* Act), and are subject to legislative provisions under those acts, a great many more do not and as a such are extraneous to statutory assessment processes.

The modified list below presents the range of codes that are, in various combinations, applied to each listed plant species.

- **1** Species only known from one collection
- **2** Species with a geographic range of less than 100km in Australia
- **3** Species with a geographic range of more than 100km in Australia
- **X** Species presumed extinct; no new collections for at least 50 years
- **E** Endangered species at risk of disappearing from the wild state if present land use and other causal factors continue to operate
- **V** Vulnerable species at risk of long-term disappearance through continued depletion.
- **R** Rare, but not currently considered to be endangered.
- **K** Poorly known species that are suspected to be threatened.
- **C** Known to be represented within a conserved area.
- **a** At least 1,000 plants are known to occur within a conservation reserve(s).
- **i** Less than 1,000 plants are known to occur within a conservation reserve(s).
- **-** The reserved population size is unknown.
- **t** The total known population is reserved.
- + The species has a natural occurrence overseas.

APPENDIX 3

Fauna Results

Animal species recorded in the study area

Scientific Name	Common Name	Observation Type
Birds -Native		
Cracticus torquatus	Grey Butcherbird	OW
Grallina cyanoleuca	Magpie-lark	OW
Gymnorhina tibicen	Australian Magpie	OW
Cacatua roseicapilla	Galah	OW
Vanellus miles	Masked Lapwing	OW
Ocyphaps lophotes	Crested Pigeon	OW
Corvus coronoides	Australian Raven	OW
Rhipidura leucophrys	Willie Wagtail	
Hirundo neoxena	Welcome Swallow	O
Platycercus eximius	Eastern Rosella	OW
Manorina melanocephala	Noisy Miner	OW

Key: O: Observed, **W:** Heard,

APPENDIX 4

Impact Assessment following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act

Flora

Impact assessments are undertaken for one endangered ecological community, which may be impacted by the proposal: Cumberland Plain Woodland.

Cumberland Plain Woodland

Cumberland Plain Woodland is listed as an Endangered Ecological Community on the TSC Act. An area of approximately 0.16 ha of Cumberland Plain Woodland will be cleared as a result of the proposal if Goaf Gas Extraction Plant Option 2 is developed.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

NA.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Approximately 0.16 ha will be cleared as a result of the proposal if Goaf Gas Extraction Plant Option 2 is developed. Approximately 2010 ha of Cumberland Plain Woodland has been mapped as occurring within 10 km of the study area by DECC (NPWS 2002b). The area of habitat in the Study Area to be impacted (directly and indirectly) by the proposal equates to less than 0.01% of similar habitat types in the locality and this is not considered to be a significant amount of habitat.

The proposal is not likely to have a significant effect on the habitat of the species in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Cumberland Plain Woodland occurs on the Cumberland Plain of western Sydney. Much of the original extent of the community has been cleared, however bushland remnants exist in an area bounded by Scheyville (north), Penrith (west), Parramatta (east) and Thirlmere (south) (NPWS 2004). The study area is near the south-western limit of distribution of Cumberland Plain Woodland.

How is the proposal likely to affect current disturbance regimes?

The proposal is not likely to alter the intensity and frequency of fire or modify any flooding flows. The proposal is not likely to affect disturbance regimes.

How is the proposal likely to affect habitat connectivity?

The removal of a small isolated patch of Cumberland Plain Woodland in poor condition is not likely to affect habitat connectivity. Currently the patch of Cumberland Plain Woodland that may be impacted is surrounded by cleared paddocks, separated from a relatively intact riparian corridor along the Nepean River by approximately 75 m of cleared farmland. The proposal will not significantly affect habitat connectivity for Cumberland Plain Woodland.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General of Department of Environment and Climate Change maintains a Register of Critical Habitat. To date, no critical habitat has been declared for Cumberland Plain Woodland.

The proposal will not have an adverse effect on critical habitat (directly or indirectly).

Conclusion:

The impact of the proposal on Cumberland Plain Woodland is likely to be minor as:

- The proposal is unlikely to have a major impact on the occurrence of Cumberland Plain Woodland within the locality;
- Potential impacts to less than 0.01% of the local occurrence of Cumberland Plain Woodland is not considered to be a major amount of habitat;
- The proposal will not result in fragmentation Cumberland Plain Woodland; and,
- No critical habitat has been declared for Cumberland Plain Woodland.

Fauna

Forest Owls

The Barking Owl and Powerful Owl are listed as Vulnerable on Schedule 2 of the TSC Act and have been grouped on the basis of their similar habitat requirements.

These species inhabit woodland and/or forest habitats and are dependent upon tree hollows for nesting sites and habitat for hollow-dwelling arboreal marsupials (possums and gliders), which comprise a large proportion of the owls' diet, (Higgins 1999). The Study Area contains potential foraging habitat only for these species, no large hollow bearing trees suitable for either species is present.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Study Area contains potential foraging habitat only for these species, no large hollow bearing trees suitable for either species is present. The Proposal may remove and/or modify approximately 0.16 ha of woodland foraging habitat in poor condition. However, given these species are highly mobile, have a large home range (in the order of several hundred hectares) and the extent of potential foraging habitat within the locality and in adjacent areas it is unlikely that foraging resources in the Study Area . It is unlikely that the proposal would impact on the lifecycle of the two species of forest owls.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Powerful Owl and Barking Owl have a large home range, which is in the order of several hundred hectares (Gibbons and Lindenmayer 1997). The Proposal may modify (including direct and indirect impacts) approximately 0.16 ha of potential woodland within the Study Area. The amount of potential habitat that may be modified and /or removed represents approximately 0.01% of suitable foraging habitat for these species within the locality. Given the mobility of these species and the extent of higher quality potential habitat within the locality it is unlikely that the proposal would have a significant impact on the habitats for these species in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Powerful Owl has been recorded along the eastern coast of Australia from south-eastern Queensland to Victoria (Debus, 1994). Records are concentrated on the coastward side of the Great Dividing Range but in many places its distribution extends to the inland slopes, mostly within approximately 200 km of the coast.

The Barking Owls occurs in forests and woodlands in the tropical, temperate and arid zones (NPWS 2003b). Its distribution covers most of the continent excluding. the arid zones of WA, SA and the NT (Pizzey and Knight 2007).

The Study Area is not at the limit of known distribution for either species.

How is the proposal likely to affect current disturbance regimes?

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

How is the proposal likely to affect habitat connectivity?

Given the extent of potential habitat within the locality, mobility and home range of the two owl species, it is unlikely that the Proposal would result in the fragmentation or isolation of potential habitat for these species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Conclusion

The impact of the proposal on the two species of forest owl is likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the forest owls;
- The proposal is unlikely to have a major impact on the composition of potential habitat for forest owls within the locality;
- The Study Area contains approximately 0.16 ha of woodland in poor condition. The amount of potentially impacted habitat, estimated to be 0.01% of the local occurrence of potential foraging habitat for this species, is not considered to be a significant amount of habitat;
- There would be no clearing of any large hollow bearing trees therefore there would be limited impact on potential habitat for these species;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the two forest owl species.

Woodland Birds

The Turquoise Parrot and Black-chinned Honeyeater are listed as Vulnerable under Schedule 2 of the TSC Act. The Little Lorikeet and Little Eagle are proposed to be listed as vulnerable under the Schedule 2 of the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Proposal may remove and/or modify approximately 0.16 ha of woodland habitat in poor condition. There are minimal trees that may be removed and only two hollow bearing trees suitable for the Turquoise Parrot and Little Lorikeet. The Little Eagle is known to breed in lightly timbered areas. There were no nests of this species or other large birds of prey observed within the study area. The Black-chinned Honeyeater mostly breeds on the western slopes of the Great Dividing Range.

The study area may provide some foraging resources for these species however there are continuous areas of bushland in the locality and the may impact a small area of previously disturbed habitat (0.16 ha).

Given the extent of potential habitat for these species in the locality, the mobility of these species it is unlikely that the proposal would impact on the lifecycle of these four woodland bird species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The amount of potential habitat that may be modified and /or removed represents approximately 0.01% of suitable foraging habitat for these species within the locality. Given the mobility of these species and the extent of higher quality potential habitat within the locality it is unlikely that the proposal would have a significant impact on the habitats for these species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Turquoise Parrot is distributed from south-east Queensland to North-east Victoria(Pizzey and Knight 2007).

The Black-chinned honeyeater is distributed from South-eastern South Australia to North Queensland, the Northern Territory and Western Australia (Pizzey and Knight 2007).

The Little Lorikeet is distributed for north Queensland to south-eastern South Australia (Pizzey and Knight 2007).

The Little Eagle is distributed widely throughout the Australian mainland except for the heavily forested parts of the great dividing range(Marchant and Higgins 1993).

The study area is not at the limit of the known distribution for any of these species.

How is the proposal likely to affect current disturbance regimes?

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

How is the proposal likely to affect habitat connectivity?

The proposal will not fragment any areas of existing bushland and the areas to be impacted do not form any continuus areas of foraging habitat. Given the extent of potential habitat within the locality, the mobility of these species and the minor vegetation clearing to be undertaken, it is unlikely that the Proposal would result in the fragmentation or isolation of potential habitat for these species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Conclusion

The potential impact of the proposal on these woodland birds likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of these four species;
- The proposal is unlikely to have a major impact on the composition of potential habitat for these species within the locality;
- The Study Area contains approximately 0.16 ha of woodland in poor condition. The amount of potentially impacted habitat, estimated to be 0.01% of the local occurrence of potential habitat for this species, is not considered to be a major amount of habitat;
- There would be no clearing of any large hollow bearing trees therefore there would be limited impact on potential habitat for these species;

- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for these four woodland bird species.

Swift Parrot and Regent Honeyeater

The Regent Honeyeater and Swift parrot are listed as Endangered under Schedule 1 of the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes (DEC 2005r).

The Regent Honeyeater breeds at only three known key breeding regions: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (DEC 2005r). However, significant breeding events have also been recorded in the winter foraging habitat of the Quorrobolong and Kurri areas of the Hunter Valley (DECC unpublished, 2007). The Study Area is not located near any of the key breeding areas for this species, however there is potential for breeding to occur. .

Therefore it is unlikely that the Study Area supports a local population of the Swift Parrot or Regent Honeyeater, however it is possible that these species utilise the woodland habitat within the Study Area to forage occasionally. This habitat type are widely distributed throughout the locality (0.16 ha). Given that these species are highly mobile and the extent of potential habitat within the locality, it is unlikely that the Regent Honeyeater and Swift Parrot would be dependant on the habitat resources within the Study Area for continued survival. Therefore it is unlikely the potential removal and/or modification of 0.16 ha of potential habitat (0.01 % of available habitat within the locality) would have a major impact on the lifecycle of these species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The Regent Honeyeater has a patchy distribution throughout a large geographic range and is considered to be highly mobile occurring in temperature eucalypt woodlands and open forests (NPWS 1999d; Higgins *et al.* 2001). Most records are from box-ironbark eucalypt forests associations and wet lowland coastal forests

(NPWS 1999d; Pizzey and Knight 2007). The species is known to breed at a small number of sites containing a variety of key *Eucalyptus* spp., particularly *E. sideroxylon*, *E. melliodora* and *E. albens*, *E. robusta*, but also *E. tereticornis* and *E. moluccana* (Schedvin 1996; Webster & Menkhorst 1992; Franklin *et al*. 1989). There are particular box-ironbark woodlands, usually associated with breeding for the Regent Honeyeater, which were not observed during the survey and there are no known breeding sites within the locality.

In NSW the Swift Parrot mostly occurs on the coast and south west slopes (DEC 2005r). When migrating during the non-breeding season, the Swift Parrot can occur on the mainland in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as *Eucalyptus robusta*, *Corymbia maculata*, *C. gummifera*, *E. sideroxylon*, and *E. albens*. Commonly used lerp infested trees include *E. microcarpa*, *E. moluccana* and *E. pilularis* (DEC 2005r).

The habitat within the study area is considered to be marginal foraging habitat. Neither species were recorded during the current survey or within the Study Area but have been recorded on a few occasions within the locality. It is unlikely this proposal would have major impacts on the composition of potential habitat of these bird species. Further, given the lack of mature foraging trees within the Study Area it is unlikely to constitute prime or core habitat for this species. It is possible that these species would use the resources within the Study Area on occasion however it is unlikely to be dependant on them.

The proposal may impact 0.16 ha of potential woodland habitat. Given this represents only 0.01 % of the broader distribution of these habitats within the locality, it is unlikely that the proposal would have a significant impact on the habitats for both these species. Larger, higher quality areas of potential habitat occur within the locality and as such it is unlikely that the habitat which may be removed is important to the long-term survival of the species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland.

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland.

The Study Area is not at the limit of the distribution for the Regent Honeyeater or the Swift parrot.

How is the proposal likely to affect current disturbance regimes?

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

How is the proposal likely to affect habitat connectivity?

Given the extent of potential habitat within the locality, mobility and home range size of the two species, it is unlikely that the Proposal would result in the fragmentation or isolation of potential habitat for these species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Regent Honeyeater or Swift Parrot.

Conclusion

The impacts of the proposal on the Regent Honeyeater and Swift Parrot are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of these two species;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Regent Honeyeater and Swift Parrot within the locality;
- The Study Area contains approximately 0.16 ha of Woodland habitat for these species. Potential habitat within the Study Area is not considered to be prime or core habitat for the Regent Honeyeater or Swift Parrot given the lack of preferred winter flowering trees. There may be impacts to 0.01 % of the local occurrence of potential habitat for the Regent Honeyeater and Swift Parrot.
- The proposal would not result in significant long-term isolation or fragmentation of habitat for these two bird species; and,
- No critical habitat has been declared for the Regent Honeyeater or Swift Parrot.

Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-fox is listed as Vulnerable on Schedule 2 of the TSC Act. Potential foraging habitat for this species occurs within the woodland habitat where flowering eucalypts provide potential foraging resources.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

This species congregates in large numbers at roosting sites (camps) in a wide range of vegetation types. Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring. Grey-headed Flying-foxes are known to travel up to 50 km from their camps to forage (NPWS 2001a). The diet of the Grey-headed Flying-fox is varied, encompassing a wide range of fruits and blossoms from both native and non-native trees (Strahan 1995).

There area no known camps within the Study Area, however there is one known Grey-headed Flying-fox camp on the Nepean River approximately 3.5 km to the north-east (DECC 2007). It is unlikely that the proposal would interfere with breeding of the Grey-headed Flying-fox at these camp sites.

The proposal would remove 0.16 ha of potential foraging habitat for this species in the form of woodland habitats containing nectar producing eucalypts. Potential habitat for the Grey-headed Flying-fox occurs in the Study Area and also in larger, continuous, higher quality stands of vegetation within the locality. The total extent of similar habitat types within the locality is 0.16 ha, meaning the area which may be cleared/modified represents 0.01 % of the potential habitat for this species within the locality.

Given the mobility of this species, the lack of camps within the Study Area and the extent of higher quality potential habitat within the locality, it is unlikely that the proposal would disrupt the lifecycle of the Grey-headed Flying-fox.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

The proposal may directly impact 0.16 ha of potential woodland habitat. The area to be modified or cleared as part of the proposal represents 0.01 % of the broader distribution of these habitat types within the locality. This potential habitat contains flowering, nectar producing eucalypts that may provide the species with foraging opportunities. Large areas of continuous, higher quality stands of vegetation are present outside the Study Area within the locality. Given the mobility of this species, the lack of camps within the Study Area and the extent of higher quality potential habitat within the locality it is unlikely that the proposal would have a significant impact on the habitats for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. The Study Area is not at the limit of the distribution for this species

How is the proposal likely to affect current disturbance regimes?

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

How is the proposal likely to affect habitat connectivity?

The proposal may remove 0.16 ha of Grey-headed Flying-fox potential foraging habitat from within woodland habitat in the Study Area. Potential foraging habitat types are widely distributed within the locality (0.16 ha), therefore the proposal may clear 0.01 % of potential foraging habitat for this species within the locality. This species is highly mobile and is known to travel up to 50 km from their camps to forage (NPWS 2001a).

Given the mobility of this species and the extent of similar potential foraging habitat in the locality, it is unlikely that the proposal would significantly fragment or isolate any areas of potential foraging habitat or movement corridors for the Grey-headed Flying-fox.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

Conclusion

The impacts of the proposal on the Grey-headed Flying fox are likely to be minor as:

- The proposal is unlikely to have a major impact on the lifecycle of the Grey-headed Flying-fox;
- The proposal is unlikely to have a major impact on the composition of potential habitat for the Grey-headed Flying-fox within the locality;
- The Study Area contains approximately 0.16 ha of potential woodland habitat for this species. There may be impacts to 0.01 % of the local occurrence of potential habitat for the Grey-headed Flying fox however this

is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;

- The proposal would not result in significant long-term isolation or fragmentation of habitat for this species; and,
- No critical habitat has been declared for the Grey-headed Flying fox.

Microchiropteran Bats

The Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat, Eastern Bentwing Bat, and Large-footed Myotis are listed as Vulnerable on Schedule 2 of the TSC Act

The Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat are hollow–roosting species. The Large-footed Myotis is a cave and hollow roosting species. These Microchiropteran bat species have been grouped on the basis of their similar habitat requirements and local recordings. The Eastern False Pipistrelle tends to fly with good manoeuvrability and forages below or within the forest canopy. The Greater Broad-nosed Bat tends to forage along gaps and edges of forests and bushland patches (Churchill 1998; Law *et al.* 2000). The Large-footed Myotis utilises mainly water sources for foraging, catching small fish and insects with its feet (Churchill 1998). Little is known of the foraging habits of the Eastern Freetail Bat (Churchill 1998).

Potential habitat for these species occurs within the Study Area in woodland habitat.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Factors likely to disrupt the life cycle of these bat species include the loss, disruption or modification of roost sites, which, for these species includes tree hollows bark of trees. Two hollow bearing trees were identified in the study area and these may be removed.

The Proposal may remove and /or modify approximately 0.16 ha of potential foraging habitat. These habitats are widely distributed throughout the locality. The potential removal and /or modification of potential foraging habitat for these species represents approximately 0.01 % of the available habitat within the locality.

Given the mobility of these species and extent of potential habitat in the immediate vicinity of the study area the proposal is unlikely to have a significant effect on the lifecycle of these species.

How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

Potential habitat for these species occurs in the woodland habitat. The proposal may impact approximately 0.16 ha of potential habitat for these species. These habitat types are widely distributed within the locality. The potential removal and /or modification of potential habitat for Microchiropteran bats represents approximately 0.01 % of the available habitat within the locality.

Potential habitat within the study area is considered to be in poor to moderate condition. Finer scale habitat features such as abundant tree hollows and watercourses provide foraging and roosting habitat for these Bat species, have also been widely identified in the local area. Two hollow bearing trees which contain potential roosts for these species were identified and these may be impacted. These resources are abundant in adjacent areas including areas along Nepean River. Overall quality of potential foraging and roosting habitat within the greater area is unlikely to have a significant effect on potential habitat by the proposal.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. The distribution of the Greater Broad-nosed Bat is poorly known. It is restricted to east coast and adjacent Great Dividing Range from the Queensland to southern NSW (Churchill 2008).

The Study Area is not at the limit of the distribution of these species.

How is the proposal likely to affect current disturbance regimes?

The Proposal is unlikely to affect fire regimes or the natural flooding regime of the Study Area.

How is the proposal likely to affect habitat connectivity?

The woodland habitat of the study area is currently fragmented by farmland and roads. These species are all highly mobile and a small scale clearing event such as the current proposed development is unlikely to result in further fragmentation and/or isolation given that the extent of potential habitat in the local area and the mobility of these species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for these species.

Conclusion

The impacts of the proposal on these bat species are likely to be minor as:

- The proposal is unlikely to have a significant impact on the lifecycle of these species;
- The proposal is unlikely to have a major impact on the composition of potential habitat for these Bat species within the locality;
- The Study Area contains approximately 0.16 ha of woodland habitat for these species. Potential impacts to 0.01% of the local occurrence of potential habitat for these Bat species is not considered to be a major amount of habitat considering the quality of potential habitat within the locality;
- The proposal would not result in significant long-term isolation or fragmentation of habitat for these four Microchiropteran Bat species; and,
- No critical habitat has been declared for these Microchiropteran Bat species.

APPENDIX 5

EPBC Act Significant Impact Criteria

Significant Impact Guidelines

The EPBC Act Significant Impact Guidelines (DEH 2006) list Significant Impact Criteria for matters of national environmental significance that should be taken into consideration to determine whether a proposal is likely to have a significant impact on threatened species, populations or ecological communities that are known to occur or potentially occur in the Study Area.

Under the EPBC Act, if the proposal has the potential to have an adverse impact on a threatened species, population or ecological community listed on the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration.

Cumberland Plain Woodland

Cumberland Plain Woodland (CPW) is listed as an Endangered Ecological Community on the EPBC Act. This plant community was recorded within the study area and will be impacted by the proposal, with approximately 0.16 ha which may be impacted by the proposal.

Is the action likely to reduce the extent of a community?

The vegetation in the study area occurs within a largely cleared rural area. Vegetation mapping (NPWS 2002b) indicates that approximately 2010 ha of CPW (Shale Plains Woodland and Shale Hills Woodland) occurs within a 10 km radius of the study area. This mapping also shows the plant community generally occurs as small disturbed remnants within agricultural land and developed land. The proposal may result in direct impacts to approximately 0.16 ha of CPW. This is not likely to reduce the extent of the community.

Is the action likely to fragment or increase fragmentation of ecological community?

The removal of a small isolated patch of Cumberland Plain Woodland in poor condition is not likely to affect habitat connectivity. Currently the patch of Cumberland Plain Woodland to be impacted is surrounded by cleared paddocks, separated from a relatively intact riparian corridor along the Nepean River by approximately 75 m of cleared farmland. The proposal will not fragment or increase fragmentation of Cumberland Plain Woodland.

Is the action likely to adversely affect habitat critical to the survival of an ecological community?

‘Habitat critical to the survival of a species or ecological community’ is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or,
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, there is no critical habitat listed by the Minister for the Department of the Environment, Water, Heritage and the Arts for Cumberland Plain Woodland. Further, there is currently no recovery plan for this EEC.

The potential habitat in the study area is not an area considered to be necessary for breeding, dispersal or succession; to maintain genetic diversity; or for the reintroduction of populations or recovery of the ecological community. Therefore, the proposal will not impact on habitat critical to the survival of Cumberland Plain Woodland.

Is the action likely to modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for the community's survival?

The proposal may result in the removal of 0.16 ha of CPW that is in Poor condition. The action is not likely to modify or destroy abiotic factors that are necessary for the survival of the remaining patches of CPW in the vicinity of the study area, as the disturbance area will be restricted to the footprint of the Goaf Gas Extraction Plant and the proposal will not involve use of any chemicals or result in disturbance to the soil profile of any nearby native vegetation. The potential disturbance of 0.16 ha of an isolated patch of CPW is not considered likely to impact on the communities' survival.

Is the action likely to cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;

The proposal may result in the removal of approximately 0.16 ha of CPW. The area directly impacted may be permanently altered, with the construction of the Goaf Gas Extraction Plant Option 2 if this option is utilised. However, other patches of CPW in the area will remain unaffected, with no additional patches occurring within the indirectly impacted area. The proposal is not likely to cause a substantial change to other patches of CPW outside the area of direct impact.

Is the action likely to cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

– assisting invasive species, that are harmful to the listed ecological community, to become established; or

– causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or

Currently, the patch of vegetation in the study area that may be removed by the proposal is modified through weed invasion. Invasive weed species were dominant in the understorey, consisting mostly of pasture grasses which have invaded from the adjoining cleared paddocks. Given the presence of weeds in the study area, there is potential for further weed dispersal post clearing, however, given the high density of weed species in adjacent areas and the ongoing impacts from the agricultural activities in the area it is considered unlikely to further impact this EEC.

The proposal will not require the use of fertilisers, herbicides or other chemicals or pollutants.

Is the action likely to interfere with the recovery of an ecological community?

No Recovery Plan as published by DEWHA is available for CPW. Currently the Recovery Plan for CPW is in preparation.

Conclusion

Based on the above assessment, CPW is unlikely to be significantly impacted by the proposal and, as such, a Referral under the provisions of the EPBC Act is not recommended for this ecological community.

Fauna

Endangered Species

Swift Parrot	*Lathamus discolor*

Is there a real chance or a possibility that the action would lead to a long-term decrease in the size of a population of a species?

The study area does not contain breeding habitat however some *E. tereticornis* which is a potential feed tree species will be removed. Given the range and mobility of this species and the small number of native flowering trees offering foraging opportunities, the Swift Parrot is unlikely to be wholly dependent upon resources within the study area. Additionally, the species has not been recorded within the study area (DECC 2008). It is therefore unlikely that the Proposal would lead to a long-term decrease in the size of a population of the Swift Parrot.

Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?

The Proposal would not impact breeding sites (which exist in Tasmania only). Some winter/spring flowering potential feed trees (*Eucalyptus tereticornis*) will be removed, but these are few and not a species normally sought out by the Swift Parrot. It is possible that the trees in the study area would be used opportunistically by Swift Parrots at best, as they travel to other areas where food resources are more abundant. It is therefore unlikely that the Proposal would reduce the area of occupancy of a population of the Swift Parrot.

Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?

The study area and surrounds are already fragmented. The Swift Parrot is a highly mobile, migratory, and somewhat nomadic species that ranges far and wide over eastern Australia to south-eastern Queensland. It is highly unlikely that the vegetation to be removed would be important to this species. The removal of the vegetation is unlikely to create a barrier for this species that would fragment a population.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, no critical habitat for the Swift Parrot has been listed on the Register of Critical Habitat.

The potential habitat for the Swift Parrot in the study area is not likely to be critical habitat, as the species was not recorded in the study area and only a few potential feed trees were identified.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?

Swift Parrots breed in Tasmania. Following winter on the mainland they return to Tasmania where they breed from September to January (DEC 2005r). The study area does not contain any breeding habitat for the Swift Parrot and very limited foraging resources that would be unlikely to support Swift Parrots for longer than a brief visit. The Proposal is therefore unlikely to disrupt the breeding cycle of a population of the Swift Parrot.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Proposal may directly impact approximately 0.16 ha of habitat containing foraging resources. This represents a small percentage of the distribution of similar potential habitat within the locality. The potential habitat for this species in the study area is very small, containing few possible feed trees of a species not normally preferred by the Swift Parrot. This species is known to travels large distances in search of favoured feed trees that produce large amounts of nectar. Given the species' mobility and the low quality of potential habitat for this species in the study area, it is unlikely that the Proposal would decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?

Potential habitat within the study area has been previously disturbed to a high degree and is subject to ongoing disturbance including weed invasion. The Proposal may remove a vegetated area that is already weed infested, but is unlikely to increase weed invasion in other parts of the study area.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

The Swift Parrot, like any other parrot species in Australia, is vulnerable to Psittacine Circovirus Disease (PCD). This disease is transferred through faeces or feathers and is unlikely to be exacerbated by the proposal.

Clearing vegetation and the associated construction works have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Swift Parrot in the study area is already degraded and fragmented by existing roads and farmland, it is unlikely that the Proposal would introduce new diseases into the area which could result in the species' decline.

Is there a real chance or a possibility that the action will interfere with the recovery of the species?

The Australian Government Minister for the Department of Environment and Water Resources may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

There is a recovery plan for the Swift Parrot. Recovery Actions identified in the plan include:

- Action 1. Identify the extent and quality of foraging habitat;
- Action 2. Manage Swift Parrot habitat at a landscape scale;
- Action 3. Reduce the incidence of collisions;

- Action 4. Population and habitat monitoring;
- Action 5. Community education and information; and,
- Action 6. Manage the recovery process through a recovery team.

The Proposal may result in the clearing of a small amount of potential foraging habitat for the Swift Parrot. Clearing of potential habitat is identified as a threat to the recovery of the Swift Parrot in the plan, but the proposed area which may be cleared is estimated to be a small percentage of the broader distribution of potential habitat in the locality. In addition, potential habitat within the study area is considered to be of poor quality and contains no breeding sites. It is therefore unlikely that the proposal would interfere with the recovery of the Swift Parrot.

Conclusion

Based on the above assessment, the Swift Parrot is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Regent Honeyeater	***Xanthomyza phrygia***

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of a population of a species?

The Study Area does not contain breeding habitat however some *E. tereticornis* which is a potential feed tree species will be removed. Given the range and mobility of this species it is unlikely to be dependent upon the scarce resources within the study area. Additionally, the species has not been recorded within the study area (DECC 2008). It is therefore unlikely that the Proposal would lead to a long-term decrease in the size of a population of the Regent Honeyeater. Given the above, it is unlikely that the proposal would lead to a long-term decrease in the size of a population of the Regent Honeyeater.

Is there a real chance or a possibility that the action will reduce the area of occupancy of the species?

The Proposal would not impact breeding sites as they occur only in a few key areas where favoured trees that produce large amount of nectar grow. Some winter/spring flowering potential feed trees (*Eucalyptus tereticornis*) will be removed, but these are few and not a species normally sought out by the Regent Honeyeater. It is probable that the trees in the study area would be used opportunistically by Regent Honeyeaters at best as they travel to other areas where food resources are more abundant. It is therefore unlikely that the Proposal would reduce the area of occupancy of a population of the Regent Honeyeater.

Is there a real chance or a possibility that the action will fragment an existing population into two or more populations?

The study area and surrounds are already fragmented. The Regent Honeyeater is a highly mobile, partially nomadic species that ranges far and wide over eastern Australia from north-eastern Victoria to south-eastern Queensland. It is highly unlikely the vegetation to be removed would be important to this species. The proposal is unlikely to create a barrier for this species that would fragment a population.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, no critical habitat for the Regent Honeyeater has been listed on the Register of Critical Habitat.

The potential habitat for the Swift Parrot in the study area is not likely to be critical habitat, as the species was not recorded in the study area and only a few potential feed trees were identified.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of a population?

Breeding of this species is well known (Higgins *et al.* 2001) and the study area does not contain any known breeding sites. The study area also does not contain preferred foraging resources for this species, and the potential feed trees available are in low numbers. The proposal is therefore unlikely to disrupt the breeding cycle of a population of the Regent Honeyeater.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Proposal may directly impact approximately 0.16 ha of habitat containing foraging resources. This represents a small percentage of the distribution of similar potential habitat within the locality. This species is very mobile and can travel large distances in search of favoured feed trees that produce large amounts of nectar. The potential habitat for this species in the study area is very small, containing few feed trees that are not considered preferred tree species by the Regent Honeyeater. Given the species' mobility and the low quality of potential habitat for this species in the study area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat?

Potential habitat within the study area has been previously disturbed to a high degree and is subject to ongoing disturbance including weed invasion. The proposal may remove a vegetated area that is already weed infested, but is unlikely to increase weed invasion in other parts of the study area.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Diseases have not been identified as a threat to populations of the Regent Honeyeater (DEC 2005o).

Clearing vegetation and the associated construction works have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Regent Honeyeater in the study area is already modified and fragmented by existing roads and farmland, it is unlikely that the proposal would introduce new diseases into the area which could result in the species' decline.

Is there a real chance or a possibility that the action will interfere with the recovery of the species?

The Australian Government Minister for the Department of Environment and Water Resources may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

There is a recovery plan for the Regent Honeyeater. Recovery Actions identified in the plan include:

- Action 1. Organisational arrangement including continued use of the Regent Honeyeater Recovery team to guide and review progress as well as close liaison with the Regent Honeyeater Recovery team, state agencies and other groups;
- Action 2. Active management including preparation of regional work plans in four key regions by Operations Groups;
- Action 3. Monitor population levels and changes in distribution;
- Action 4. Conduct research on post-breeding movements, isolation between population, habitat availability and resource use;
- Action 5. Maintain and develop community participation and awareness; and,
- Action 6. Maintain and improve captive population management.

In addition, with relation to Regent Honeyeater habitat, Objective 2 of the recovery plan states: 'Maintain and enhance the value of Regent Honeyeater habitat at the key sites and throughout the former range'.

The Proposal may result in the clearing of a small portion of potential foraging habitat for the Regent Honeyeater. Clearing of potential habitat is identified as a threat to the recovery of the Regent Honeyeater in the plan, but the proposed area to be cleared is estimated to be a small percentage of the broader distribution of potential habitat in the locality. In addition, potential habitat within the study area is considered to be of poor quality and contains no known breeding sites. It is therefore unlikely that the proposal would interfere with the recovery of the Regent Honeyeater.

Conclusion

Based on the above assessment, the Regent Honeyeater is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Vulnerable Species

Potential habitat occurs within the Study Area for one Vulnerable animal species listed on the EPBC Act, the Grey-headed Flying-fox. There are three bird species with potential habitat listed as Migratory Species under the EPBC Act. The potential impacts of the proposal on this species are assessed against the Significant Impact Criteria of the EPBC Act below.

Grey-headed Flying-fox	***Pteropus poliocephalus***

Populations of the Grey-headed Flying-fox that may occur within the Study Area are not considered important populations because:

- they are unlikely to be key source populations either for breeding or dispersal, as no camps have been recorded in the study area;
- they are unlikely to be necessary for maintaining genetic diversity, as there is no evidence that the study area contains an isolated genetic variant of this species or that the proposal would impact on the overall genetic diversity of the species; and,
- the study area is not at or near the limit of the species range which extends along the coast from Bundaberg in Queensland, south to western Victoria.

Is there a real chance or a possibility that the action will lead to a long-term decrease in the size of an important population of a species?

The Study Area is not considered to contain an important population of the Grey-headed Flying-fox. Furthermore there area no known camps within the Study Area. However there is one known Grey-headed Flying-fox camp on the Nepean River approximately 3.5 km to the north-east (DECC 2007). The study area only represents a very small area of potential foraging habitat and it is unlikely to be wholly dependent upon resources within the Study Area. Therefore the proposal is unlikely to lead to a long-term decrease in the size of an important population.

Is there a real chance or a possibility that the action will reduce the area of occupancy of an important population of this species?

The proposal is unlikely to impact potential roost sites (camps) as there are none known to exist in the area. Some flowering eucalypts that may offer foraging opportunities may be removed. It is therefore unlikely that the proposal would reduce the area of occupancy of an important population of this species.

Is there a real chance or a possibility that the action will fragment an existing important population into two or more populations?

The Study Area and surrounds are already fragmented however the proposal will not increase this fragmentation, given the Grey-headed Flying-fox is a highly mobile species. It is considered unlikely that clearing required for the proposal would create a barrier for this species that would fragment a population.

Is there a real chance or a possibility that the action will adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, no critical habitat for the Grey-headed Flying-fox has been listed on the Register of Critical Habitat.

The potential habitat for the Grey-headed Flying-fox in the Study Area is not likely to be critical habitat, as the species was not recorded in the study area and potential foraging resources for the species are low in abundance and diversity.

Is there a real chance or a possibility that the action will disrupt the breeding cycle of an important population?

The Study Area does not contain any known roosting/breeding sites. The Study Area also does not contain a diversity of foraging resources for this species, or a regular food supply. The proposal is therefore unlikely to disrupt the breeding cycle of a population of the Grey-headed Flying-fox.

Is there a real chance or a possibility that the action will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposal may directly impact approximately 0.16 ha of habitat containing foraging resources. This represents a small percentage of the distribution of similar potential habitat within the locality. This species is very mobile and can travel large distances in search of food. Given the species' mobility and the low quality of potential habitat for this species in the study area, it is unlikely that the proposal would decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is there a real chance or a possibility that the action will result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

Potential habitat within the Study Area has been previously disturbed to a high degree and is subject to ongoing disturbance including weed invasion. The proposal will remove a vegetated corridor already weed infested, but is unlikely to increase weed invasion in other parts of the study area.

Is there a real chance or a possibility that the action will introduce disease that may cause the species to decline?

Diseases have not been identified as a threat to populations of the Grey-headed Flying-fox (NPWS 2001a).

Clearing vegetation and the associated construction works have the potential to introduce or increase incidence of external diseases into vegetation or fauna populations. However, as the potential habitat for the Grey-headed Flying Fox in the study area is already modified and fragmented by farmland and existing roads, it is unlikely that the proposal would introduce new diseases into the area which could result in the species' decline.

Is there a real chance or a possibility that the action will interfere substantially with the recovery of the species?

The Australian Government Minister for the Department of Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act).To date, there is no recovery plan for the Grey-headed Flying-fox.

The proposal may result in the clearing of potential foraging habitat for the Grey-headed Flying-fox. Although clearing of habitat is identified as a threat to the recovery of the Grey-headed Flying-fox, the proposed area which may be cleared is estimated to be a small percentage of the broader distribution of potential habitat in the locality. In addition, potential habitat within the Study Area is considered to be of poor quality and contains no recorded camps/roosting sites. For these reasons it is unlikely that the proposal would interfere with the recovery of the Grey-headed Flying-fox.

Conclusion

Based on the above assessment, the Grey-headed Flying-fox is unlikely to be significantly impacted by the proposal, and as such, a Referral under the provisions of the EPBC Act is not recommended for this species.

Migratory species

The Cattle Egret, White-bellied Sea-eagle and Rainbow Bee-eater are listed as Migratory species under the EPBC Act. These 3 species have not been recorded within the Study Area during the current survey.

For the purposes of the Act, an area of important habitat for migratory species is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- habitat that is of critical importance to the species at particular life cycle stages;
- habitat utilised by a migratory species which is at the limit of the species range; and/or
- habitat within an area where the species is declining.

The Study Area contains approximately 0.16 ha of woodland habitat for these three migratory species. The proposal may modify/remove approximately 0.16 ha of potential habitat within the Study Area (which equates to less than 0.1% from the locality).

The known and/or potential habitat which may be impacted by the proposal is not considered to be an area of important habitat for the Cattle Egret, White-bellied Sea-eagle and Rainbow Bee-eater as it is:

- unlikely to support an ecologically significant proportion of the population of these species;
- unlikely to be critical to particular life cycle stages of these species;
- not located at the limit of distribution for these species; and,
- not located in area where the species is declining.

Is the action likely to substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for the migratory species?

The Study Area is not considered to contain an area of important habitat for the Cattle Egret, White-bellied Sea-eagle and Rainbow Bee-eater,

These species generally require terrestrial wetlands, streams, or riverbanks in which to breed. The Study Area does not contain any areas of potential breeding habitat for any of these species and only represents marginal foraging habitat.

It is unlikely that the proposal would substantially modify, destroy or isolate area of important habitat for these species.

Is the action likely to result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?

Potential habitat within the Study Area has been previously disturbed to a high degree and is subject to ongoing disturbance including weed invasion. The proposal may remove a vegetated corridor already weed infested, but is unlikely to increase weed invasion in other parts of the study area.

Is the action likely to seriously disrupt the life cycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the migratory species?

The proposal is unlikely to seriously disrupt the life cycle of an ecologically significant proportion of a population of the Cattle Egret, White-bellied Sea-eagle and Rainbow Bee-eater.

Conclusion:

Based on the above assessment the Cattle Egret, White-bellied Sea-eagle and Rainbow Bee-eater are unlikely to be significantly impacted by the proposal and as such a Referral under the provisions of the EPBC Act is not recommended for these species.

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Annex E

E. Cultural Heritage & Archaeology Assessment

BIOSIS
RESEARCH

Archaeological and Cultural Heritage Impact Assessment of Proposed Appin Area 7 Goaf Gas Drainage Project

May 2009

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ACKNOWLEDGMENTS

Biosis Research acknowledges the contribution of the following people and organisations in preparing this report:

- Bruce Blunden and Gary Brassington (BHP Billiton Illawarra Coal)
- Peter Chudleigh and Philip Paton (Cardno Forbes Rigby)
- Shannon Freeburn (DECC)
- Glenda Chalker (Cubbitch Barta Native Title Claimants Aboriginal Corporation)
- Donna Whillock (Tharawal Local Aboriginal Land Council)
- Matthew Richardson, Matthew Swan, Sian Wilkins, Ashleigh Pritchard and Leigh Bate (Biosis Research)

ABBREVIATIONS

AHC	Australian Heritage Council
AHIMS	Aboriginal Heritage Information Management System
BHPBIC	BHP Billiton Illawarra Coal
CHL	Commonwealth Heritage List
CBNTCAC	Cubbitch Barta Native Title Claimants Aboriginal Corporation
DECC	Department of Environment and Climate Change
DEWH&A	Department of Environment, Water, Heritage and the Arts
GPS	Global Positioning System
GIS	Geographic Information System
GSV	Ground surface visibility
ICOMOS	International Council on Monuments and Sites
TLALC	Tharawal Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
MGA	Map Grid of Australia – unless otherwise specified all coordinates are in MGA
NHL	National Heritage List
NNTT	National Native Title Tribunal
NPWS	National Parks and Wildlife Service (now part of DECC)
PAD	Potential Archaeological Deposit
REP	Regional Environment Plan
RNE	Register of the National Estate
SHI	State Heritage Inventory
SHR	State Heritage Register

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EXECUTIVE SUMMARY

BHP Billiton Illawarra Coal (BHPBIC) is seeking approval for works associated with the drainage of goaf gas for the Appin Area 7 Longwalls 703-704. Goaf gas is the accumulation of coal seam methane in the area of collapsed rock strata associated with the extraction of coal by the longwall mining method (Cardno Forbes Rigby 2008:3).

As a result of previous archaeological work and the current archaeological assessment, 54 Aboriginal sites are located within a 5 km radius of what is defined as the Appin Area 7 Longwalls 703-704 Goaf Gas Drainage Project Study Area. Seventeen of these sites are located within 2 km of the proposed gas goaf drainage locations. The site types include open camp sites, a single scarred tree, shelter with deposit, shelter with art and deposit, shelter with Potential Archaeological Deposit (PAD) and isolated artefacts.

Three new aboriginal sites were identified during the survey of the Appin Area 7 Longwalls 703-704 Goaf Gas Drainage Project Study Area. These site types consist of two isolated artefacts and one open camp site.

Potential Impacts to Historical sites

There were no new or previously registered historical sites located within the Appin Area 7 Longwalls 703-704 Goaf Gas Drainage Project Study Area.

SUMMARY OF RECOMMENDATIONS

Aboriginal archaeological sites

There are 20 Aboriginal cultural heritage sites situated within the Goaf Gas Drainage Study Area. Four of these sites; Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673) may be impacted by the installation of the Goaf Gas Drainage surface pipeline reticulation system (Figure 3).

Aboriginal Recommendations

A copy of this report should be distributed to the Registered Stakeholder Aboriginal communities for their review and comment on receipt of final comments from BHP Billiton Illawarra Coal.

Recommendation 1 - Conservation

- Sites Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673) – comprising isolated stone artefact occurrences and open camp sites are required to be registered as Aboriginal sites with NSW DECC. The sites have been listed on the Aboriginal Heritage Information Management System.

- Where it is reasonable and practicable to do so, BHP Billiton Illawarra Coal should avoid impact to Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673).

- If the archaeological sites can be avoided, they should be temporarily fenced prior to construction using protective barriers, and all contractors should be notified of the importance of avoiding archaeological sites prior to the undertaking of ground disturbance activities.

- If the archaeological sites cannot be avoided then an Aboriginal Cultural Heritage Management Plan should be developed and implemented. This Plan will facilitate the management, salvage and relocation of any impacted sites.

Recommendation 2 – Aboriginal Cultural Heritage Management Plan

- An Aboriginal Cultural Heritage Management Plan (ACHMP) should be developed. This will outline the management of Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673), and the management of any Aboriginal cultural material uncovered during construction. The ACHMP will describe Aboriginal community consultation and involvement of registered stakeholder groups.

- The ACHMP will be included and implemented as part of the Environmental Management Plan (EMP).

Recommendation 3 - Stop work provision: Aboriginal sites

- All Aboriginal places and objects are protected under the NSW *National Parks and Wildlife Act 1974*. This protection includes Aboriginal places and objects which have not been identified in this report, but which may be identified during construction. Should any previously unidentified Aboriginal objects or places be identified during excavation and construction, all works must cease in the vicinity of the find and the following be notified:

    - NSW Department of Environment and Climate Change

    - A qualified archaeologist

    - Aboriginal stakeholders.

Recommendation 4 – Human Remains

In the case of skeletal remains the following process will be implemented.

- All works must cease in the vicinity of the find
- The find will be reported to police and state coroner
- BHP Billiton Illawarra Coal and Cardno Forbes Rigby will be notified of the find
- Aboriginal stakeholders will be notified of the find
- NSW DECC will be notified of the find
- If the skeletal remains are of Aboriginal ancestral origin an appropriate management strategy will be developed in consultation with the Aboriginal stakeholders
- The find will be recorded in accordance with the National Parks and Wildlife Act 1974 (NSW) and the NSW NPWS Aboriginal Cultural Heritage Standards and Guidelines Kit
- The Aboriginal Cultural Heritage Management Plan will be amended to include the newly discovered Aboriginal ancestral remains in the management regime established by the plan.

Historical archaeological sites

There were no new or previously registered historical archaeological sites within the Goaf Gas Drainage Project Study Area.

Recommendation 1

No further historical archaeological assessment will be required for the Appin Area 7 Longwalls 703-704 Goaf Gas Drainage Project.

1.0 INTRODUCTION

Cultural heritage legislation protecting Aboriginal and historical heritage places applies in New South Wales. These places are an important part of our heritage. They are evidence of more than 40,000 years of occupation of New South Wales by Aboriginal people, and of the more recent period of post-contact settlement.

Heritage places can provide us with important information about past lifestyles and cultural change. Preserving and enhancing these important and non-renewable resources is encouraged.

It is an offence under sections of legislation to damage or destroy heritage sites without a permit or consent from the appropriate body (see Appendix 3 for a discussion of relevant heritage legislation and constraints).

When a project or new development is proposed, it must be established if any cultural heritage places are in the area and how they might be affected by the project. Often it is possible to minimise the impact of development or find an alternative to damaging or destroying a heritage place. Therefore, preliminary research and survey to identify heritage places is a fundamental part of the background study for most developments.

The first stage of an archaeological and cultural heritage assessment usually incorporates background research to collect information about the land relevant to the proposed project (the Study Area). A second stage often involves a field survey and assessment of this area.

Possibly the most important part of the study involves assessing the cultural heritage significance of heritage places in the Study Area. Understanding the significance of a heritage place is essential for formulating management recommendations and making decisions.

1.1 Project background

This report has been commissioned in order to identify and assess Aboriginal and historical cultural heritage values of the area around the proposed goaf gas drainage project that will service Longwalls 703-704 within Appin Area 7, previously known as the Douglas Project, west of the township if Appin (Figure 1). Goaf gas is the accumulation of coal seam methane in the area of collapsed rock strata associated with the extraction of coal by the longwall mining method. If unmanaged this gas can enter the ventilation system within the mine and cause operational and underground safety issues. BHPBIC will use the proposed plant to draw the goaf gas to the surface and resolve these issues (Cardno Forbes Rigby 2008:3).

Results of this investigation will be used to assess the proposed goaf gas drainage project in relation to previously and newly registered (as a result of this project) Aboriginal archaeological and cultural heritage sites; and historical archaeological and heritage sites.

Recommendations designed to minimise and manage impacts to cultural heritage places have been formulated according to legislative constraints and 'best practice' heritage management.

1.2 Study Area

The Study Area is located south west of Sydney between Douglas Park and Menangle, within the Wollondilly Local Government Area (LGA). The proposed goaf gas drainage project is situated on the transitional zone of the Woronora Plateau and the Cumberland Plain, known as the Cumberland Lowlands, where the open undulating plains meet the rugged sandstone plateau. The proposed longwall layout is primarily located within the undulating plain region, with the eastern margin bounded by the Nepean River and its tributaries.

Most of the Study Area comprises undulating plains. These areas have generally been cleared of vegetation for farming, resulting in extensive ground disturbance. Along the Nepean River, large stretches of native vegetation remain where the steep terrain has been unsuitable for farming.

Mapping of the Study Area (see Figures 2 and 3) shows the proposed goaf gas drainage project layout (shown as a green line).

1.3 Aims

The following is a summary of the major objectives of this assessment:

- Conduct heritage register searches to identify any previously recorded cultural heritage sites within the Study Area. Searches will include the Aboriginal Heritage Information Management System (AHIMS), the National Heritage List, Commonwealth Heritage List, Register of the National Estate, State Heritage Register, Local Environmental Plan and National Trust heritage lists.

- Conduct additional background research in order to recognise any identifiable trends in site distribution and location, in order to develop a Site Prediction Model.

- Consult with identified statutory stakeholders and stakeholders identified through DECC's *National Parks and Wildlife Act 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants* for the Study Area.

- Undertake landform and transect survey of the Study Area where existing information is limited. Survey coverage will target landforms with high potential for heritage places within the Study Area, as identified through background research.

- Undertake targeted survey of all previously recorded sites within the Study Area, to reassess the condition of these sites.

- Record and assess sites identified during the survey in compliance with the guidelines endorsed by the NSW Department of Environment and Climate Change (DECC) and the NSW Heritage Office.

- Identify impacts to all identified Aboriginal and historical cultural heritage sites and places based on potential changes as a result of the Project.

- Assess the heritage significance of all identified Aboriginal and historical cultural heritage sites and places.

- Make recommendations to manage potential impacts to cultural heritage values within the Appin Area 7 Goaf Gas Drainage Project Study Area.

- Make recommendations to manage the cultural heritage values within the Study Area.

1.4 Consultation with the Aboriginal Community

The following organisations registered an interest in the Aboriginal Cultural Heritage Assessment Project for Douglas Area 7 as per the DECC *Part 6 Approvals – Interim Community Consultation Requirements for Applicants* in 2006 (Biosis Research 2006). These organisations are referred to below as the Aboriginal Stakeholders:

- Tharawal Local Aboriginal Land Council (via Lance Syme)

- The Wadi Wadi Coomaditchie Aboriginal Corporation (via Allan Carriage)

- Northern Illawarra Aboriginal Collective (NIAC – Chris Illert)

- Cubbitch Barta Native Title Claimants Aboriginal Corporation (Glenda Chalker)

For the purpose of the Appin Area 7 Goaf Gas Drainage Project survey, representatives of Tharawal Local Aboriginal Land Council (Donna Whillock) and Cubbitch Barta Native Title Claimants Aboriginal Corporation (Glenda Chalker) were engaged to participate in the Appin Area 7 Goaf Gas Drainage Project archaeological and cultural field survey.

2.0 ABORIGINAL CULTURAL HERITAGE ASSESSMENT METHODOLOGY

2.1 Philosophy

A methodology is a system of principles that are formulated to govern the way an assessment is carried out. In archaeological and cultural heritage assessments the methodology employed is influenced by several factors including: the type of development or project, environmental factors, ethnographic and historical land-uses, and previous archaeological and cultural heritage work.

2.2 Guiding Principles

The methodology employed for this investigation has been designed to conform to the requirements of the relevant advisory documents and guidelines as endorsed by the NSW Department of Environment and Climate Change (DECC). These guidelines and documents are:

- *National Parks and Wildlife Act* 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants (DEC 2004);
- Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation (DEC July 2005);
- The Australia ICOMOS Burra Charter, 1999;
- Working Draft Aboriginal Cultural Heritage Standards and Guidelines Kit (NSW NPWS 1997); and
- Guidelines for Aboriginal Heritage Impact Assessment (DRAFT) (DEC no date).

In line with these documents, the methodology adheres to the following principles:

- Aboriginal people are the primary determinants of the significance of their heritage;
- Input from those Aboriginal people with a cultural association to the land is an essential part of assessing the significance of Aboriginal heritage objects and values that could be impacted by an activity;
- Aboriginal heritage can have both cultural and scientific/archaeological significance and both should be the subject of assessment;
- Aboriginal community involvement needs to take place early in the assessment process to ensure that their values and concerns are fully taken into account, and so that their own decision-making structures are able to function adequately; and

- Consideration should be given to measures that could be implemented to avoid, mitigate or offset likely impacts.

The DECC *National Parks and Wildlife Act* 1974: *Part 6 Approvals – Interim Community Consultation Requirements for Applicants* states that the community consultation process ensures that Aboriginal communities have the opportunity to positively influence assessment outcomes by:

- Influencing the design of the assessment of cultural and scientific significance;
- Providing relevant information in relation to cultural significance values; and
- Contributing to the development of cultural heritage management recommendations.

2.3 Methodology

The following is a detailed outline of the methods employed for this assessment.

2.3.1 Background Research

The following activities were undertaken during the background research phase:

- Search for sites registered on the NSW DECC AHIMS for the Study Area and surrounding vicinity.
- Review of relevant site records for the Study Area and surrounds.
- Review of relevant reports from the region.
- Search of the NSW Heritage Office database and State Heritage Register.
- Search of the National Heritage List, Commonwealth Heritage List and Register of the National Estate.
- Inspection of heritage lists in relevant local planning instruments.
- Search of the National Trust Heritage Register.

This data was collated and mapped to show the locations of the previously recorded sites. The data was also used to formulate predictive statements regarding Aboriginal archaeological site distribution within the Study Area. The predictive statements were based on terrain units, and were used to help determine the specific locations of the field survey.

2.3.2 Cultural and Archaeological Survey

The cultural and archaeological survey was conducted as follows:

- Known sites were revisited to confirm their location, and to make a record of their current condition.
- Pedestrian survey was undertaken at selected representative areas.
- The location of all sites was recorded using a hand-held GPS unit.
- Survey data was recorded on purpose-designed recording forms.
- Details of each site were recorded using purpose-designed recording forms.
- Appropriate plans and maps were prepared.
- Photographs of all sites and features were taken.
- Appropriate Aboriginal Community representatives assisted with the field assessment.

2.3.3 Assessment of Significance

The NSW DECC recognises that 'Aboriginal community are the primary determinants of the significance of their heritage' (NSW DEC 2004). Biosis Research recognises that our role in the cultural heritage assessment process is to provide specialist skills, particularly in regard to archaeological and heritage management expertise. These specialist skills can be articulated and enhanced through consultation with the Aboriginal community, with the aim of providing a holistic assessment of cultural heritage significance.

Archaeologists study the material cultural heritage—artefacts, sites and structures—of past peoples and societies. However, not all places and sites of cultural heritage value and significance have material evidence. Places, sites and objects have heritage value because of what they mean to people, and because of the values they represent for people. Places, sites and objects will have different heritage values for different people. These different values may require negotiation among various stakeholders and can shape what decisions are made about conservation. Cultural heritage management is the process of investigation, consultation and making decisions about the conservation of heritage places through the assessment of heritage values.

Heritage management is based on the principle that the heritage significance of a place will guide all future decisions that affect the place. The determination of cultural heritage significance relies on a comprehensive approach to heritage assessments and to the values that are attached to heritage places. Cultural heritage significance can be considered to be the importance of a place, site or object arising from the combination of values attributed to it. These values determine the 'what' and 'how' of conservation and direct management decisions. The categorisation and significance of a place or site will also determine the statutory protection that may be afforded to it.

This approach is laid out in the Australia ICOMOS Burra Charter (1999), which has been adopted by cultural heritage managers and government agencies as the set of guidelines for best practice heritage management in Australia. The Burra Charter identifies the following categories of values: aesthetic, historic, scientific and social. Most assessment approaches also include a ranking of significance – high, moderate or low, for example. For each value associated with a place, an attempt is made to assess the degree or level of significance in terms such as *unique, important, representative, rare* and so on – which relies on a comparison of that value in relation to other places. One of the more common applications of the significance assessment process is to mitigate or control landscape modifying activities, including the protection or conservation of identified heritage values.

Both professional and community understandings are important when determining heritage and its significance. ‘Expert’ interpretation will often need to be integrated with other understandings and assessments of heritage. This is particularly relevant in a discussion of Aboriginal cultural heritage, where there can be differences in the way places are valued and in understandings of how knowledge can be used. As a consequence, outcomes should rely on processes and practices that promote integration and an effective incorporation of different values in decision making.

For example, an ‘archaeological’ site can be of broader interest to groups other than archaeologists. There are additional scientific interests in archaeological sites than those that arise through archaeology alone. Many types of scientific research or ‘informational’ interests can use data from archaeological sites, and these can all contribute the ‘scientific value’ of a place or site. Also, the wider interests of the general community can be complementary to archaeological values. In terms of Aboriginal communities, heritage places – including those that are otherwise defined as ‘archaeological sites’ – will attract differing values. These may include custodianship obligations, education, family or ancestral links, identity, and symbolic representation.

History and traditions are important: this generation has an obligation to future generations to retain certain things as they are currently seen and understood. This includes retaining alternative understandings to those that come through scientific assessments. Heritage places are often more complex than is identified through the scientific determination of value. Cultural and social values can be complex and rich - the past is a vital component of cultural identity. Feelings of belonging and identity are reinforced by knowledge of the existence of a past, and this is further reinforced and maintained in the protection of cultural heritage.

Assessment of Cultural Heritage Significance

As well as the ICOMOS Burra Charter, DECC has endorsed the *Guidelines for Aboriginal Impact Assessment.* The relevant sections of this document are presented and discussed below.

The *Guidelines* state that an area may contain evidence and associations which demonstrate one or any combination of the following Aboriginal heritage values. The values described by the *Guidelines* are drawn from the Burra Charter.

Social value (sometimes termed Aboriginal value) refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day Aboriginal community. Places of social significance have associations with contemporary community identity. These places can have associations with tragic or warmly remembered experiences, periods or events. Communities can experience a sense of loss should a place of social significance be damaged or destroyed. These aspects of heritage significance can only be determined through consultative processes with one or more Aboriginal communities.

Historic value refers to the associations of a place with a person, event, phase or activity of importance to the history of an Aboriginal community. Historic places may or may not have physical evidence of their historical importance (such as structures, planted vegetation or landscape modifications). Gaining a sufficient understanding of this aspect of significance will often require the collection of oral histories and archival or documentary research, as well as field documentation. These places may have 'shared' historic values with other (non-Aboriginal) communities. Places of post-contact Aboriginal history have generally been poorly recognised in investigations of Aboriginal heritage, and the Aboriginal involvement and contribution to important regional historical themes is often missing from accepted historical narratives.

Scientific value refers to the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects. Assessment of scientific value is often based on the likely research potential of the area, place or object and will consider the importance of the data involved, its rarity, quality or representativeness, and the degree to which it may contribute further substantial information.

Aesthetic value refers to the sensory, scenic, architectural and creative aspects of the place. It is often closely linked with social values and may include consideration of form, scale, colour, texture, and material of the fabric or landscape, and the smell and sounds associated with the place and its use.

All Aboriginal sites and places, including those that are considered to be 'archaeological' – for example, middens or artefact scatters – may have a particular value and meaning to Aboriginal people.

Cultural Landscapes

In addition to these four definitions of value, the *Guidelines* also specify the importance of considering cultural landscapes when determining and assessing Aboriginal heritage values. The principle behind a cultural landscape is that 'the significance of individual features is derived from their inter-relatedness within the cultural landscape'. This means that sites or places cannot be 'assessed in isolation' but must be considered as parts of the wider cultural landscape. Hence the site or place will possibly have values derived from its association with other sites and places. By investigating the associations between sites, places and (for example) natural resources in the cultural landscape, the stories behind the features can be told. The context of the cultural landscape can unlock 'better understanding of the cultural meaning and importance' of sites and places.

Determination of Cultural Heritage Significance

The Burra Charter suggests that heritage practitioners 'should prepare a succinct statement of cultural significance, supported by, or cross referenced to, sufficient graphic material to help identify the fabric of cultural significance'. The statement must be clear and concise, and must not simply restate the physical or documentary evidence presented as part of the assessment.

This study will present determinations of cultural heritage significance as *statements of significance* that preface a concise discussion of the contributing factors to the cultural heritage significance.

Reference to each of the categories defined above will be made when evaluating cultural significance for sites and places. Nomination of the level of value—high, moderate, low or not applicable—for each relevant category will also be proposed. Consideration of the thresholds for each level of value for the categories will be guided by the contributing factors defined above for each category. The categories are:

- *Social value*
- *Historic value*
- *Scientific value*
- *Aesthetic value*
- *Cultural landscape value*

The determination of cultural landscape value will be applied to both individual sites and places (to explore their associations) and also, to the Study Area as a whole.

3.0 HERITAGE STATUS AND PLANNING DOCUMENTS

3.1 National Registers

3.1.1 The National Heritage List, Commonwealth Heritage List and Register of the National Estate

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) establishes two mechanisms for protection of heritage places. The National Heritage List provides protection to places of cultural significance to the nation of Australia. The Commonwealth Heritage List comprises natural, Aboriginal and historical heritage places owned and controlled by the Commonwealth and therefore mostly includes places associated with defence, communications, customs and other government activities.

Nominations to these two lists are assessed by the Australian Heritage Council (AHC), which also compiles the Register of the National Estate, a list of places identified as having national estate values. There are no management constraints associated with listing on the Commonwealth Heritage List or Register of the National Estate unless the listed place is owned by a commonwealth agency.

APPLICATION TO THE STUDY AREA – NATIONAL HERITAGE REGISTERS

There are no items listed on the Register of the National Estate within the Study Area.

3.1.2 National Native Title Register

The Commonwealth *Native Title Act* 1993 (Cth) establishes the principles and mechanisms for the recognition of and determination of Native Title for Aboriginal people.

The purpose of searching the register is to identify any Traditional Owner groups with current registered claims close to the Study Area that may identify themselves as relevant stakeholders with traditional knowledge or experience.

APPLICATION TO THE STUDY AREA – NATIONAL NATIVE TITLE REGISTER LISTINGS

A search of the National Native Title Register, the Register of Native Title Claims and the Register of Indigenous Land Use Agreements was completed on 19 February 2009. The search results identified one Native Title Claim lodged by the *Gundungurra Tribal Council Aboriginal Corporation #6* (reference NC97/7), encompassing a large area west of the Nepean River, including the present Study Area.

3.2 State Registers

3.2.1 National Parks and Wildlife Act 1974 Registers

The Department of Environment and Climate Change (DECC) maintains a database of Aboriginal sites within NSW under Part 6 of the NSW *National Parks and Wildlife Act* 1974. Aboriginal objects and places in NSW are legally required to be registered on the Aboriginal Heritage Information Management System (AHIMS) register.

The area searched on the AHIMS database was larger than the Study Area, as Aboriginal sites recorded within the wider area will provide a regional perspective on the types of sites that maybe expected to be found within the Study Area.

APPLICATION TO THE STUDY AREA – AHIMS DATABASE

A search of the AHIMS Database completed on 20 February 2009 identified 54 previously recorded Aboriginal sites within a 6 km x 6 km search area centred on the Study Area (see Section 5.4.). Seventeen of these sites were situated within the current Appin Area 7 Goaf Gas Drainage Project Study Area.

3.2.2 Heritage Act 1977 Registers

The Heritage Branch of the Department of Planning NSW maintains registers of heritage and archaeological items that are of State or local significance.

The State Heritage Register (SHR) contains items that have been assessed as being of State Significance to New South Wales. The State Heritage Inventory (SHI) contains items that are listed on Local Environmental Plans and/or on a State Government Agency's Section 170 registers that are deemed to be of local significance.

If an item or place does not appear on either the SHR or SHI this may not mean that the item or place does not have heritage or archaeological significance; many items have not been assessed to determine their heritage significance. An assessment is required for items that are 50 years or older. Items that appear on either the SHR or SHI have a defined level of statutory protection. This is discussed more fully in Appendix 2.

APPLICATION TO THE STUDY AREA – NSW STATE HERITAGE REGISTER LISTINGS

The Appin Area 7 Goaf Gas Drainage Project Study Area contains no items listed on the State Heritage Register.

APPLICATION TO THE STUDY AREA – NSW STATE HERITAGE INVENTORY LISTINGS

The Appin Area 7 Goaf Gas Drainage Project Study Area contains no items that are listed on the State Heritage Inventory.

In addition, Section 170 of the NSW *Heritage Act 1977* requires that culturally significant items or places managed or owned by Government agencies be listed on departmental Conservation and Heritage Registers. Information in these Registers has been prepared according to NSW Heritage Office guidelines and should correspond with information in the State Heritage Inventory. As noted above, the Upper Canal Water Supply System is listed on the Sydney Catchment Authority s.170 Heritage and Conservation Register.

APPLICATION TO THE STUDY AREA – NSW HERITAGE ACT 1977 RELICS PROVISIONS

There are no identified archaeological sites within the Study Area; however, the relics provisions are applicable to relics regardless of heritage listing. Archaeological sites that may be identified in the Study Area during survey will be protected by the relics provisions of the NSW *Heritage Act 1977*.

3.2.3 Environmental Planning and Assessment Act 1979 Registers

The *Environmental Planning and Assessment Act 1979* includes provisions for local government authorities to consider environmental impacts in land-use planning and decision making. Such impacts are generally considered in relation to the planning provisions contained in the Local Environment Plan (LEP) or Regional Environment Plan (REP).

<u>Local Environmental Plans</u>: Each Local Government is required to create and maintain a LEP that includes Aboriginal and historic heritage items. Local Councils identify items that are of significance within their Local Government Area (LGA), and these items are listed on heritage schedules in the local LEP and are protected under the *EP&A Act 1979* and *Heritage Act 1977*.

APPLICATION TO THE STUDY AREA – WOLLONDILLY LEP 1991 SCHEDULE 1

There are no items within the Appin Area 7 Goaf Gas Drainage Project Study Area that are listed in the heritage schedule of the *Wollondilly LEP 1991 Schedule 1*.

3.3 Non-Statutory Registers

3.3.1 The National Trust of Australia (NSW)

The National Trust of Australia (NSW) is a community-based conservation organisation. The Trust maintains a Register of heritage items and places. Although the Register has no legal foundation or statutory power, it is recognised as an authoritative statement on the significance to the community of particular items, and is held in high esteem by the public. The National Trust lists items or places that have heritage or cultural value to the community and, as such, the Trust encourages and promotes the public appreciation, knowledge, and enjoyment of heritage items for future and present generations.

APPLICATION TO THE STUDY AREA – NATIONAL TRUST OF AUSTRALIA (NSW)
The Study Area contains no heritage items classified (listed) by the National Trust of Australia.

3.4 Summary of heritage listings in the Study Area

Seventeen Aboriginal archaeological sites are currently listed by DECC AHIMS database as being within the Appin Area 7 Goaf Gas Drainage Project Study Area (Table 1). The details of each Aboriginal site listed on the DECC AHIMS register can be found in Section 5.4 of the report.

Table 1: Summary of known heritage items within the vicinity of the proposed Appin Area 7 Goaf Gas Study Area, NSW.

ITEM	*RNE*	*CHL*	*NHL*	*AHIMS*	*SHR*	*SHI*	*WLEP 1991*	*NATIONAL TRUST*
17 Aboriginal archaeological sites				**Y**				

4.0 ENVIRONMENTAL CONTEXT

The environmental background to the Study Area is provided in order to give a context to the archaeological assessment. The environmental conditions of the Study Area may have influenced the land use by people in the past; the conditions will also affect the processes by which archaeological sites are preserved, and the environmental aspects of an area also influence the type of archaeological sites that are likely to be present. Environmental values of an area can also contribute to the cultural significance and attachments people have to a place.

The following background is a summary of information relevant to the current assessment of archaeological values of the Study Area.

4.1 Geomorphology

4.1.1 Geology, Landforms and Soil

The Study Area is located within the Sydney Basin, a geological province that consists of Permian and Triassic aged sedimentary rock. The surface geology is characterised by shales of the Wianamatta Group and sandstones of the Hawkesbury Sandstone, which both date to the middle-Triassic. Below this lie the sedimentary units of the Narrabeen Group, and the Illawarra Coal Measures which include the Bulli and Wongawilli coal seams (Branagan and Packham 2000: 56-8).

More specifically, the Study Area is situated on the transitional zone between two distinct physiographic regions: the Cumberland Plain and the Woronora Plateau (Hazelton and Tille 1990). The Cumberland Plain is more commonly characterised by a moderate undulating landscape formed by the weathering of the underlying Wianamatta shales, while the Woronora Plateau can be characterised by steep blocky valleys and cliff lines of the underlying Hawksbury sandstone, exposed by major rivers and creeks. Both the open undulating ridgelines and sandstone scarps of these features have the potential to contain archaeological sites.

The physiographic features of the surrounding landscape have been incised by the Nepean River, Foot Onslow Creek and the major feeder tributaries of Harris creek. Across the varying landscape of the Study Area, one soil landscape has been defined (Hazelton and Tille 1990). Each soil landscape has distinct morphological and topological characteristics, resulting in each soil landscape having different archaeological potential. Because they are defined on a combination of soils, topography, vegetation and weathering conditions, soil landscapes are essentially terrain units that provide a useful way to summarise archaeological potential and exposure. A brief description of the Blacktown (bt) landscape and associated archaeological potential follows.

Blacktown (bt)

The Blacktown residual landscape characterises much of the Cumberland Lowlands and the Woronora Plateau. It has gently undulating rises without rock outcrops (local relief to 30 m with slopes less than 5% grade). Broad rounded crests and ridges with gently inclined slopes are the dominant topography of this landscape (Hazelton & Tille 1990). The soils consist of shallow to moderately deep podzols. Due to their age and slow accumulation residual soil landscapes have reasonable potential to contain archaeological deposits in an open context, such as stone artefacts derived from occupation sites. However, the slow accumulation and high impact of extensive land clearing (usually associated with pastoral development) during more recent times often results in poor preservation of archaeological material.

4.2 Climate

The climate at Picton (8 kilometres south west of the Study Area) generally consists of mild summers with an average maximum of 29.3 degrees Celsius and minimum of 15.4 degrees Celsius in February, and cold, wet winters with an average minimum of 1.7 degrees Celsius and a maximum of 16.8 degrees Celsius in July (Bureau of Meteorology website 2007, 1975 Mean Temperature). Recorded rainfall readings taken in 2007 indicate an average annual rainfall of 805.5 millimetres. The average number of rain days at Picton is 10 days during summer and 28 days during winter (Hazelton and Tille 1990). Whilst conditions and temperatures are wide ranging, the conditions in the Study Area can be summarised as being mild and very suitable for year round hunter-gatherer occupation of all parts of the region.

4.3 Flora and Fauna

Much of the Study Area comprises open grassed paddocks as a direct result of settlement and land clearing that has occurred in the area since early settlement c1811. Some remnant vegetation communities occur along the Nepean River. Small pockets of remnant vegetation also occur along minor drainage features and on some hill slopes.

The following vegetation communities are indicative of the species that once thrived across these areas prior to exploration and settlement in New South Wales. Cumberland Plain Woodland is the only native vegetation community occurring in the study area. However, Shale Sandstone Transition Forest occurs in nearby areas. Both of these vegetation communities are described below.

Cumberland Plain Woodland (CPW) occurs across the Cumberland Plain region, away from creeks and rivers. Major species of this vegetation community include Grey Box *Eucalyptus moluccana* and Forest Red Gum *E. tereticornis*, with Narrow-leaved Ironbark *E. crebra*, Spotted Gum *Corymbia maculata* and Thin-leaved Stringybark *E. eugenioides* occurring less frequently. The shrub layer is dominated by Blackthorn *Bursaria spinosa*, and it is common to find abundant grasses such as Kangaroo Grass *Themeda australis* and Weeping Meadow Grass *Microlaena stipoides var stipoides* (NSW NPWS 2002).

Shale Sandstone Transition Forest (SSTF) occurs in the transition zone between the surrounding Hawkesbury Sandstone and the clay derived Cumberland Plain, with small patches occurring along Mallaty, Ouesdale, Leafs Gully and Nepean creeks. It is dominated by *Eucalyptus tereticornis*, with *E. eugenioides, E. crebra, E. fibrosa* with *E. punctata* occurring less frequently (Biosis Research 2007c). The sub-community SSTF – High Sandstone Influence is dominated in the understorey by sandstone shrub-layer species such as *Kunzea ambigua* and *Persoonia linearis* (NPWS 2001). The other sub-community SSTF – Low Sandstone Influence is dominated in the understorey by *Bursaria spinosa, Themeda australis* and *Echinopogon ovatus* (NPWS 2001).

This transitional zone would have provided a wide diversity of resources, in a relatively small geographic area, for the Aboriginal hunter-gatherer population. This diversity is even greater when it is considered how close the coastal resource areas are to the rugged plateau.

Land mammals such as kangaroos and arboreal mammals such as possums would have been important prey species. Birds, reptiles and fish would also have been important resources. As well as being important food sources, animal products were also used for tool making and fashioning myriad utilitarian items. For example, tail sinews are known to have been used as a fastening cord, while ‘bone points’, which would have functioned as awls or piercers, are often an abundant part of the archaeological record.

4.4 Resource Statement

The landscape would have provided various sources of stone material for the Aboriginal people, from which a range of stone tools could be manufactured. Raw materials types might have included quartz and quartzite, silcrete, and harder stone such as basalt which could be sourced from the west. Locally, quartz would have been the main stone raw-material type suitable for tool manufacture that would occur in the vicinity of the Study Area in any abundance. This would be in the form of pebbles derived from the Hawkesbury sandstone. Such pebbles would have been available along the Nepean River channels as they eroded or weathered out of the sandstone. Other raw materials, including tuff, mudstone, silcrete, chert, quartzite and basalt would have been sourced outside the present Study Area, west from other areas of the Cumberland Plain.

Depending on seasonal variations the Nepean River flows all-year-round, providing an easily accessible source of water and other resources. Seasonal knowledge for harvesting plants and hunting food and material resources was an important factor in the timing of movements into, and out of the Study Area. This might have involved exploiting resources along the coast at one time of year and resources throughout the plateau at another. Various plant and animal species present within the Study Area would have provided a range of resources for Aboriginal people. Food, tools, shelter and ceremonial items were derived from floral resources, with the locations of many campsites predicated on the seasonal availability of resources. These include using wood to make implements; berries, leaves and tubers for food and medicines, as well as bark for shelter construction.

5.0 ABORIGINAL CONTEXT

5.1 Ethnohistory

Archaeological evidence clearly indicates that Aboriginal people have occupied the greater Sydney region for up to 20,000 years. Our knowledge of the social organisation and languages of Aboriginal people prior to European contact is, to a large extent, reliant on documents written by European people. Such documents contain the inherent bias of the class and cultures of these authors, however, they can be used in conjunction with archaeological information in order to gain a picture of Aboriginal life in the region. The majority of this information was gathered during the late nineteenth century, taking place in already decimated communities where significant disruptions to the pre-existing societies had already taken place.

According to Mathews and Everitt (1900:262), the *Gundangarra* occupied the coastal regions, from the Hawksbury River to Cape Howe, and extending inland to the Blue Mountains. The *Dharawal* speaking language group inhabited the coast from Port Hacking, south to Jervis Bay, and inland for a considerable distance (Mathews 1901:127).

These 'defined' language areas are considered to be indicative only, and would have changed through time, and possibly also changed depending on circumstances. It is more likely that language groups shared enough common dialect that definitive boundaries varied, and are not set along a single defined geological boundary. Many early sources identify the Nepean River as the boundary between the Tharawal (east) and the Gundangarra (west). However, the present Study Area is considered to be situated on the margin of the Gundangarra language group.

According to Barralier 1802 (1975:2-3) the present Study Area would have been inhabited by the *Gundangarra* language group. On his expedition through the Menangle region he describes the swamps in the Nepean River as excellent sources of fish, shellfish and eels, stating that;

> '*the people from this area usually fed upon opossum and squirrels, which are abundant in that country, and also upon kangaroo rats and kangaroo, but they can only catch this last one with greatest trouble, and they are obliged to unite in great numbers to hunt it.*' (Barralier 1802 (1975:2-3).

A variety of studies of the language groupings that made up the greater Sydney region have been summarised by Attenbrow (2002). Language groups were not the main political or social units in Aboriginal life. Instead, land custodianship and ownership centred on the smaller named groups that comprised the broader language grouping. There is some variation in the terminology used to categorise these smaller groups; the terms used by Attenbrow (2002) will be used here.

Land ownership was centred on small extended family groups or *clans* (also referred to as local descent groups, local clans or territorial clans). As it was normal practice to disallow intermarriage in close family bands, a number of groups would travel together making up larger units. These units are often referred to as *bands*.

Groups were delineated by physical boundaries within the landscape, such as watercourses and particular varieties of vegetation. Group members were usually united by common dialect, descent, history, and a shared 'Dreaming' ancestor, with each group led by influential individuals. In the Sydney area spiritual attachment and allegiance to land was centred on the clan. Bands were an economic, resource based grouping and do not seem to have been named, although in other parts of the country band-sized groupings were named and carried different emphasis to the cultural life of local people (Attenbrow 2002).

Gatherings of numbers of smaller groups such as bands occurred for ceremonial reasons or to share in seasonally abundant resources. These larger groupings could number many hundreds of individuals. Occasions for large gatherings included predictable seasonal events such as bird migrations but also one off ‘windfall’ events such as whale beachings (McDonald 1992a).

Interactions between different types of social groupings would have varied with seasons and resource availability. It has been noted that interactions between the groups inhabiting the multiple resources zones of the Sydney Basin (coastal and inland) would have varied but were continuous. This is reflected in the relatively homogenous observable cultural features such as art motifs, technology and resource use (McDonald 1992a).

It is likely that groups in different resource areas would have had regular contact, although it is not known exactly how much each group’s territory was restricted by a particular resource. It is known that some specific technology was used to adapt to the particular conditions of an area. Aboriginal people in the mountains were frequently observed wearing cloaks of animal skins in contrast to the coastal people, who were not noted to wear cloaks. Items such as grub catching ‘hooks’ described by Barrallier in 1802, special ‘squirrel traps’ in tree hollows and bird catching nets described by Collins (cited in McDonald 1992a) in and around Menangle, are evidence of specific locally adapted technology.

5.2 Contact History

The arrival of Europeans had a rapid and dramatic effect on the traditional Aboriginal lifestyle patterns in the Sydney region. Even so, evidence of the continued presence of Indigenous people, despite the disruptions to prior lifestyle, is also recorded and historically significant throughout the region. As in many places competition for land and resources and cultural differences led to conflict. This happened rapidly within the region and the Study Area following European settlement.

The arrival of settlers in the region around Appin and new competition for resources began to restrict the freedom of movement of the Indigenous inhabitants from around 1813 (McGill 1994). This was quickly followed by severe drought in 1814 and 1816. By 1814 numbers of Aboriginal people had begun to congregate in the Appin area in search of food and other resources. These people were not only the original inhabitants of the area but also other Aboriginal people from elsewhere who had been pushed off their own lands. In May 1814 the militia killed an Aboriginal boy. When others of the group sought revenge they attacked three militia members before they had time to reload killing one of them (McGill 1994). The trouble brewing between settlers and local inhabitants and the growing pressure on resources resulted in Governor Macquarie sending a punitive military expedition in 1816. The expedition ended in the 'Appin Massacre'. The militia claimed their intentions were to capture prisoners but as they found and pursued a group of Aboriginal people on Broughton's property panic ensued. Fourteen Aboriginal men, women and children were driven over a cliff to their deaths. The exact site of the massacre is not known but Broughton's original 1810 land grant was at Brooks Point.

5.3 Regional Overview

It is generally accepted that people have inhabited the Australian landmass for at least 50,000 years (Allen and O'Connell 2003). Dates of the earliest occupation of the continent by Aboriginal people are subject to continued revision as more research is undertaken. The exact timing for the human occupation of the Sydney Basin is still uncertain. The earliest undisputed radiocarbon date from the region comes from a rock shelter site on the western side of the Nepean known as Shaws Creek K2 which has been dated to 14,700 years before present (BP) (Attenbrow 2002: 20). This site is over 50 km north of the Study Area along the Nepean River. To the south along the coast just north of Shellharbour a site at Bass Point has been dated at 17,101 +/- 750 BP (Flood 1999). Archaeological evidence of Aboriginal occupation of the Cumberland Plains indicates that the area was intensively occupied from approximately 4,000 years BP (JMCHM 2007a). On the Woronora Plateau the oldest date for Aboriginal occupation recorded so far is 2,200 +/- 70 BP (Sefton 2002a). Such a 'young' date is probably more a reflection of poor site conditions for the preservation of datable material and sporadic archaeological excavation, rather than actual evidence of absence of an Aboriginal hunter-gatherer population prior to this time.

Results of archaeological work completed in the northern central and southern Cumberland Plain region have clearly identified that the predominant recorded sites on the Cumberland Plain are open camp sites (Kohen 1986; Smith 1989; Haglund 1989; McDonald 1992b; JMCHM 1996, 2007a, b & c; Dibden 2001, 2002, 2003). Towards the peripheries of the plain on Hawkesbury sandstone, shelters with art and/or deposit and grinding grooves have been recorded. Most recent archaeological studies have been impact driven assessments in response to increasing development activity in the region and changing legislation requirements.

The area along the Nepean and around Appin, Menangle and Douglas Park has been subject to reasonably continuous archaeological study during the last 20 years. The majority of this work has been undertaken for impact assessments related to longwall mining and residential development (see Section 5.5.), with only a small amount of work associated with research grants and post-graduate theses, and limited archaeological excavations.

The most significant exploratory studies have been undertaken by the voluntary Illawarra Prehistory Group, which has successfully recorded hundreds of Aboriginal archaeological sites across the Woronora Plateau. The majority of these sites comprise sandstone shelters and overhangs containing art and / or archaeological deposit. The abundance of this site type is a reflection of the predominant incised Hawksbury Sandstone along major drainage features including the Nepean River, and its feeder tributaries, such as Harris, Foot Onslow and Navigation creeks. The incised sandstone gullies and valleys of the Nepean River result in significant sandstone cliff lines, and smaller outcrops and overhangs suitable for occupation or art depiction. Other site types do occur, and can include open artefact scatters, axe grinding grooves, and scarred trees. Open artefact sites are usually present on the undulating land above the gullies or within shelter sites, while scarred trees are limited to what little remnant vegetation remains. The low frequency of these recorded site types can be attributed to previous land use history, disturbance, visibility and exposure within the landscape.

The recorded frequency of sandstone overhang / rockshelter sites can also be attributed to the intense survey effort on the Hawksbury Sandstone landform across the Woronora Plateau. Sefton (1988:86, 1998:12) has completed extensive analysis of data collected from this work over the past 15 years that describes the frequency and distribution of art techniques on the Woronora Plateau (1988). As part of this analysis, Sefton (1998:12) has provided a review of the techniques and motifs of shelter art within the Georges River Basin. Her summary is reproduced in Table 2 below. It clearly shows that the most common defined art technique within sandstone shelters on the Woronora Plateau is charcoal drawings.

Table 2: Summary of art techniques by method of application and colour, Woronora Plateau (from Sefton 1998)

Summary of art techniques (Sefton 1998)				
Technique	**No. of Shelters**	**% of Shelters**	**No. of Motifs**	**% of Motifs**
Charcoal drawing	427	92	3906	78
Red stencil	86	18	490	9
Red drawing	86	18	183	4
White stencil	37	7	201	4
White drawing	38	8	119	2
Bichrome	28	6	46	1
Ochre painting	19	4	172	3

Charcoal drawing accounts for 78% of the total motifs in 92% of shelters that contain art. Whilst there is a wide diversity of charcoal drawn motifs, the majority of the motifs depict forms that are indeterminate, a situation arising from poor preservation, and also possibly the fact that some motifs are complete but not readily interpretable.

JMCHM work has resulted in the development of a predictive model for Aboriginal site distribution on the Cumberland Plain that will be applicable to the Study Area (1996; 1999). This has been developed using the Aboriginal occupation models proposed for the Camden area by Haglund (1989) and data collected from other areas of the Cumberland Plain where trends in the distribution of archaeological sites have been apparent. The following predictive model for the Cumberland Plain has been taken from JMCHM (1999) and will be used to devise the site prediction model for the Study Area (Section 5.6).

1) The size (density and complexity) of archaeological features will vary according to permanence of water, landscape unit and proximity to stone resources in the following way:

- At the headwaters of upper tributaries (first order creeks) archaeological evidence will be sparse and will comprise little more than background scatters of stone artefacts;

- At the middle reaches of minor tributaries (second order creeks) archaeological evidence will be sparse but indicate focussed activity;

- At the lower reaches of tributary creeks (third order creeks) archaeological evidence will indicate more frequent occupation and evidence of repeated, more concentrated activities;

- On major creek lines and rivers (fourth order creeks) archaeological evidence will indicate more permanent occupation which is of greater complexity;

- Creek junctions and swamps may provide foci for site activity;

- Ridgetop locations between drainage lines will usually contain limited archaeological evidence.

2) Where sandstone features occur (overhangs or platforms), these may have provided a focus for a number of activities including camping or art production or the sharpening of axes. Sandstone platforms may also have been used for the production of art (engravings) although these are very rare on the margins of the Cumberland Plain.

5.4 AHIMS Results

A search of the NSW DECC Aboriginal Heritage Information Management System (AHIMS) database was conducted on 20 February 2009. Fifty four previously recorded sites are located within a 6 km x 6 km search area centred on the Study Area (refer to Figure 2). Of these, 17 sites are located within goaf gas drainage Study Area (see Table 3 below).

It should be noted that the AHIMS database reflects Aboriginal sites that have been officially recorded and included on the list. Large areas of NSW have not been subject to systematic, archaeological survey; hence AHIMS listings may reflect previous survey patterns and should not be considered a complete list of Aboriginal sites within a given area.

Of the 17 sites recorded near the Study Area, the predominant site types are Open Camp Site (26%). The remaining site types are Shelter with Art (19%), Shelter with Deposit (19%), Shelter with Midden (6%), Shelter with Art and Deposit (6%), Shelter with Potential Archaeological Deposit (6%), Axe Grinding Grooves (6%), Scarred Tree (6%), and Isolated Artefact (6%).

Table 3 (following) provides details of the registered Aboriginal archaeological sites located within close proximity to the proposed goaf gas abatement. Details of specific site location are considered sensitive and have not been included in this report.

Table 3: AHIMS sites registered within a 5 x 5 km search area of the proposed goaf gas drainage project.

AHIMS SITE NO.	*SITE NAME*	*SITE TYPE*
52-2-1213	Unit e rubbish dump; Didicoolum	Axe Grinding Grooves
52-2-1214	Unit d ground axe paddock; Didicoolum	Open Campsite
52-2-0014	No Name	Shelter with Art
52-2-1921	Brooks Point 8	Shelter with Art
52-2-1922	Nepean River 2	Shelter with Art
52-2-2094	Nepean River 5 (Duplicate)	Shelter with Deposit
52-2-2095	Nepean River 6	Shelter with Deposit
52-2-2096	Nepean River 7	Scarred Tree
52-2-2097	Nepean River 5	Shelter with Deposit
52-2-2098	Nepean River 4	Shelter with Midden
52-2-2099	Brooks Point 9	Shelter with Art and Deposit
-	Mountbatten 2	Open Campsite
52-2-3674	Mountbatten 1	Open Campsite
-	Harris Creek 3 (HC 3)	Isolated Artefact
-	Moreton Park Road 4 (MPR4)	Open Camp Site
-	AA7-07	Shelter with Potential Archaeological Deposit

The site types within the Study Area generally reflect the regional patterning, with a high frequency of open stone artefact sites on the plain and a number of shelters with deposit sites occurring on the incised Hawksbury sandstone along the Nepean River.

5.5 The Archaeological Record – Localised Studies

There have been a number of localised archaeological impact assessment surveys undertaken in the Douglas Park / Menangle area, many of which are associated with longwall mining for the Appin Mine (Sefton 1998, 1999; Biosis Research 2004, 2006), and more recently for the Camden Gas Projects (Dibden 2001, 2003). The earliest work undertaken within the Study Area was a research project completed by Demkiw in 1985.

All of these studies resulted in the identification and assessment of Aboriginal archaeological sites. The following report summaries only include previous archaeological assessment work that has been undertaken within or in close proximity to the current Goaf Gas Drainage Project Study Area (see Figure 3).

Demkiw (1985) conducted surveys of the property immediately south of current Study Area, known as ‘Didicoolum’ as part of an undergraduate archaeology course. These surveys were conducted around the unnamed tributary, which Demkiw refers to as Lyrebird Creek. Two sites from this study are registered on the AHIMS, axe grinding grooves (52-2-1213) and an open camp site (52-2-1214). As it is an undergraduate study rather than a management report Demkiw’s work contains a number of anomalies. As well as the AHIMS registered sites, the report also contains descriptions of rockshelters (none containing art or artefacts), possible scarred trees, unusual sandstone artefacts and what appears to be a historically pecked and dressed sandstone block that Demkiw initially speculates may be Aboriginal art. The open camp site (52-2-1214) is of particular interest as it identifies a paddock from which several stone axes and other unusual artefacts have been recovered during tilling (Demkiw 1985:36). Some of these items may be artefacts, but the photographs and illustrations suggest otherwise for many of them. It is unlikely that all these items are artefacts, and it is unusual that a range of large artefacts such as grinders and axes should occur without an associated chipped stone assemblage. However, stone artefacts could be expected to occur on the undulating country above the Nepean River, especially near larger drainage features (which presumably provide an attraction for hunter-gatherer populations and definitely provide erosion and archaeological exposure).

It appears Demkiw may have been an influence on one of the more enigmatic Aboriginal heritage sites claimed to exist in the Study Area. The Menangle Eel Farm was listed on the non-statutory ‘Register of Historic Places and Objects’ of the Professional Historians Association of NSW in 2001. The register describes the feature as ‘5 acres of systematic pondage on Lyrebird Creek, a minor tributary of the Nepean, used for eel farming.’ Demkiw presents no archaeological evidence for an eel farm here. He does, however, speculate that a small valley to the northwest of the ‘Didicoolum’ property may have been the location of swamps that were described by Barrallier in 1802 (Demkiw 1985: 45-47). Barrallier noted the Aboriginal population catching fish and eels in these swamps. Demkiw provides accurate coordinates for a chain of ponds on a tributary of Navigation Creek (3 km northwest of the Didicoolum), which are clearly visible on current topographic maps and aerial photography. Demkiw suggests that this location is the same as that where Barrallier described ‘ditches’ and mounded, denuded earth for watering cattle in 1802. Demkiw speculates that the features described by Barrallier are a corroborree ground and the ditches were used for 'trapping eels' (implying they were constructed specifically for this purpose by the Aboriginal population) (1985:47). All this speculation is placed within a wider discussion of other eel and fish traps that are well represented in the archaeological record elsewhere, and reflects the fancy for Aboriginal hunter-gatherer 'intensification' that was so much the fashion of academic Australian archaeology during the 1980s (Lourandos 1983, Lourandos and Ross 1994). In conclusion, there is no archaeological evidence for an 'eel farm' in this area.

Sefton (1998) conducted an archaeological survey of an area for proposed Tower Colliery Longwalls 16 and 17 and future mining extensions that took in both sides of the Nepean River, Simpsons, Elladale and Harris creeks. This Study Area covered the area to the south east of the present Study Area, focussing on suitable cliff lines suitable for occupation and art depiction. The survey found that most of the Nepean River comprised large cliff lines with steep talus slopes that contained frequent overhangs. These overhangs had poor access and sloping sandstone floors containing little or no deposit, considered unsuitable for Aboriginal occupation. However, four archaeological sites were recorded, including one shelter with archaeological deposit, and three shelters with art, none of which are situated within the current Study Area. These sites occur on minor creeks lines, or where small side drainage features feed into the Nepean River, creating smaller more suitable sandstone overhangs. Sefton also identified seven overhangs with the potential for archaeological deposits, but these were not formally registered with DECC.

Sefton (1999) surveys were not as extensive as those conducted previously, but nevertheless covered both sides of the Nepean, the southern side of Ousedale Creek and an unnamed tributary (sometimes referred to as Lyrebird Creek). During these surveys six previously unknown sites were discovered: a shelter with art, four shelters with deposit and a single scarred tree. All of these six sites are within the current area of interest. In addition, Sefton identified three sites with potential archaeological deposit, which were not formally recorded.

Dibden (2001a) undertook the first archaeological and heritage assessment for the Camden Coal Bed Methane project, north east of the present Study Area. A total of 13 Aboriginal archaeological sites were identified, including three low density artefact scatters and ten isolated artefact occurrences. All sites were identified on low gradient simple slopes or valley flats associated with ephemeral streams. A number of these were situated on valley flats nestled at the base of Razorback Range, indicating some use of the area, most likely for resources. These findings reflect the overall site model for the Cumberland Plain that suggests low-density stone artefact sites or isolated stone artefacts will occur along ephemeral water courses.

Dibden (2002a) completed an archaeological assessment for the proposed Camden Coal Bed Methane Project for a proposed gas gathering system at "Kay Park", north west of the present Study Area. The assessment identified two low density artefact scatter sites (KPS1: 52-2-2267 and KPS2: 52-2-2268) along the proposed gas pipeline corridor. Both sites were assessed as being of low-moderate archaeological significance as they are situated on previously disturbed paddocks. An addendum to the assessment was completed by **Dibden (2002b)** to determine an alternative gas gathering route that would avoid the recorded sites KPS1 and KPS2. No Aboriginal archaeological sites or areas of potential were identified along the alternative pipeline corridor.

Dibden (2003) undertook an archaeological and cultural heritage assessment for Stage 2 of the Camden Gas Project. This involved a survey of almost 80 proposed gas well site locations and associated gathering systems to determine the presence and significance of Aboriginal heritage at each location (Dibden 2003: 3). This field survey resulted in the identification of 20 previously unrecorded Aboriginal archaeological sites, primarily comprising isolated artefact occurrences. In most cases, the artefacts were noted to be in their original depositional contexts. The majority of these sites are also considered to be of low significance, as these sites have low research potential, have been subject to high levels of disturbance, have low aesthetic value and are representative of a common site type of the Cumberland Plain.

Dominic Steele Consulting Archaeologists (2005) completed an Aboriginal archaeological survey for 12 proposed gas production well sites, gathering systems and access routes on a Razorback property, north west of the current Study Area. A total of nine Aboriginal archaeological sites were identified. Six of these were isolated finds, and the other three sites were low – moderate density artefact scatters. The isolated finds were situated on moderate slopes near ephemeral creeks, where as the low-moderate density scatters were located adjacent to major drainage features and swamps. These results also reflect the current site prediction models for the region.

Navin Officer (2006) completed a detailed cultural heritage assessment of the proposed gas turbine power station near Leafs Gully, situated in the north east of the present Study Area. The majority of the Study Area was surveyed in detail, with the remainder being assessed on archaeologically sensitive landforms. This resulted in the identification of one area of Potential Archaeological Deposit (PAD) for Aboriginal cultural material across upper slopes and crests of a spur line complex that descends towards Leafs Gully and the Nepean River respectively (Navin Officer 2006:25). Navin Officer (2006:25) suggested that bioturbation within the sandy soils of LGPAD1 area causes stone artefacts to move down into the soil profile, thus remaining undetected during surface surveys. Despite moderate levels of disturbance due to previous land use, the likelihood of Aboriginal cultural material being present was considered high.

Biosis Research (2004) conducted surveys of several areas in and around Appin Area 7 (formerly known as Douglas Park) Study Area in 2004. These surveys took in portions of the undulating plateau above the Nepean River, as well as the rugged sandstone terrain that had been focused on by Sefton. The surveys revisited some previously recorded sites and discovered three new sandstone overhangs with potential archaeological deposit. They also noted the presence of potential scarred trees and located several features of historical interest. Of these sites, only three overhangs with potential archaeological deposit are within the current Study Area.

Biosis Research (2006) completed a large scale EIS project for the proposed Appin Area 7 (formerly known as Douglas Area 7) Longwalls 701-704. This study included the southern section of the present Study Area. Due to high levels of previous archaeological work throughout the region, the study involved complimentary surveys and reassessment of previously recorded archaeological sites. The complimentary field assessment identified four new Aboriginal archaeological sites, all of which were stone artefact scatters. All previously recorded Aboriginal rock art shelter sites were revisited and photos of the rock art taken at each site for comparison. A number of these archaeological sites were flagged for potential impacts by subsidence by MSEC (2006). Biosis Research (2006) recommended a continued program of monitoring of sites within the predicted area of subsidence impact.

5.6 Discussion and Predictive Model

The archaeological predictive model has been formulated based on the results of the location and type of Aboriginal sites that were recorded within the regional area, the results of the AHIMS database search and information about previous archaeological work. This information has been broken down into patterns that have been compared to the character of the Study Area to allow for an understanding of Aboriginal archaeological potential.

Most of the sites described in Table 3 were identified as a result of surveys undertaken in response to proposed mining activities and recent gas production wells. As most of the Study Area comprises the Cumberland Plain, a greater frequency of open artefact scatter sites are present compared with shelter with art and/or deposit sites that more frequently occur along the incised sandstone valleys of the Nepean River and other major water lines.

Although some sections of the Study Area have been subject to intense archaeological survey, additional Aboriginal archaeological sites are likely to be encountered where survey has not been undertaken due to land access restrictions, and where ground surface visibility is good.

The following section discusses Aboriginal sites types with regard to the likelihood for such sites to occur within the present Study Area.

Rock shelters with art and/ or deposit

Rock shelter sites include rock overhangs, shelters or caves, and generally occur on, or next to, moderate to steeply sloping ground as characterised by the cliff lines along the Nepean River and its tributaries. These naturally formed features may contain rock art, stone artefacts or midden deposits. The sites will only occur where suitable sandstone exposures or overhangs possessing sufficient sheltered space occur, in areas where such geological features exist, such as the Hawkesbury Sandstone. Such topographical features occur within the larger study area but will not be affected by the works that will occur as part of the Appin Area 7 Goaf Gas Drainage development foot print.

Open campsites, artefact scatters and isolated finds

Open campsites and artefact scatter sites can range from high-density concentrations of artefacts to sparse low-density 'background' scatters. These represent a diversity of everyday activities, settlement, hunting and gathering and tool manufacture. Isolated stone artefact occurrences can be located anywhere in the landscape and most likely represent discard or loss during transitory movement.

The identification of these sites depends greatly on ground surface visibility, resulting in the boundaries of a site being defined by the visible extent of the artefacts on the surface. Paddock grasses and open woodland vegetation occur within the Study Area and are likely to obscure stone artefact scatters or isolated occurrences. However, the relatively frequent occurrence of these sites across the southern region of the Study Area indicates that where ground exposure does occur, there is a moderate likelihood of finding stone artefacts. Low density artefact scatters and isolated artefact occurrences are likely to be the most commonly occurring site types within the Study Area.

Thus, there is a moderate likelihood of identifying such sites within the present Study Area, where areas of open ground surface are visible, particularly within close proximity to Foot Onslow Creek and tributaries of Harris creeks. Stone artefact sites that have been previously recorded have been located within close proximity to water sources and along ridgelines.

Axe Grinding Grooves

Axe grinding grooves are often found on large open and relatively flat areas of sandstone shelving and outcrops. Individual grooves are elongated, narrow depressions often found in sedimentary rock, such as sandstone, in association with water sources, including creeks and swamps. Water was essential in the shaping and sharpening process in the manufacture of each axe. In the Woronora Plateau region engraved channels, used to divert the run of water, are a feature associated with some axe grinding grooves.

Although only one grinding groove site has been previously identified within the Study Area to date, they are still considered a frequently occurring site type in the wider region. There is low potential for these to occur on sandstone exposures along major tributaries of the Nepean River and Foot Onslow Creek.

Scarred Trees

Scarred trees exhibit scars caused by the removal of bark used in the manufacture of shields, canoes, containers or shelters. These occur on older trees, generally of a size from which a suitable piece of bark can be removed. A small number of scarred trees are known to exist within close proximity to the Study Area.

Scarred trees can be expected to occur in all landscapes where stands of old growth timbers remain. Such stands should be present within the Study Area. The likelihood of mature trees exhibiting evidence of scarification being present within the Study Area is consequently considered to be low given that most of the Study Area has been cleared of trees for agricultural purposes.

Post-Contact Sites

These are sites relating to the shared history of Aboriginal and non-Aboriginal people of an area. Many of these sites can hold special significance for Aboriginal people and may include places such as missions, massacre sites, post-contact camp sites and buildings associated with post-contact Aboriginal use. This site type is usually known from historical records or knowledge preserved within the local community. It is considered unlikely that any additional, unregistered post-contact sites will be present within the Study Area.

Aboriginal Resource and Gathering Sites

Aboriginal Resource and Gathering Sites are sites where there is ethnographic, oral, or other, evidence that suggest that natural resources have been collected and utilised by Aboriginal people. These natural resources have a cultural significance and connection for the Aboriginal community, such as ochre outcrops that were used for art or ceremonial purposes. These sites are still considered important places today. There are no such known sites within the Study Area however the likelihood of these sites occurring will be further identified through a separate Aboriginal Cultural Assessment involving consultation with the local Aboriginal community.

6.0 HISTORICAL CONTEXT

Historical research has been undertaken to identify the historical context of the Study Area. This history incorporates an understanding of land-use, building patterns and areas of disturbance. This research provides an understanding of the historical archaeological potential for the site.

The following historical background is based on information gathered from the NSW Lands and Title Office, local Appin Parish Plans, local history sources, subdivision plans containing survey information and a number of useful historical websites. Register searches of the National and Commonwealth Heritage Lists, The Register of the National Estate, the State Heritage Register and Inventory, the National Trust of Australia and the Heritage Schedule for the Wollondilly LEP were all competed (see Section 3.0).

All of this information was used to locate known and potential historical archaeological sites.

6.1.1 Establishment of Douglas Park

The Study Area is situated near Douglas Park in the Parish of Camden and the Wollondilly Shire. Explorations in the area of Camden and Appin began in 1790, two years after white settlement of New South Wales. Captain Watkin Tench, William Dawes and George Worgan set out on an expedition from Prospect in August 1790 to explore and record the unknown territory to the south. The published journals of Watkin Tench note that in seven days of walking:

> *Except for the discovery of a river, which is unquestionably the Nepean near its source, nothing very interesting was marked* (Tench 1979: 174).

Governor Hunter led two expeditions into the area in 1795 and in 1796. These expeditions were undertaken following the location of runaway cattle and it was during these trips that Governor Hunter adopted the term 'Cow Pastures' for the area and marked up maps accordingly. The area became a Government Reserve for the purpose of raising stock. The first house was referred to as Cowpastures House and was built as accommodation for constables minding cattle (Vincent 1995: 5). It was completed in early 1805 at Elderslie, near the ford crossing of the Nepean River (Vincent 1995: 5).

In 1802 Francis Barrallier, an Ensign in the New South Wales Corps and a surveyor, was given order by Governor King to attempt to find a path across the Blue Mountains. The attempt to find a path across the Blue Mountains failed, with Barrallier navigating his way south along the foot of the mountains into the Illawarra district. During this expedition Barrallier mapped the location of "Manhangle" swamp, named after the Aboriginal name for the swamp, it is noted in the journal that:

> *"…enormous eels, Fishes and various species of shells are found, which are sometimes used by the natives as food."* (Barrallier 1802:2)

The swamp was recorded on the surveyed map by Barrallier.

George Caley attempted to follow the path of Barrallier later in 1802. Sent by Governor King as a botanist 'collector', Caley also failed in an attempt to find a crossing over the Mountains possibly due to his expertises as a botanist rather than as a surveyor. During his expedition, he explored the area around and beyond the Nepean River, leading to the discovery of Picton (Thirlmere) Lakes. He also camped on "Munangle" lagoon, presumably Menangle Swamp where it is reported that he met and interacted with Aborigines who were also at the lagoon, and gave them shelter during a thunder storm (Mylrea 2002:6-7).

Caley noted in his journal the damage that cattle grazing had done in the local area, likely to have been caused by the wild cattle on the 'Cow Pastures' (Burton 1992). He also reported on the increase in free settlers who were in the area harvesting the timber resources, mostly cedar, in the area for the growing shipbuilding industry in the Colony.

Fearing losing the Hawkesbury supply of cedar and other timbers of 'value', Governor King issued a general order to restrict timber felling along rivers and creeks (Rosen 1995). A 'prohibition' was also placed on crossing the Nepean River. This was to stop the spread of holdings and control them between the coast and the river to help in the development of the region (Moloney 1929).

In 1805 Governor King lifted his prohibition to grant the first allotments in the 'Cow Pastures': 5000 acres to John Macarthur and 2000 acres to Walter Davidson, who later sold his land to John Macarthur. No further land grants were made in the area until 1810, when Governor Macquarie began assigning smaller portions of land and also convicts to settlers in order to encourage farming. From c.1810 to c.1820 most of the land in the area was divided up into farming grants.

To the west Governor Macquarie made the first land grant at Appin, of 1000 acres, to Deputy Commissary General Broughton on 18 October 1811 (Browne 1949: 70). In 1815 Macquarie visited Appin and was impressed with the farming developments in the area. Macarthur was very successful in raising sheep and he continued to expand his acreage. Other settlers followed and also established cattle and wheat properties. Produce from the farms was transported by horse and bullock drays to Sydney via the Appin Road. The Appin Road was an important communication and access corridor in the early stages, however, it declined in importance once the Hume and Princes Highways were built.

In 1821 Governor Macquarie gave 100 acres to Andrew Hume who had journeyed to NSW as an instructor in agriculture. The town of Appin was not surveyed until 1834, however, the agricultural value of the area was already known. Cows from the 'Cow Pastures' were herded and farmed in the district, as well as the farming of wheat, that lead to the establishment of several mills surrounding Appin (www.stonequarry.com.au/towns/appin.html).

Douglas Park was named after an early land grantee in the area. A land grant of 800 acres in 1822 was made in the name of Arthur Douglass, the eight year old son of Dr Henry Gratin Douglass. Dr Douglass came to Australia in 1821 and was born in Ireland of Scottish descent. He was the doctor in charge of the women's reformatory at Parramatta, known as the Factory. He was also the founder of the NSW Benevolent Society and was a supporter of the establishment of the University of Sydney. Dr H.G. Douglass died in 1865 and was buried at St John's Church, Camden.

Arthur Douglass named his estate Hoare Town and to fulfil the terms of the land grant lived there for three years with his mother (Mylrea 2000: 12, Wrigley 1988: 8). As the Hoare Town land grant was sold and sub-divided the area became known as Douglass's Park. This became Douglas Park, and in September 1904 council correspondence decreed that Douglas Park was the official name of the town (Vincent 1995: 53).

These early grants and subsequent subdivisions were used for 'mixed farming' to meet the growing demand in the Sydney and Parramatta Markets. Much of the area was cleared through the use of convict labour gangs and a range of crops were grown. For example, De Arrietta, who had Moreton Park immediately to the east of Douglas Park, cultivated tobacco on his property, while John Macarthur's land to the north of Douglas Park, near Camden, was used for sheep and dairy grazing.

The development of Douglas Park was likely to have been inhibited by its close location to both Camden and Appin. Camden, approximately nine kilometres to the north was a government and economical centre, with a court and post office and public buildings constructed in 1840s. Appin, which was not surveyed and allotments sold until 1834, had a strong flour milling industry and infrastructure established.

The geographical location of Douglas Park was also a factor which restricted its growth. The early access into the area was along the 1805 Cowpasture Road. This road led to the early land grants of Macarthur in the Camden area. Another main road was built between Campbelltown and Picton, which passed by the first land grants to Arthur Douglass. This was reportedly an easier road to Picton, however, it bypassed many of the settler houses (Mylrea 2000: 44). People travelling into the Illawarra at this time would not travel along the Cowpastures or Campbelltown – Picton Road, but used the Appin Road, using Appin as a main staging post.

In 1832 a Great South Road was constructed that followed sections of the original Cowpasture Road and led to the southern districts of NSW. This road passed though Camden, missing Douglas Park to the east and it crossed over the Razorback Range (Mylrea 2000: 43).

The railway initially opened in 1858 from Sydney to Campbelltown. The railway was extended to Menangle in 1863, and later to Douglas Park and Picton in 1869. In 1882, a tramway was established connecting Camden and Campbelltown. It operated until 1963, transporting silver ore from the mines of Yerranderie and milk from the local dairy farms. Campbelltown became the first country town to have piped water - supplied by the Upper Nepean scheme which commenced in 1888. In 1907 work was completed on Cataract Dam, the first of the Upper Nepean dams.

The new road and rail lines in the area aided in the beginning of suburban subdivisions in the 1880s occurring to the north at Minto, Ingleburn, Macquarie Fields and Glenfield. Morton Park Estate, located to the east of Douglas Park located on the land grant to De Arrietta was subdivided into 31 allotments in 1915 (DP8738). The division was mostly into 70 acre and above allotments; however, the proposed division of the estate also included approximately 15 allotments that were less than 20 acres in size.

Later in 1929 road access was upgraded with the building of the (old) Hume Highway that deviated away from the Great South Road. This road was also located to the east of Douglas Park, however, later arterial roads connected the (old) Hume Highway to the Campbelltown – Picton Road. This road was later superseded with the building of the F5 Freeway in 1980.

Within the Douglas Park area agricultural industries continue around the growth of regional centres, such as Camden. Sheep and Dairy farming continued, along with the establishment of Estate type pastoral leases, such as the Mountbatten Estate.

The second land grant in the area of Douglas Park was to Jean Baptiste Lehimaz De Arrietta (also known as D'arriete and D' Arrietta) on 9 July 1822. Governor Thomas Brisbane granted De Arrietta 2000 acres of land. The land was known as Moreton Park (also Moreton Park Estate) and was bounded to the northwest by the extensive land grants of John Macarthur, to the west by Harris Creek, to the east by the Nepean River and to the southwest by the 320 acres granted to Arthur Douglass known as Hoare Town and then as Douglas Park (Mylrea 2000: 10-12).

De Arrietta is thought to be Australia's first settler of Spanish origin (Ballyn 2001). He was a colourful identity in the area of Camden and was credited as the first person to use guard dogs on long leads to protect property (Valentine 1939: 126). The land still known as Spaniards Hill, on the western side of Harris Creek, is named after him and was the site of the first school in Douglas Park. In 1862 a Catholic school was established on the crest of Spaniards Hill (Douglas Park School 1983: 10).

Sources are divided as to whether De Arrietta arrived in Australia as a free settler or a convict. Information in the Wollondilly Heritage Study notes that:

> *Jean Baptiste Lehemaz, [was] a Spaniard taken prisoner by the British and shipped to the colonies. Unsure as to whether to treat d'Arrietta as a gentleman or labour,*

> *the authorities granted him the land together with 25 convicts and required that he produce wine. D'Arietta planted tobacco instead. The crop failed and the convicts escaped*. (JRC 1993: WO 0085, page 4).

However, the notes accompanying the Colonial Secretary's papers describe De Arrietta as a native of Spain who arrived in Sydney as a free settler on the Duke of York in 1821 (Colonial Secretary papers microfiche). It was also noted that De Arrietta was in Spain during the Peninsular War helping the British Army with stores and some spying. He went to England, asked for payment and was promised a grant of land if he came to New South Wales. The land grant was made to him in consideration of the amount of capital he brought to the country and to foster his intention to cultivate the vine (Vincent 1995: 8). The conditions of the land grant were that the land not be sold or alienated for the period of five years and that he took 20 convicts to assist with the clearing and farming (Mylrea 2000: 8-9).

The New South Wales Colonial Secretary correspondence with De Arrietta records that he was granted the land in order to cultivate wine and olives and to rear sheep (Colonial Secretary correspondence July 31, 1821). He was also assigned 10 cows from the Government Stocks at Cowpastures in January 1822 and an additional 20 cows from the Government Stocks in April 1825 (Colonial Secretary Correspondence). Despite this, it was recorded that De Arrietta grew tobacco on the property and was not successful with this crop (Wrigley 1988: 8)

De Arrietta married and built a cottage on the land. This cottage appears to have later been resumed into the courtyard area of the 1860s homestead and kitchen. The Australian Heritage Database describes the cottage as a single-storey dwelling with a central door and two timber nine-paned windows. However, this entry goes on to note that little remains of the original fabric (Place ID 101973).

De Arrietta began to sell off sections of the original 2000 acre land grant during the 1830s due to a series of money problems. He died in 1837 or 1838 and his wife Sophia married a William Walker and moved to Sydney in 1838.

6.2 Previous Archaeological Work and Heritage Listings

6.2.1 State Heritage Register

The State Heritage Register is a list of places and items of State heritage significance, endorsed by the NSW Heritage Council and the Minister of Planning. It was established under the *Heritage Amendment Act* 1998, and replaces the old system of Permanent Conservation Orders as a means of protecting items of State significance. The Register lists a diverse range of places, including archaeological sites, which are of particular importance to the State and which enrich our understanding of the history of NSW. These are legally protected under the NSW *Heritage Act* 1977 and require approval from the Heritage Council of NSW prior to undertaking any work that results in their alteration or modification.

The Register is included within the State Heritage Inventory, which is a database of all statutory protected heritage items in NSW (see below).

There are no areas or items registered on the State Heritage Inventory List within the Goaf Gas Drainage Project Study Area.

6.2.2 State Heritage Inventory

The State Heritage Inventory (SHI) is a database of statutory listed heritage items in New South Wales that are protected by heritage schedules attached to local environmental plans (LEPs), regional environmental plans (REPs), or by the State Heritage Register.

> *The Study Area has no Local Heritage Listing on the State Heritage Inventory based upon the listing in the LEP.*

6.2.3 Local and Regional Environmental Plans

A Review of the Wollondilly Shire Council's Local Environmental Plan (1991) heritage list (schedule 1) revealed no items listed that were within the current Study Area.

6.2.4 Register of the National Estate

The Register of the National Estate contains lists and descriptions of places that are protected under the EPBC Act by the same provisions that protect Commonwealth heritage places. These provisions require that actions:

- taken on Commonwealth land which are likely to have a significant impact on the environment will require the approval of the Minister,
- taken outside Commonwealth land which are likely to have a significant impact on the environment on Commonwealth land, will require the approval of the Minister, and

- taken by the Australian Government or its agencies which are likely to have a significant impact on the environment anywhere, will require approval by the Minister.

There were no items within the Study Area that were registered with the National Estate.

6.2.5 Site Prediction Model

Given the nature of historic development within the Study Area, it is unlikely that further historical sites, additional to those already discussed, will be present. Should any additional sites be identified, they are likely to be associated with known development, being components of Moreton Park Road, the Hume Highway and Main Southern Rail Line construction and development, pastoral use, including domestic remains or farming associated remains.

7.0 SURVEY METHODS

Survey methods for Aboriginal sites have been designed in consultation with the Local Aboriginal community. They have been designed to locate archaeological sites within the Study Area with reference to the following information:

- Previously registered sites within the Study Area.
- Areas of potential as identified by the background research predictive model (regional site patterns as compared to the physical environment of the Study Area, or items identified in historic plans).
- The proposed development footprint.

The survey was conducted exclusively within the Study Area as outlined in Section 1.2 only, and has used the following method:

Targeted survey –

A targeted field method was employed for the survey of the site. The survey targeted areas within the impact area of the proposed development, as well as landforms and areas identified in the predictive modelling as having high likelihood for the presence of sites.

7.1.1 Survey Effectiveness

Factors that influence the effectiveness of the survey include:

Ground Surface Visibility:

Ground Surface Visibility (GSV) is an average amount of the physical ground that could be viewed at the time of survey, and is expressed as a percentage. The primary effect on GSV is vegetation cover, however modern cultural material, such as concrete, rubble, rubbish or land fill can also hamper GSV.

Disturbance

Physical ground disturbance that occurs within the area has been noted and mapped. Ground disturbance includes events such as natural erosion and impacts from historical land-uses such as farming and construction. Ground disturbance can often result in areas of better GSV, therefore making it easier to identify sites, however, such sites tend to have been impacted by the disturbance event.

7.1.2 Aboriginal Participation

Aboriginal representatives from the Tharawal Local Aboriginal Land Council and the Cubbitch Barta Native Title Claimants Aboriginal Corporation participated in the survey. The representatives were asked to provide comment on the cultural significance of the locality and any archaeological objects or areas that were recorded during this survey.

7.1.3 Archaeological Survey Constraints

With any archaeological survey there are several factors that influence the effectiveness or the likelihood of finding sites. The factors that contribute most to how detectable archaeological sites may be are summarised as *visibility* and *exposure.* A brief discussion of these factors is presented below.

Visibility

In most Aboriginal archaeological reports and guidelines, visibility refers to *ground surface visibility*, and is usually a percentage estimate of the ground surface that is visible and allowing for the detection of (usually stone) artefacts that may be present on the ground surface (NSW NPWS 1997: Appendix 4). The visibility of sandstone overhang sites however is not considered here and differs to the visibility of other archaeological sites. The obtrusiveness of sandstone rock shelter and overhang sites, even in heavily vegetated areas is always high, so these sites are likely to be detected and inspected during survey. In comparison the obtrusiveness of surface sites, such as axe grinding grooves, engraved channels and motifs on sandstone platforms, or stone artefact scatters, which occur virtually anywhere, is low to very low because of the limited ground surface visibility described above.

Sandstone shelter sites aside, the primary factor that affects visibility across most of the Study Area is vegetation cover. Grassed paddocks obscure large areas of the ground surface throughout the open paddocks and creek lines in the central and western sections of the Study Area.

Exposure

Exposure refers to the geomorphic conditions of the local landform being surveyed, and attempts to describe the relationship between those conditions and factors that may allow for the exposure of (buried) archaeological materials. While also usually expressed as a percentage estimate, exposure is different to visibility in that it is in part a summation of geomorphic processes, rather than a simple observation of the ground surface (Burke and Smith 2004: 79, NSW NPWS 1997: Appendix 4).

Factors that affect archaeological exposure include the natural geomorphic process acting on a landscape—whether it is aggrading, stable or eroding—and the level of previous disturbance which will expose or potentially bury archaeological sites. A number of geomorphic processes were observed within the Study Area corridor, including fluvial, erosional and residual components within the general landscape. Residual landscapes are likely to accumulate archaeological material over long periods but are not particularly likely to reveal buried artefacts. Erosional landscapes within the Study Area, particularly areas with shallower soils may expose artefacts as surface expressions. Fluvial areas associated with each of the creek banks will have been affected by various episodes of depositional and erosional processes caused from the varying flow levels of the creeks. These processes are most likely to have washed away any Aboriginal archaeological material associated with these areas.

Exposures occurred most frequently within the erosional and fluvial landscapes, as a result of surface disturbance, while exposures within residual landscapes were limited to intrusive processes, such as ploughing.

Disturbance

Disturbance in the Study Area is associated with natural and human agency. Natural agents generally effect small areas and include the burrowing and scratching in soil by animals such as foxes, and rabbits, and sometimes exposure from slumping or scouring. Disturbance associated with recent human action is prevalent in the Study Area, and covers large sections of the land surface. The agents include farming practices such as the initial vegetation clearance for the creation of paddocks, ploughing and cropping, fencing, pony, goats and cattle grazing and stock movement, unsealed tracks, excavation of dams and clearance of creek and drainage channels, and the development of the Hume Highway, Main Southern Railway Line and Moreton Park Road.

Accessibility

There were some issues of access for one of the private properties within the Goaf Gas Drainage Project Study Area. The property, in which a section of the surface pipeline reticulation system and borehole 703B is located, was not assessed by Registered Aboriginal Representatives as part of the cultural heritage assessment due to access not being granted for this type of assessment. This section of pipeline from borehole 703B is marked on Figure 2 in red. The surface pipeline route on this property has assessed by Renée Regal (archaeologist) from Biosis Research. No Aboriginal sites were identified.

Recorded Site Accuracy

As has been the case with many recent archaeological surveys, sites that have been previously recorded are not always easily relocated. This can be attributed to the original method of site recording. If sites were originally recorded by hand on a 1:25,000 map sheet, there is likely to be some inaccuracies. This coupled with a change in co-ordinate systems, from AMG to MGA, increases the likelihood of inaccuracies from the original recorded site co-ordinates. Quite often, recorded sites can be inaccurate to between 20 to 100 metres.

7.2 Survey Results

A total of three new Aboriginal archaeological sites were identified during the current archaeological survey for proposed Appin Area 7 Goaf Gas Drainage Project. These sites include one open artefact scatter sites and two isolated artefact occurrences.

The single previously recorded Aboriginal archaeological site within the Study Area was accessed for reassessment; however the artefact was not relocated.

The recorded Aboriginal archaeological site within the Study Area comprised of an isolated artefact.

The effective survey coverage of the Study Area is considered to be very low, primarily due to seasonal grass cover within the road reserve and adjacent private properties. Areas of ground surface visibility were limited to stock tracks, unsealed tracks, erosion on slopes and creek banks, farm dams, sheet wash and patchy grass cover.

7.2.1 Existing Condition of the Study Area

The Study Area is made up of open, cleared undulating hills that have been heavily disturbed by farming practices and cattle grazing as well as other site disturbances. Due to limited visibility from blackberries and long grass areas of erosion and exposure from both animal and human interaction were targeted as part of this survey.

Plate 1: Visibility on south eastern side of the goaf gas drainage project study area.

Plate 2: Areas of exposure at Mountbatten 1 (52-2-3674).

7.2.2 Aboriginal Archaeological Sites within Study Area

One previously recorded Aboriginal archaeological site (Mountbatten 1 52-2-3674) was visited during the current assessment. The site was rephotographed and reassessed for changes since the original site recording and a new, more accurate, site position was recorded using a hand held GPS. No previously recorded Aboriginal stone artefact sites could be relocated due to poor ground surface visibility. However four artefacts were relocated during a survey by Biosis Research on the 28th November 2008, during this survey both Renée Regal from Biosis Research and Donna Whillock from the Tharawal Local Aboriginal Land Council were present.

The following description of the site is taken from the AHIMS site card as well as the Biosis Research 2006a and 2009 reports.

Mountbatten 1 (52-2-3674) Isolated Artefact

This site was identified originally during archaeological surveys for Appin Area 7 Longwalls 701-704 Subsidence Management Plan (Biosis Research 2006a). This site comprises an isolated stone artefact exposed in the scald of an existing farm vehicle track on the saddle, on the lower slopes of the eastern ridge line of Spaniards Hill. The track appears to have been used continuously, causing erosion along its entire length. The site consists of one multi-directional tuff core. No further cultural material was identified and due to the high levels of ground surface visibility, it is unlikely that further stone artefacts will occur here.

During the 2008 survey a further two artefacts were exposed these consisted of two chert flakes. One is a complete flake with retouch, made from a light grey chert, whilst the second is the distal end of a yellow chert that appears to have faded in sections due to sun exposure. This second flake does not have any retouch.

Plate 3: Western view of exposure where artefacts were relocated.

Plate 4: Southern end of exposure were artefacts identified. Note the vehicle tracks.

Plate 5: Exposure where the artefacts were identified during the survey conducted on 28th November 2008 by Biosis Research.

Plate 6: Dorsal side of light grey silcrete artefact with evidence of retouch.

Plate 7: Dorsal side of yellow chert broken flake with evidence of fading of artefact colour.

Plate 8: Original multi directional tuff core identified during Biosis Research's 2006. The picture was taken during the areas resurvey in 2008.

7.2.2.1 New Aboriginal Archaeological Sites

Three new Aboriginal archaeological sites were recorded during the assessment, all of which comprised open stone artefact scatters or isolated artefact occurrences.

Moreton Park Road IA-1 (52-2-3671) **Isolated Artefact**

This site comprises of a single mudstone flake. The site was located in an exposure in undulating cleared farmland on a private property on the eastern side of Moreton Park Road, Menangle NSW.

The area appears to have been used as a land fill at some stage as there were numerous shards of modern glass and ceramic across the exposure. There were also Welsh ponies grazing in the adjoining paddocks.

Plate 9: Dorsal surface of Moreton Park Road IA-1.

Plate 20: The exposure where Moreton Park Road IA-1 was relocated.

Moreton Park Road IA-2 (52-2-3672) **Isolated Artefact**

The site comprises of a single silcrete artefact on the crest of a hill that has been partly cut away for the development of the Hume Highway. The site was also located on the same private property as Moreton Park Road IA-1.

The artefact is a broken red silcrete flake; whose distal end has broken off. It has 50% cortex present and no evidence of retouch.

Again this site is on an exposure of a highly disturbed nature as it lies right on the fence line; which has a telephone line running underneath it. There are currently a number of Welsh ponies grazing within the paddock that surrounds this site.

Plate 31: Location of Moreton Park Road IA-2 note the cut and fill scar on the western side of the fence

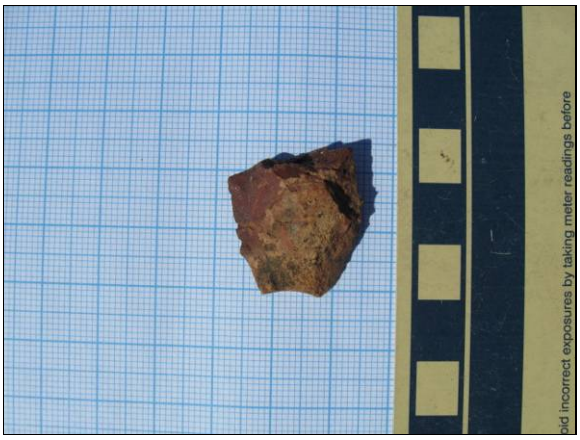

Plate 42: Dorsal surface of Moreton Park Road IA-2

line where the telephone cable was emplaced.

Moreton Park Road OCS-1 (52-2-3673) **Open Camp Site**

This site consists of two artefacts; and was relocated in an exposure in undulating cleared farmland on a private property on the eastern side of Moreton Park Road, Menangle NSW.

The site has been heavily grazed. Again this site is quite close to the fence line; that has been disturbed by the emplacement of the telephone cable.

The first artefact was made from a dark orange silcrete and is a large intact flake (174.1 mm x 65.5 mm x 25.1 mm). The flake has evidence of retouch, and there are several scars where previous flakes have been removed. The second artefact was located approximately 5 metres from the first and is a light grey mudstone artefact (34.5 mm x 24.1 mm x 10.3 mm), with retouch on the dorsal edge and one previous flake scar.

Plate 53: Both artefacts from Moreton Park Road OCS-1

Plate 64: Welsh ponies still grazing at the location of Moreton Park Road OCS-1

7.2.3 Historic Sites

The current survey resulted in the assessment of no previously recorded historical archaeological sites.

8.0 SIGNIFICANCE ASSESSMENT

8.1 Introduction to the Assessment Process

Heritage assessment criteria in NSW fall broadly within the significance values outlined in the Australia ICOMOS Burra Charter (Australia ICOMOS 1999). This approach to heritage has been adopted by cultural heritage managers and government agencies as the set of guidelines for best practice heritage management in Australia. These values include historical, aesthetic, social and scientific significance. The significance of Aboriginal and historic sites and places will be assessed on the basis of the significance values, the details of which are outlined in Appendix 2.

As well as the ICOMOS Burra Charter significance values guidelines, various government agencies have developed formal criteria and guidelines that have application when assessing the significance of heritage places within NSW. Of primary interest are guidelines prepared by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWH&A) and the NSW Department of Environment and Climate Change (DECC) and the Heritage Branch of the NSW Department of Planning. The relevant sections of these guidelines are detailed in Appendix 2.1. It includes the assessment of Aboriginal significance based on Part 1 of the *DECC Guidelines for Aboriginal Heritage Impact Assessment* (1997), which are based on the ICOMOS Burra Charter significance values. In addition to the previously outlined heritage values, the *DECC Guidelines* also specify the importance of considering cultural landscapes when determining and assessing Aboriginal heritage values (see Appendix 2).

8.1.1 Aboriginal Archaeological Sites - Assessment of Significance

Table 4 presents the results of the significance assessment of the sites recorded within the Appin Area 7 Goaf Gas Drainage Project Study Area.

Table 4: Archaeological significance assessment for registered Aboriginal sites identified and considered as part of the proposed Appin Area 7 Goaf Gas Drainage Project study.

SITE NAME	*DISCUSSION OF CONTRIBUTING FEATURES AND ASPECTS*	*ARCHAEOLOGICAL SIGNIFICANCE*
Mountbatten 1 (52-2-3674)	*General*: This site contains three stone artefacts occurrence in an open context, giving only limited value under the general criteria. *Representativeness:* The site has a limited number of artefacts and hence low representative value. *Rarity:* Isolated stone artefact occurrences are not rare. *Research Potential:* Isolated artefacts have limited research potential beyond their basic recording. *Aesthetic:* Located on the upper slopes of a ridge with a vista of the surrounding region, the site has some aesthetic value.	Low
Moreton Park Road IA-1 (52-2-3671)	*General*: This site contains an isolated artefact occurrence in an open context, giving only limited value under the general criteria. *Representativeness:* The site has a limited number of artefacts and hence low representative value. *Rarity:* Isolated stone artefact occurrences are not rare. *Research Potential:* Isolated artefacts have limited research potential beyond their basic recording. *Aesthetic:* Located on the lower slopes of an undulating plain it has little aesthetic value.	Low

SITE NAME	DISCUSSION OF CONTRIBUTING FEATURES AND ASPECTS	ARCHAEOLOGICAL SIGNIFICANCE
Moreton Park Road IA-2 (52-2-3672)	*General*: This site contains an isolated artefact occurrence in an open context, giving only limited value under the general criteria. *Representativeness:* The site has a limited number of artefacts and hence low representative value. *Rarity:* Isolated stone artefact occurrences are not rare. *Research Potential:* Isolated artefacts have limited research potential beyond their basic recording. *Aesthetic:* Located on the lower slopes of an undulating plain it has little aesthetic value.	Low
Moreton Park Road OCS-1 (52-2-3673)	*General*: This site contains two stone artefacts occurrence in an open context, giving only limited value under the general criteria. *Representativeness:* The site has a limited number of artefacts and hence low representative value. *Rarity:* Isolated stone artefact occurrences are not rare. *Research Potential:* Isolated artefacts have limited research potential beyond their basic recording. *Aesthetic:* Located on the upper slopes of a ridge with a vista of the surrounding region, the site has some aesthetic value.	Low

Statement of Cultural Significance

All Aboriginal cultural heritage sites located in the Study Area are considered to be of cultural significance to the Tharawal Local Aboriginal Land Council and the Cubbitch Barta Native Title Claimants Aboriginal Corporation, and it is important that comment on the area is provided directly by members of these Aboriginal communities. Written comments from these Aboriginal stakeholders will be provided when received in Appendix 1.

The sites are evidence of past Aboriginal occupation and use of the area, and are the main source of information about the Aboriginal past. In addition, any recorded (and unrecorded) pre-contact sites are of cultural significance because they are rare or, at least, uncommon site-types. In particular, many sites in the greater Sydney region have been destroyed as a result of land clearance and land-use practices in the historical period.

Cultural landscape values / significance

We firstly approach the assessment of cultural landscape values by considering the value of the assemblage of sites within the identified Study Area – an assemblage of sites in a wider context of other sites, and in the context of the fragmented, localised bushland environment. It is important to note that the value of the cultural landscape as a social phenomenon does not have to rely on robust archaeological interpretation; but rather is a contemporary expression of value to the Aboriginal community, archaeologists, and the community at large. We believe this is in-line with current approaches and policy directions for the NSW DECC (NSW NPWS n.d., Byrne, Brayshaw and Ireland 2001).

The current Study Area is situated on the Cumberland Lowlands, between the Woronora Plateau and the Cumberland Plain, in an area that has been subject to moderate levels of disturbance from various land uses including agriculture and housing development. As a landscape, the Study Area contains limited value as only a small number of archaeological sites occur there and the majority of the Study Area has been cleared and been subject to some level of disturbance, the effect of which is to fragment and disassociate the sites from each other and the landscape. However, it is situated within a physiographic 'transition' zone, giving it a higher variation of site types, including isolated stone artefacts, open campsites, scarred trees, sandstone overhangs with art and / or deposit. These sites provide a record of Aboriginal use of the Study Area prior to European arrival in the region. In addition, the presence of many archaeological sites in the region is a well known fact amongst local Aboriginal communities. This gives the landscape value as a well known though often inaccessible (many places being in private land or restricted access areas such as water catchments) cultural resource for the local Aboriginal communities. Overall, the low frequency of known sites and high historical impact to the landscape of the Study Area suggest it must be considered to have low value as a cultural landscape.

8.2 Historic Sites – Assessment of Significance

8.2.1 Heritage Assessment Criteria

The State Heritage Register, which was established by the amendments to the NSW *Heritage Act* in 1999, has a separate set of significance assessment criteria broadly based on those of the Australia ICOMOS Burra Charter (1999) (see Appendix 2.2 for details of assessment criteria).

8.2.2 Historic sites – assessment of significance

No heritage items are located within the Appin Area 7 Goaf Gas Drainage Project Study Area.

9.0 IMPACT ASSESSMENT

9.1 Proposed Development

Impacts on remaining cultural heritage associated with the proposed development works include the following:

- BHP Billiton Illawarra Coal is proposing to drain goaf gas from the proposed longwall sections of Appin mine by drilling boreholes, called wells, between the goaf and the surface (Cardno Forbes Rigby 2008; 8).

- The goaf gas will be drawn up the boreholes by an extraction plant located on the surface to ensure underground concentrations remain well below 1.25%. The proposed gas extraction plant will be in a centralised location (Figure 2). This assessment involved looking at two possible options for the goaf gas extraction plant/s locations. The preferred option for the location of the extraction is on the property described as Lot 2 DP 576136 and a second contingency or back up extraction plant is proposed to be located on the property described as Lot 7 DP 250231. Both properties and proposed extraction plant locations were assessed as part of this assessment.

- Pipeline will also be placed in trench just below the ground surface as a reticulation system connecting multiple goaf gas wells to the extraction plant. This will involve the excavation of a small trench approximately 0.65 metres wide, to a depth of 1.4 metres. The pipeline routs follows existing fence lines to minimise disruption to landowners.

9.2 Potential Impacts

As discussed above, the proposed development requires a small level of disturbance within the Study Area. This disturbance may impact the physical remains and significance of archaeological sites in the following ways:

The excavation of the trench to emplace the surface pipeline reticulation system may disturb the following sites Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673).

9.3 Recommendations

Ideally heritage management involves conservation of sites through the preservation and conservation of fabric and context. In cases where conservation is not possible or practical, several options for management are available. For archaeological sites management often involves mitigation through the salvage of features or artefacts and retrieval of information through excavation or collection, and interpretation, especially where impact cannot be avoided

Aboriginal archaeological sites

There are 20 Aboriginal cultural heritage sites situated within the Goaf Gas Drainage Study Area. Four of these sites: Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673) may be impacted by the installation of the Goaf Gas Drainage surface pipeline reticulation system (Figure 2).

Aboriginal Recommendations

A copy of this report should be distributed to the Registered Stakeholder Aboriginal communities for their review and comment on receipt of final comments from BHP Billiton Illawarra Coal.

Recommendation 1 - Conservation

- Sites Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673) – comprising isolated stone artefact occurrences and open camp sites- are required to be registered as Aboriginal sites with NSW DECC. The sites will be listed on the Aboriginal Heritage Information Management System.

- Where practicable, BHP Billiton Illawarra Coal should avoid impact to Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673)

- If the archaeological sites can be avoided, they should be fenced prior to construction using protective barriers, and all contractors should be notified of the importance of avoiding archaeological sites prior to undertaking of ground disturbance activities.

- If the archaeological sites cannot be avoided then a Cultural Heritage Management Plan should be developed and implemented to facilitate the management, salvage and relocation of both sites.

Recommendation 2 – Aboriginal Cultural Heritage Management Plan

- An Aboriginal Cultural Heritage Management Plan (ACHMP) should be developed and implemented. This will outline the management of Mountbatten 1 (52-2-3674), Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673), and the management of any Aboriginal cultural material uncovered during construction. The ACHMP will detail Aboriginal community consultation and involvement of registered stakeholder groups.

- The ACHMP will be included and implemented as part of the Environmental Management Plan (EMP).

Recommendation 3 - Stop work provision: Aboriginal sites

- All Aboriginal places and objects are protected under the NSW *National Parks and Wildlife Act 1974*. This protection includes Aboriginal places and objects which have not been identified in this report, but which may be identified during construction. Should any previously unidentified Aboriginal objects or places be identified during excavation and construction, all works must cease in the vicinity of the find and the following be notified:
  - NSW Department of Environment and Climate Change
  - A qualified archaeologist
  - Aboriginal stakeholders

Recommendation 4 – Human Remains

In the case of skeletal remains the following process will be implemented.

- The find will be reported to police and state coroner
- BHP Billiton Illawarra Coal and Cardno Forbes Rigby will be notified of the find
- Aboriginal stakeholders will be notified of the find
- NSW DECC will be notified of the find
- If the skeletal remains are of Aboriginal ancestral origin an appropriate management strategy will be developed in consultation with the Aboriginal stakeholders
- The find will be recorded in accordance with the National Parks and Wildlife Act 1974 (NSW) and the NSW NPWS Aboriginal Cultural Heritage Standards and Guidelines Kit
- This Aboriginal Cultural Heritage Management Plan will be amended to include the newly discovered Aboriginal ancestral remains in the management regime established by the plan

Historical archaeological sites

There were no new or previously registered historical archaeological sites within the Goaf Gas Drainage Project Study Area.

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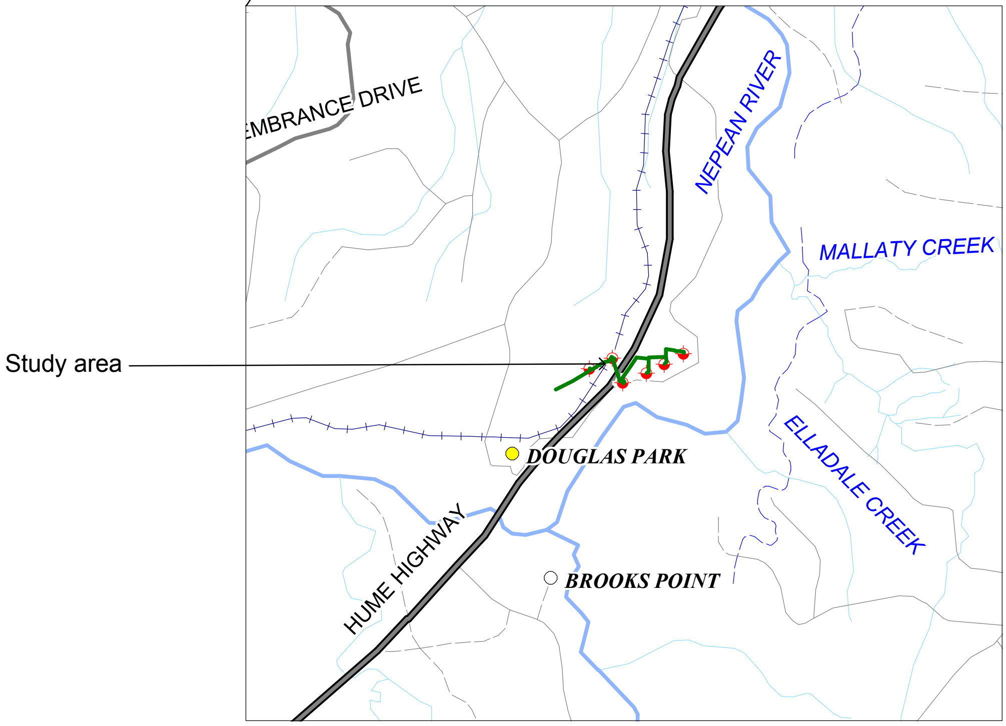
FIGURES



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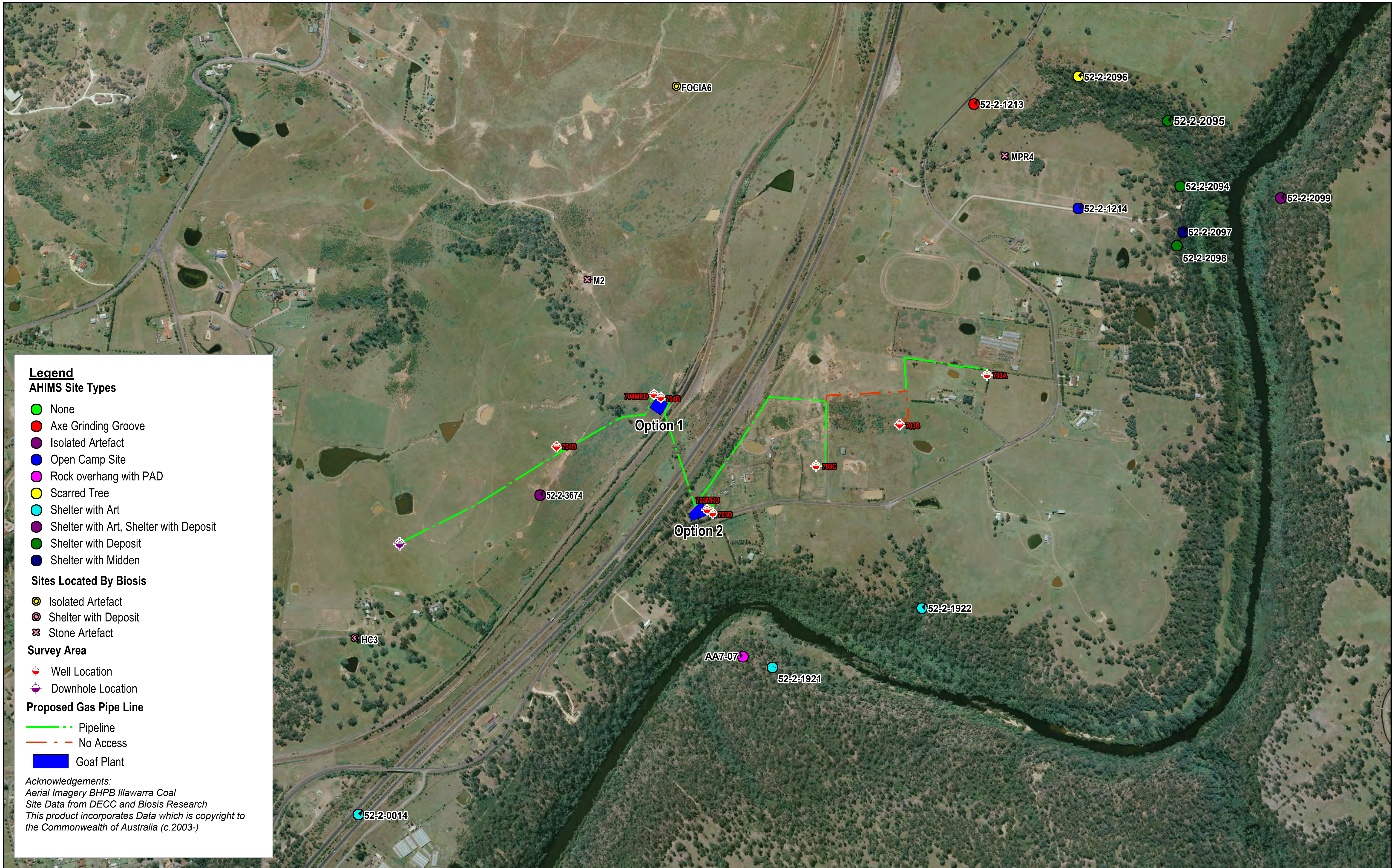

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NEW SOUTH WALES 2500

BIOSIS RESEARCH

Figure 2: Previous Archaeological sites from the AHIMS Register within a regional context.

Figure 2: Previous Archaeological sites from the AHIMS Register within a regional context.

Date: 15 May 2009

Checked by: RBR | File number: S5310

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N W E S

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NEW SOUTH WALES 2500

Figure 3: New Archaeological sites identified during the current survey

Figure 3: New Archaeological sites identified during the current survey

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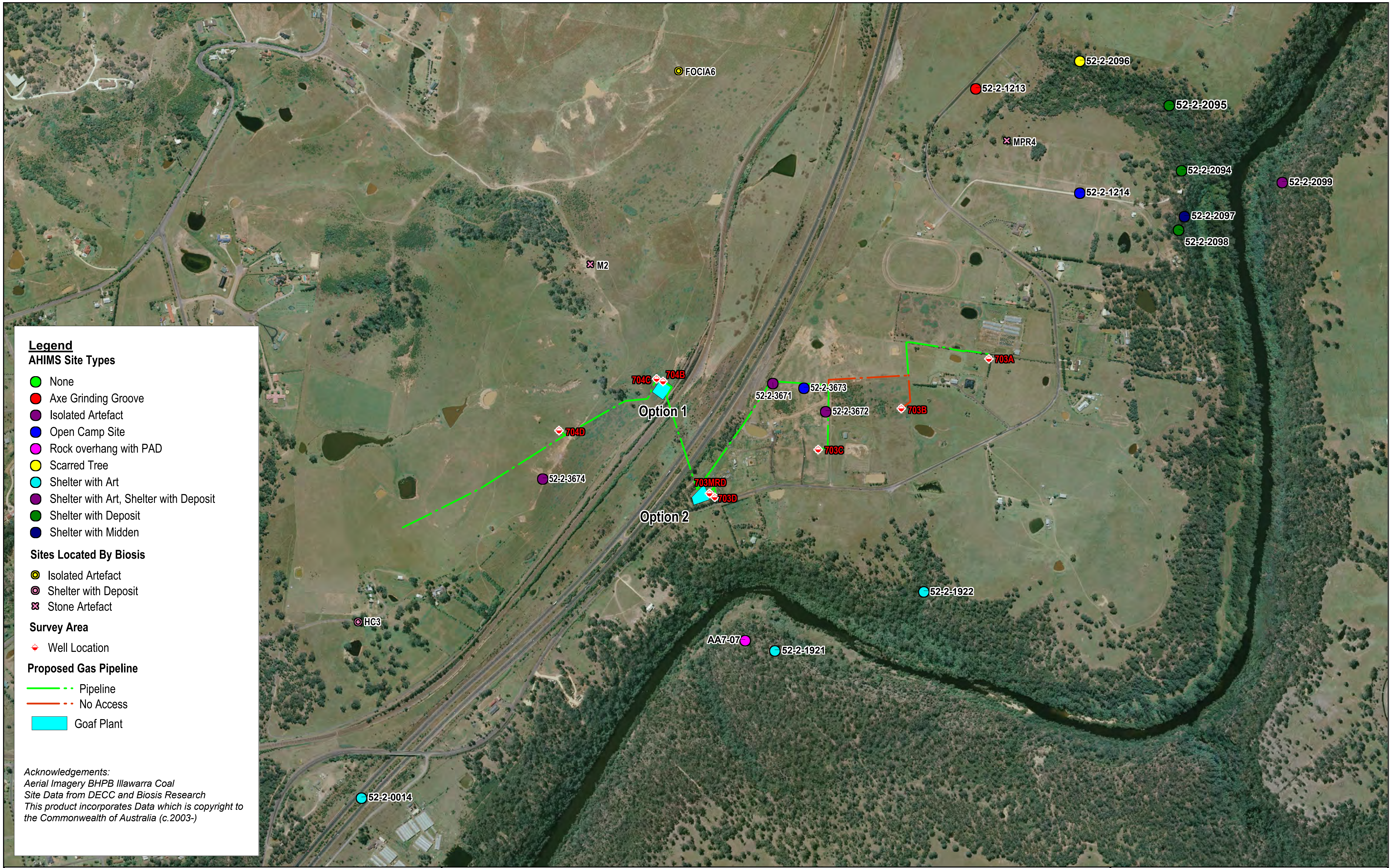

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Figure 4: All recorded Aboriginal sites recorded within the present Study Area

Figure 4: All recorded Aboriginal sites recorded within the present Study Area

Date: 08 May 2009

Checked by: RBR | File number: S5310

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APPENDICES

APPENDIX 1

1.0 ABORIGINAL COMMUNITY COMMENT

TO BE INCORPORATED WHEN RECEIVED.

Glenda Chalker (Cubbitch Barta Native Title Claimants Aboriginal Corporation) has been contacted in regards to their community comments on the proposed development. Glenda committed to getting written comments to Renée Regal, however these comments are yet to be received by Biosis Research.

THARAWAL LOCAL ABORIGINAL LAND COUNCIL

Gibbergunyah (Formerly Stonequarry Lodge)
50 Matthews Lane, Picton NSW 2571

Biosis Research
Renee Regal
8 Tate Street,
WOLLONGONG NSW 2500

26th of May 2009

Re: The proposed Goaf Gas Drainage, Douglas Park

Dear Renee,

I have read report 1 and report 2 on the Goaf Gas drainage project at Douglas Park and I am pleased with your recommendations for Aboriginal sites to be avoided if possible. However I am aware that there are a couple of sites that will be affected by the proposed Gas project and I was relived that you recommended fencing the area off and also the possible collection of artefacts till the work is completed and the re-dispersal of artefacts back in the original area after completion of the Goaf Gas project.

I support your recommendations.

Donna Whillock
Cultural and Heritage Representative
Tharawal Local Aboriginal Land Council

PO Box 20
Buxton NSW 2571
Phone: 02 4681 0059 Fax: 02 4683 1375
tharawal.lalc@bigpond.com

APPENDIX 2

2.0 ASSESSMENT OF SIGNIFICANCE

2.1 Significance Assessment Process

Heritage assessment criteria in NSW fall broadly within the significance values outlined in the Australia ICOMOS Burra Charter (Australia ICOMOS 1999). This approach to heritage has been adopted by cultural heritage managers and government agencies as the set of guidelines for best practice heritage management in Australia. These values include:

- **historical** significance (evolution and association) refers to historic values and encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all of the terms set out in this section. A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may also have historic value as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives in situ, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment.

- **aesthetic** significance (Scenic/architectural qualities, creative accomplishment) refers to the sensory, scenic, architectural and creative aspects of the place. It is often closely linked with social values and may include consideration of form, scale, colour, texture, and material of the fabric or landscape, and the smell and sounds associated with the place and its use.

- **social** significance (contemporary community esteem) refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day community. Places of social significance have associations with contemporary community identity. These places can have associations with tragic or warmly remembered experiences, periods or events. Communities can experience a sense of loss should a place of social significance be damaged or destroyed. These aspects of heritage significance can only be determined through consultative processes with local communities.

- **scientific** significance (Archaeological, industrial, educational, research potential and scientific significance values) refers to the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects. Assessment of scientific value is often based on the likely research potential of the area, place or object and will consider the importance of the data involved, its rarity, quality or representativeness, and the degree to which it may contribute further substantial information.

The significance of Aboriginal and historic sites and places will be assessed on the basis of the significance values outlined above. As well as the ICOMOS Burra Charter significance values guidelines, various government agencies have developed formal criteria and guidelines that have application when assessing the significance of heritage places within NSW. Of primary interest are guidelines prepared by the Commonwealth Department of Environment, Water, Heritage and the Arts(DEWH&A) and the NSW Department of Environment and Climate Change (DECC) and the Heritage Branch, NSW Department of Planning. The relevant sections of these guidelines are presented below.

Aboriginal Sites – Assessment of Significance

The following Aboriginal significance assessment is based on Part 1 of the *DEC Guidelines for Aboriginal Heritage Impact Assessment* (1997). These guidelines state that an area may contain evidence and associations which demonstrate one or any combination of the ICOMOS Burra Charter significance values outlined above in reference to Aboriginal heritage. Reference to each of the values will be made when evaluating Aboriginal significance for sites and places.

In addition to the previously outlined heritage values, the *DEC Guidelines* also specify the importance of considering cultural landscapes when determining and assessing Aboriginal heritage values. The principle behind a cultural landscape is that 'the significance of individual features is derived from their inter-relatedness within the cultural landscape'. This means that sites or places cannot be 'assessed in isolation' but must be considered as parts of the wider cultural landscape. Hence the site or place will possibly have values derived from its association with other sites and places. By investigating the associations between sites, places, and (for example) natural resources in the cultural landscape the stories behind the features can be told. The context of the cultural landscape can unlock 'better understanding of the cultural meaning and importance' of sites and places.

Although other values may be considered – such as educational or tourism values – the two principal values that are likely to be addressed in a consideration of Aboriginal sites and places are the cultural/social significance to Aboriginal people and their archaeological or scientific significance to archaeologists. The former is discussed in greater depth below, as it is more comprehensively addressed in the Guidelines for Aboriginal Impact Assessment. However we note here that it is best practice for archaeologists when undertaking significance assessments to keep in mind that scientific assessments are part of a larger picture.

The determinations of Aboriginal significance for sites and places will then be expressed as *statements of significance* that preface a concise discussion of the contributing factors to Aboriginal cultural heritage significance. Nomination of the level of value—high, moderate, low or not applicable—for each relevant category will also be proposed and presented in a summary table.

Aboriginal community or cultural values

The NSW DECC recognises that 'Aboriginal community are the primary determinants of the significance of their heritage' (NSW DEC 2004). Biosis Research recognises that our role in the cultural heritage assessment process is to provide specialist skills, particularly in regard to archaeological and heritage management expertise. These specialist skills can be articulated and enhanced through consultation with the Aboriginal community, with the aim of providing a comprehensive assessment of cultural heritage significance.

The heritage assessment criteria outlined above that relate to community or cultural values include social, historic and aesthetic value. Social and aesthetic values are often closely related. Social value refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day Aboriginal community. Aesthetic values related to Aboriginal sites and places that may contain particular sensory, scenic, architectural and creative values and meaning to Aboriginal people. Historic value refers to the associations of a place with a person, event, phase or activity of importance to the history of an Aboriginal community. Gaining a sufficient understanding of this aspect of significance will often require the collection of oral histories and archival or documentary research, as well as field documentation. Places of post-contact Aboriginal history have generally been poorly recognised in investigations of Aboriginal heritage, and the Aboriginal involvement and contribution to important regional historical themes is often missing from accepted historical narratives.

These aspects of heritage significance can only be determined through consultative processes with one or more Aboriginal communities. In terms of Aboriginal communities, heritage places – including those that are otherwise defined as ‘archaeological sites’ – will always attract differing values. These may include custodianship obligations, education, family or ancestral links, identity, and symbolic representation. History and traditions are important: this generation has an obligation to future generations to retain certain things as they are currently seen and understood. This includes retaining alternative understandings to those that come through scientific assessments. Heritage places are often more complex than is identified through the scientific determination of value. Cultural and social values can be complex and rich - the past is a vital component of cultural identity. Feelings of belonging and identity are reinforced by knowledge of the existence of a past, and this is further reinforced and maintained in the protection of cultural heritage.

Statement of Cultural Significance

All Aboriginal cultural heritage sites located in the Study Area are considered to be of cultural significance to the Tharawal Local Aboriginal Land Council and the Cubbitch Barta Native Title Claimants Aboriginal Corporation, and it is important that comment on the area is provided directly by members of these Aboriginal communities. The sites are evidence of past Aboriginal occupation and use of the area, and are the main source of information about the Aboriginal past. In addition, any recorded (and unrecorded) pre-contact sites are of cultural significance because they are rare or, at least, uncommon site-types. In particular, many sites in the greater Sydney region have been destroyed as a result of land clearance and land-use practices in the historic period.

Aboriginal (Scientific) Significance

Archaeological significance (also called scientific significance) refers to the value of archaeological objects or sites as they relate to research questions that are of importance to the archaeological community, including indigenous communities, heritage managers and academic archaeologists. Generally the value of this type of significance will be determined on the basis of the potential for sites and objects to provide information regarding the past life-ways of people (Burke and Smith 2004: 249, NPWS 1997). For this reason, the NSW NPWS summarises the situation as 'while various criteria for archaeological significance assessment have been advanced over the years, most of them fall under the heading of archaeological research potential' (NPWS 1997: 26). The NPWS criteria for archaeological significance assessment are based largely on the Register of the National Estate Criteria, and under the heading of 'research potential' include the following aspects and definitions (NPWS 1997):

General site considerations, including factors such as:

- *Site intactness or integrity:* This includes the state of preservation of archaeological objects, as well as the stratigraphic integrity of the site, the taphonomic processes acting on the site, the impact of past artefact collections made at the site.

- *The connectedness* of the site to other sites – when considered as part of a larger assemblage or landscape the site may have greater research potential than if it was simply considered in isolation.

- *Chronological potential* refers to the potential of a site to provide a dateable framework extending back into the past. The potential antiquity of a site is also an important consideration, as older sites are relatively less common than younger sites. In many cases stratified, dateable artefact bearing deposits are sufficiently rare to be a very valuable resource.

Representativeness

- *Representativeness* refers to the ability of a site or object to serve as a representative example of sites in the same class. This aspect of value is only meaningful when considered in conjunction with a conservation goal, and must be determined against the archaeological record at various scales of consideration - local, regional and continental for example. It takes into account site and object variability, connectedness and a consideration of what is already, and likely to be, conserved. Burke and Smith (2004: 247) define representativeness as 'an assessment of whether or not a place is a good example of its type, illustrating clearly the attributes of its significance.'

Rarity

- *Rarity* is, of course, closely related to representativeness (if a site is rare, it is likely to have high representative value), and will include a consideration of those issues discussed under general site considerations. In many ways, the determination of rarity is a summation of exceptional research potential, or a representative of a small class of sites or objects. Burke and Smith (2004: 247) further describe rarity as 'an assessment of whether the place represents a rare, endangered or unusual aspect of our history or cultural environment that has few parallels elsewhere.'

Research Potential

Research potential is essentially a summation of the above values in the general, representativeness and rarity criteria (NPWS 1997). Pearson and Sullivan note that Aboriginal archaeological sites are generally of high research potential because 'they are the major source of information about Aboriginal prehistory'(1999: 149). Indeed, the often great time depth of Aboriginal archaeological sites gives them research value from a global perspective, as they are an important record of humanity's history. Research potential can also refer to specific local circumstances in space and time – a site may have particular characteristics (well preserved samples for absolute dating, or a series of refitting artefacts, for example) that mean it can provide information about certain aspects of Aboriginal life in the past that other less or alternatively valuable sites may not (Burke and Smith 2004: 247-8). When determining research potential value particular emphasis has been placed on the potential for absolute dating of sites.

In addition to the research potential related value factors, the NSW NPWS (1997: 32) also discuss *Educational Potential* and *Aesthetic Significance*, as items that may be included in scientific significance. The NPWS general advice is that archaeologists should give careful consideration prior to attempting to determine educational and aesthetic values (NPWS 1997: 32). We make no attempt to determine educational potential of sites under scientific assessment, but do consider educational value as a contributing factor that may be included in an assessment of social significance by the Aboriginal community.

Aesthetic values

There is a diverse yet accessible literature regarding identifying aesthetic values and determining aesthetic significance (Burke and Smith 2004: 248-9, Kerr 1996: 15-16, Pearson and Sullivan 1999: 134-8). It is generally agreed that aesthetic values are an important part of cultural heritage significance, however they are dependent on an individual's sensory response, which means determining aesthetic value is fraught with difficulty, and should be applied on a case-by-case basis as it is not always a value applicable to archaeological sites (Burke and Smith 2004: 248). However, when dealing with shelter and rock art sites aesthetic values and landscape context are an important consideration. The question 'does the place have a relationship between its parts and the setting which reinforces the quality of both', while originally proposed in an architectural context (Kerr 1996: 15), is relevant also for rock art and shelter sites in a bushland setting where there is often an important relationship between the cultural site and natural environment.

2.2 Historic Sites – Assessment of Significance

The State Heritage Register, which was established by the amendments to the NSW *Heritage Act* in 1999, has a separate set of significance assessment criteria broadly based on those of the Australia ICOMOS Burra Charter (1999).

To be assessed for listing on the State Heritage Register an item will need to meet one or more of the following criteria:

CRITERION	*DESCRIPTION*	*CATEGORY*
A	An item is important in the course, or pattern, of NSW's cultural or natural history;	Nature of
B	An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history;	Nature of
C	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW;	Nature of
D	An item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons;	Nature of
E	An item has the potential to yield information that will contribute to an understanding of NSW's cultural and natural history;	Nature of
F	An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history;	Comparative
G	An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural or natural environments.	Comparative

Table 5 : Criteria for the assessment of historic cultural heritage

Amendments to the *Heritage Act* clarify and strengthen responsibility for the management of heritage items at the Local and State level. Consequently, items can be assessed as having **Local** or **State** level significance. Items should also be assigned a grading, in order to better explain its place within a cultural landscape. Criteria for grading an item or place are discussed below.

An item cannot be excluded from listing on the State Heritage Register on the basis that items with similar characteristics have already been listed. These criteria can be applied to items of State and Local significance.

These assessment criteria are useful in considering a wide range of heritage items, and may be applied to sites with items of standing heritage as well as areas with the potential to contain archaeological deposits.

APPENDIX 3

3.0 LEGISLATION

COMMONWEALTH LEGISLATION

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

In January 2004 the Commonwealth *Australian Heritage Commission Act 1975* was repealed and in its place amendments to the EPBC Act were made. The amendments were contained in three new pieces of Commonwealth Heritage Legislation. The three new Acts are the:

1. Environment and Heritage Legislation Amendment Act (No. 1) 2003 which:
   (a) amends the Environment Protection and Biodiversity Conservation Act 1999 to include 'national heritage' as a new matter of National Environmental Significance and protects listed places to the fullest extent under the Constitution
   (b) establishes the National Heritage List
   (c) establishes the Commonwealth Heritage List
2. Australian Heritage Council Act 2003 which establishes a new heritage advisory body to the Minister for the Environment and Heritage, the Australian Heritage Council, and retains the Register of the National Estate.
3. Australian Heritage Council (Consequential and Transitional Provisions) Act 2003 which repeals the Australian Heritage Commission Act, amends various Acts as a consequence of this repeal and allows for the transition to the new heritage system.

Any place that has been nominated and assessed as having cultural heritage significance at a national level can be added to the National Heritage List.

Under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) an action requires approval from the Federal Environment Minister if the action will, or is likely to, have a significant impact on a matter of national environmental significance. Matters of national environmental significance relating to cultural heritage are:

- World Heritage Places, and
- National Heritage Places.

An action includes a project, development, undertaking, activity, or series of activities.

Actions that are likely to have a significant impact on the environment of Commonwealth land (even if taken outside Commonwealth land), and actions taken by the Commonwealth that are likely to have a significant impact on the environment anywhere in the world, may also require approval under the EPBC Act.

NATIVE TITLE ACT 1993

The Commonwealth Native Title Act establishes the principles and mechanisms for the preservation of Native Title for Aboriginal people.

Under Subdivision P of the Act, *Right to negotiate*, native title claimants can negotiate about some proposed developments over land and waters (known as ‘Future Acts’) if they have the right to negotiate. Claimants gain the right to negotiate if their native title claimant application satisfies the registration test conditions.

The right to negotiate applies over some proposed developments or activities that may affect native title. These are known as future acts under the Native Title Act 1993. Native title claimants only have the right to negotiate over certain types of future acts, such as mining. Activities such as exploration and prospecting on the land do not usually attract the right to negotiate.

The right to negotiate is not a right to stop projects going ahead — it is a right to have a say about how the development takes place. In some situations, the right to negotiate does not apply. In these circumstances, claimants may have the right to be notified, to be consulted, to object and to be heard by an independent umpire.

The right to negotiate is triggered when a government issues a notice to say that it intends to allow certain things to happen on land, such as granting a mining lease. This notice is called a 'section 29 notice.

People who claim to hold native title in the area, but have not yet made a native title claimant application, have three months from the date given in the section 29 notice to file a claim if they want to have a say about the proposed development. To get the right to negotiate, the claim must be registered within a month after that.

If the right to negotiate applies, the government, the developer and the registered native title parties must negotiate 'in good faith' about the effect of the proposed development on the registered native title rights and interests of the claimants.

The parties can ask the National Native Title Tribunal to mediate during the negotiations.

If the negotiations do not result in an agreement the parties can ask the Tribunal (no sooner than six months after the notification date) to decide whether or not the future act should go ahead, or on what conditions it should go ahead.

The National Native Title Tribunal administers the future act processes under the Commonwealth legislation. The Tribunal's role includes mediating between parties, conducting inquiries and making decisions (called 'future act determinations') where parties can't reach agreements.

When the Tribunal receives a future act determination application, it must conduct an inquiry (an arbitration) in order to determine whether the future act can be done and if so whether any conditions should be imposed.

A member of the Tribunal (or a panel of three members) will be appointed to conduct the inquiry, and will initially hold a preliminary conference and set directions for the parties to provide submissions and evidence. Members who have mediated a particular matter are not usually appointed as inquiry members. Inquiry members conduct hearings, receive submissions and evidence from the parties and take into account matters set out in section 39 of the Native Title Act such as:

- the effect of the future act on the enjoyment by the native title party of their registered native title rights and interests; their way of life, culture and traditions; the development of their social, cultural and economic structures; their freedom of access to the land and freedom to conduct ceremonies and other cultural activities; and the effect of the future act on any area or site of particular (special) significance to the native title party;
- the interests, proposals, opinions or wishes of the native title party;
- the economic or other significance of the future act;
- the public interest; and
- the presence of any existing non-native title rights and interests and use of the land by other persons (for instance, pastoralists).

ABORIGINAL AND TORRES STRAIT ISLANDER HERITAGE PROTECTION ACT 1984

The Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984 provides protection for Aboriginal cultural property. Whereas the State Act provides legal protection for all the physical evidence of past Aboriginal occupation, the Commonwealth Act deals with Aboriginal cultural property in a wider sense. Such cultural property includes any places, objects and folklore that 'are of particular significance to Aboriginals in accordance with Aboriginal tradition'. There is no cut-off date and the Act may apply to contemporary Aboriginal cultural property as well as ancient sites.

PROTECTION OF MOVABLE CULTURAL HERITAGE ACT 1986

Australia's movable cultural heritage is protected at both Commonwealth and State levels. This web site only provides information on the Commonwealth laws.

In 1970 the United Nations Educational, Scientific and Cultural Organisation (UNESCO) adopted the UNESCO Convention on the Means of Prohibiting the Illicit Import, Export and Transfer of Ownership of Cultural Property. Australia ratified the convention by passing the *Protection of Movable Cultural Heritage Act 1986* (the Act), giving the 1970 Convention force in Australian law.

The Act regulates the export of Australia's significant cultural heritage objects. It is not intended to restrict normal and legitimate trade in cultural property and does not affect an individual's right to own or sell within Australia.

It implements a system of export permits for certain heritage objects defined by the Act as 'Australian protected objects'. Australian protected objects are objects which form part of the movable cultural heritage of Australia and which meet the criteria established under the National Cultural Heritage Control List. The Control List is located in the Regulations to the Act, and divides Australian protected objects into two classes:

- Class A objects which may not be exported
- Class B objects which may be exported if granted a permit under the Act.

A person wishing to export a Class B object is required to apply for a permit in writing. Applications are processed in accordance with the legislative process established under section 10 of the Act.

Certificates of Exemption, granted under section 12 of the Act, allow Australian protected objects that are currently overseas to be imported into Australia and subsequently re-exported. This includes Class A objects.

The Act also includes provisions that allow Australia to respond to an official request by a foreign government to return movable cultural heritage objects that have been illegally exported from their country of origin.

The *Protection of Movable Cultural Heritage Act 1986* is administered by the Minister for the Environment and Heritage. This responsibility was transferred from the Minister for Communication, Information Technology and the Arts in November 2001.

The Movable Cultural Heritage Unit in the Department of the Environment and Heritage provides the Secretariat to the National Cultural Heritage Committee

STATE LEGISLATION

NATIONAL PARKS AND WILDLIFE ACT 1974

The *National Parks and Wildlife Act 1974* provides for the protection of Aboriginal objects (sites, relics and cultural material) and Aboriginal places. Under the Act (S. 5), an Aboriginal object is defined as:

> *any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains.*

This includes individual artefacts, scatters of stone artefacts, rock art sites, ancient camp sites, human burials, scarred trees, and ruins and archaeological deposits associated with Aboriginal missions or reserves.

Aboriginal places (areas of cultural significance to the Aboriginal Community declared by the Minister) are protected under Section 84 of the Act.

Aboriginal objects (any material evidence of the Aboriginal occupation of NSW) are protected under Sections 86, 87 and 90 of the Act. Section 86 of the Act identifies that a person, other than the Director-General or a person authorised by the Director-General in that behalf, who:

> *(a) disturbs or excavates any land, or causes any land to be disturbed or excavated, for the purpose of discovering an Aboriginal object*

is guilty of an offence under the NPW Act.

The *National Parks and Wildlife Act* requires that a permit from the Director General be obtained before archaeological fieldwork involving disturbance to an Aboriginal site is carried out. Consent is granted under section 87 and 90 of the Act. Queries and applications to excavate or disturb an Aboriginal archaeological site for purposes of archaeological fieldwork, should directed to the relevant Planning and Aboriginal Section Manager at the appropriate Environment Protection and Regulation Branch office. For this study the relevant branch office is at Sydney.

Section 91 of the Act requires the mandatory reporting of the discovery of Aboriginal objects, and establishes a mechanism for interim protection orders that may be used to protect objects. Identified Aboriginal objects and sites are registered with the NSW Department of Environment and Conservation (DEC) on the Aboriginal Heritage Information Management System (AHIMS). DEC administers *the National Parks and Wildlife Act 1974*.

HERITAGE ACT 1977

The *Heritage Act 1977* details statutory responsibilities for historic buildings and gardens, historic places and objects, historical archaeological sites, and historic shipwrecks. The Act is administered by the Heritage Council of New South Wales, through the NSW Heritage Office.

The aim of the Act is to conserve the 'environmental heritage' of the state, which includes items such as buildings, works, relics, moveable objects or precincts significant for historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. A 'Place' is defined as an area of land, with or without improvements and a 'Relic' is defined as any:

> *deposit, object or material evidence:*
>
> *(a) which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and*
>
> *(b) which is 50 or more years old.*

An excavation permit is required for any works, excavations or activities, associated with an archaeological site. Excavation permits are issued by the Heritage Council of New South Wales in accordance with sections 60 or 140 of the *Heritage Act*.

It is an offence to disturb or excavate land to discover, expose or move a relic without obtaining a permit from the NSW Heritage Council.

> *139 Excavation permit required in certain cases*
>
> *(1) A person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit.*
>
> *(2) A person must not disturb or excavate any land on which the person has discovered or exposed a relic except in accordance with an excavation permit.*

Excavation permits are usually issued subject to a range of conditions that will relate to matters such as reporting requirements and artefact cataloguing, storage and curation. A permit may be required from the Heritage Council of NSW for works or activities associated with a registered place or object.

General queries about site issues and permit applications can be made to the archaeological officers at the Heritage Office. The contact details are:

NSW Heritage Office

3 Marist Place

PARRAMATTA NSW 2150

Ph: (02) 9873 8500

Fax: (02) 9873 8599

Consultation and discussion with the NSW Heritage Office should begin well before lodging an application for a permit to disturb or destroy a historical archaeological site.

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The *NSW Environmental Planning and Assessment Act* will have relevance for all development projects because it requires that environmental impacts are considered in land-use planning and decision making. The definition of 'environment impacts' includes impacts on the cultural heritage of the project area. The Act has three relevant parts: Part III, which governs the preparation of planning instruments; Part IV, which relates to development where consent is required under an environmental planning instrument (EPI); and Part V, which relates to activity where development consent is not required but some other government approval assessments are needed.

Under the Act, local government authorities and The Department of Infrastructure, Planning and Natural Resources (formerly Planning NSW) prepare local and regional environmental planning instruments (LEPs and REPs) to give statutory force to planning controls. These may incorporate specific provisions for conserving and managing archaeological sites.

Integrated Development Assessment (IDA) was introduced under the *Environmental Planning and Assessment Act* so that all matters affecting a development application would be considered by the consent authority in an integrated way.

Integrated Development is one which requires development consent as well as one or more approvals from different government agencies. Such agencies may include NSW DEC or the NSW Heritage Council. If a development is likely to impact a heritage item, the consent authority must refer it, to NSW DEC (for Indigenous objects) or the NSW Heritage Council (for sites listed on the State Heritage Register) prior to approval determination.

The Local Government Act 1993

Under the State Local Government Act, councils can prepare local approvals policies that set out specific matters for consideration in relation to applications to demolish, build or undertake works. Archaeological sites could be considerations under such policies.

Annex F

F. Aboriginal Cultural Heritage Management Plan

BIOSIS
RESEARCH

Appin Area 7 Longwalls 703 to 704 Goaf Gas Drainage Project

Aboriginal Cultural Heritage Management Plan and Monitoring Methodology

Report for BHP Billiton Illawarra Coal

May 2009

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ABBREVIATIONS

AHIMS	Aboriginal Heritage Information Management System
BHPBIC	BHP Billiton Illawarra Coal
DECC	NSW Department of Environment and Climate Change
DoP	NSW Department of Planning
DPI	NSW Department of Primary Industries

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SUMMARY

BHP Billiton Illawarra Coal (BHPBIC) commissioned Biosis Research to prepare an Aboriginal Cultural Heritage Management Plan (ACHMP) as identified in the Environmental Assessment (EA) for the Proposed Appin Area 7 Longwalls 703 to 704 Goaf Gas Drainage Project.

The initial and subsequent archaeological investigations undertaken across the proposed goaf gas drainage study area (Biosis Research 2004 and 2006) identified a total of one Aboriginal archaeological site within the proposed project Study Area; Mountbatten 1 (52-2-3674). This site will not be adversely affected by the proposed development. During the afore mentioned Biosis Research survey, the following Aboriginal sites were also identified; Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-1 (52-2-3673). These sites may be impacted by the proposed development

Biosis Research prepared an Archaeological and Cultural Heritage Impact Assessment (Biosis 2009) for the proposed project, and this report describes the ACHMP for the ongoing management of recorded Aboriginal archaeological sites, and identified areas of conservation within the proposed development footprint.

Through ongoing consultation, the ACHMP also details the inclusion of relevant Aboriginal stakeholders in the management of their cultural heritage, including archaeological sites and Aboriginal resources.

The ACHMP has been developed in consultation with the Tharawal Local Aboriginal Land Council, Cubbitch Barta Native Title Claimants Aboriginal Corporation and the Department of Environment and Climate Change (DECC).

1.0 INTRODUCTION

This Aboriginal Cultural Heritage Management Plan (ACHMP) outlines protocols for the recording and ongoing management of Aboriginal cultural heritage sites that may be relocated as part of the proposed Appin Area 7 Goaf Gas Drainage Project. The ACHMP is designed to support recommendations made as part of the Appin Area 7 Goaf Gas Drainage Cultural Heritage Report.

The methodology outlined in this document details the procedures that will be undertaken to conserve these sites.

1.1 Project Background

The initial environmental assessments for the Appin Area 7 (formerly Douglas Area 7) were undertaken in 2006 and formed part of the EIS (Environmental Impact Statement) submitted to the Department of Primary Industries (DPI). The extraction of Longwalls 701 and 702 is complete. To undertake the extraction of Longwall 703, coal seam methane must be drained to ensure the safety of mine operators.

An archaeological and cultural heritage assessment for the Goaf Gas Drainage Project was undertaken on 8 April and 7 May 2009 (Biosis Research). Subsequent to this, and in consultation with the relevant Aboriginal stakeholder groups, the current Aboriginal Cultural Heritage Management Plan was developed.

1.2 Objectives

The objectives of this ACHMP are to:

- Describe protocols for ongoing Aboriginal Community engagement.
- Establish methods for suitable recording.
- Propose management options for any sites that may be affected by the implementation of the goaf gas drainage project.

1.3 Consultation with the Aboriginal community

As part of the ACHMP, consultation with identified Aboriginal stakeholders with regard to managing archaeological sites and cultural heritage values within the proposed Appin Area 7 Goaf Gas Drainage Project Area will be ongoing throughout the duration of the project. It will continue to do so in respect to the following:

- The following organisations registered an interest in the Aboriginal Cultural Heritage Assessment Project for Douglas Area 7 as per the DECC *Part 6 Approvals – Interim Community Consultation Requirements for Applicants* in 2006 (Biosis Research 2006). These organisations are referred to below as the Aboriginal Stakeholders:

    - Tharawal Local Aboriginal Land Council (via Lance Syme)
    - The Wadi Wadi Coomaditchie Aboriginal Corporation (via Allan Carriage)
    - Northern Illawarra Aboriginal Collective (NIAC – Chris Illert)
    - Cubbitch Barta Native Title Claimants Aboriginal Corporation (Glenda Chalker)

- Representatives of the Aboriginal community will be invited to participate in any active management of archaeological sites and objects, including consultation, salvage excavation and relocation.

- Representatives of the Aboriginal community groups will be invited to participate in any active management of other materials of traditional significance.

- Aboriginal community groups will be consulted regarding maintaining cultural values within the proposed projects extension landscape.

- Systematic review of this Aboriginal Cultural Heritage Management Plan will be performed with the local Aboriginal stakeholder groups.

2.0 ABORIGINAL ARCHAEOLOGICAL CONTEXT

2.1 Previous Archaeological Investigations

This section summarises the previous archaeological survey that has been undertaken within the current Appin Area 7 Goaf Gas Drainage development footprint.

Biosis Research (2006) completed a large scale EIS project for the DPI approved Appin Area 7 (formerly known as Douglas Area 7) Longwalls 701-704 Subsidence Management Plan. This study included the southern section of the present Study Area. Due to high levels of previous archaeological work throughout the region, the study involved complimentary surveys and reassessment of previously recorded archaeological sites. The complimentary field assessment identified four new Aboriginal archaeological sites, all of which were stone artefact scatters, including Mountbatten 1 (52-2-3674).

Biosis Research (2009) undertook a Part 3A archaeological and cultural heritage assessment for the proposed Goaf Gas Drainage Project within Appin Area 7. It was during this survey that the Aboriginal archaeological sites Moreton Park Road IA-1 (52-2-3671), Moreton Park Road IA-2 (52-2-3672) and Moreton Park Road OCS-152-2-3673 that are part of this ACHMP were relocated.

3.0 BACKGROUND INFORMATION

The following section presents background and contextual information on each Aboriginal archaeological site derived from various archaeological surveys within Appin Area 7. The following site descriptions and condition assessments have been summarised from Biosis Research 2006, 2009a and 2009b reports.

The four Aboriginal archaeological sites that are considered as part of the Cultural Heritage Management Plan are listed in **Error! Reference source not found.** below.

Table 1: Cultural Heritage sites within the Appin Area 7 Goaf Gas Drainage Project Study Area.

SITE NUMBER	*SITE NAME*	*SITE TYPE*	*PAGE NO.*
52-2-3671	Moreton Park Road IA-1	Isolated Artefact	6
52-2-3672	Moreton Park Road IA-2	Isolated Artefact	7
52-2-3673	Moreton Park Road OCS-1	Open Camp Site	7
52-2-3674	Mountbatten 1	Open Camp Site	8

3.1.1 Moreton Park Road IA-1 (52-2-3671)

This site comprises of a single mudstone flake (refer Plate 1). The site was relocated in an exposure in undulating cleared farmland on private property on the eastern side of Moreton Park Road, Menangle NSW.

The area appears to have been used as a land fill at some stage as there were numerous sherds of modern glass and ceramic across the exposure. There were also Welsh ponies grazing in the adjoining paddocks; which would have caused surface disturbance in the area.

Plate 1: Dorsal surface of Moreton Park Road IA-1.

Plate 2: The exposure where Moreton Park Road IA-1 was relocated.

3.1.2 Moreton Park Road IA-2 (52-2-3672)

This site comprises of a single silcrete artefact on the crest of a hill that has been partly cut away for the development of the Hume Highway (refer Plates 3 and 4). The site was also located on the same private property as Moreton Park Road IA-1.

The artefact is a broken red silcrete flake (refer Plate 4); whose distal end has broken off. It has 50% cortex present and no evidence of retouch.

Again, this site is on an exposure of a highly disturbed nature as it lies right on the fence line; which has a telephone line running underneath it. There are also currently a number of Welsh ponies grazing within the paddock that surrounds this site.

Plate 3: Location of Moreton Park Road IA-2 note the cut and fill scar on the western side of the fence line where the telephone cable was emplaced.

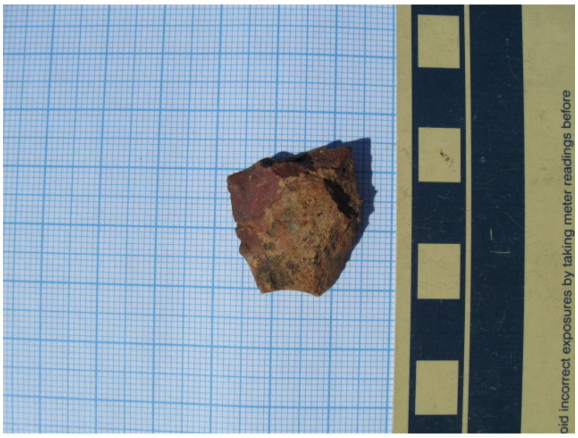


Plate 4: Dorsal surface of Moreton Park Road IA-2

3.1.3 Moreton Park OCS-1 (52-2-3673)

This site consists of two artefacts and was relocated in an exposure in undulating cleared farmland on private property on the eastern side of Moreton Park Road, Menangle NSW.

Again this site is quite close to the fence line that has been disturbed by the emplacement of the telephone cable.

The first artefact was made from a dark orange silcrete and is a large intact flake measuring 174.1 mm x 65.5 mm x 25.1 mm (refer Plate 5). The flake has evidence of retouch, and there are several scars where previous flakes have been removed. The second artefact (refer Plate 5) was located approximately five metres from the first and is a light grey mudstone artefact measuring 34.5 mm x 24.1 mm x 10.3 mm, with retouch on the dorsal edge and one previous flake scar.

Plate 5: Both artefacts from Moreton Park Road OCS-1

3.1.4 Mountbatten 1 (52-2-3674)

This site was identified originally during archaeological surveys for the Appin Area 7 Longwalls 701-704 Subsidence Management Plan (Biosis Research 2006a). This site comprises an isolated stone artefact exposed in the scald of an existing farm vehicle track on the saddle, on the lower slopes of the eastern ridge line of Spaniards Hill. The track appears to have been used continuously, causing some disturbance along its length (refer Plate 7). The site consists of one multi-directional tuff core (refer Plate 11). No further cultural material was identified and due to the high levels of ground surface visibility, it is unlikely that further stone artefacts will occur here.

During the 2008 survey a further two artefacts were exposed these consisted of two chert flakes. One is a complete flake with retouch, made from a light grey chert (refer Plate 9), whilst the second is the distal end of a yellow chert, that appears to have faded in sections due to sun exposure (refer Plate 10). This second flake does not have any retouch.

Plate 6: Western view of exposure where artefacts were relocated.

Plate 7: Southern end of exposure were artefacts identified. Note the vehicle tracks.

Plate 8: Exposure were the artefacts were identified during the survey conducted on 28th November 2008 by Biosis Research.

Plate 9: Dorsal side of light grey chert silcrete artefact with evidence of retouch.

Plate10: Dorsal side of yellow chert broken flake with evidence of fading of artefact colour.

Plate11: Original multi directional tuff core identified during Biosis Research's 2006. The picture was taken during the areas resurvey in 2008.

4.0 ARCHAEOLOGICAL ACTIVITIES

The archaeological methodology proposed below has been devised in light of the landform attributes, the results of the archaeological survey that have been undertaken previously on the Study Area. This has been undertaken in consultation with the relevant Aboriginal stakeholders.

4.1.1 Conservation of known areas of sensitivity containing cultural material

Mountbatten 1 (52-2-3674) will remain undisturbed and will be avoided by the proposed Goaf Gas Drainage development footprint.

This area will be temporally fenced prior to the commencement of any ground disturbance works to remain undisturbed for the life of the development of the Appin Area 7 Goaf Gas Drainage project.

4.1.2 Collection and Relocation of Identified Aboriginal Objects

The Aboriginal Objects shall be collected using the following methodology:

- each site will be photographed, its location recorded using GPS and additional information recorded as appropriate;
- the Archaeologist and relevant Aboriginal stakeholders will collect the surface Aboriginal Objects from each site which may be impacted;
- the collected Aboriginal Objects will be bagged and temporarily stored in a locked cabinet located at Biosis Research offices in Wollongong;
- upon completion of archaeological works under this ACHMP, the Archaeologist will analyse (see methodology outlined below) the Aboriginal Objects as part of the requirements for this ACHMP;
- following completion of the analysis requirements, collected Aboriginal Objects will be relocated to an appropriate location on-site – generally within close proximity to the original location. New co-ordinates for the relocated material will be taken using a hand-held GPS and the information gathered will be used to update the existing AHIMS Site Cards and resubmitted to DECC.

4.1.3 Topsoil Stippring - Procedure for previously undiscovered Aboriginal Objects

If, during topsoil and surface stripping for the proposed project, an Aboriginal Object is discovered, the following will occur:

- all works within the immediate vicinity should cease until the Aboriginal Object(s) can be assessed and collected for further analysis;

- the extent and significance of the Aboriginal Object(s) will be assessed, recorded and collected. Topsoil and surface stripping may continue immediately after collection;
- the Aboriginal Object(s) will be relocated, following analysis by a qualified archaeologist, to an appropriate location at the completion of works.

Aboriginal Objects considered to be culturally significant should be assessed by an archaeologist and the cultural values determined by the Aboriginal stakeholder groups.

Should any of these Aboriginal Object(s) be deemed culturally significant, then further investigation with a qualified archaeologist should be undertaken to determine the need for further archaeological investigation. If the Aboriginal Object(s) are not regarded to be significant, these will be collected for analysis, and relocated accordingly.

4.1.4 Discovery of Human Remains

If during the course of construction works Human Remains are uncovered, the following procedure should be followed:

- Inform BHP Billiton Illawarra Coal (BHPBIC) of the find and cease all works within the vicinity of the remains. Do not further disturb or remove any of the remains.
- Inform the Local Police and DECC.
- If the remains are determined to be Aboriginal, then following DECC advice the traditional owners should be informed of their discovery. Detailed excavation of the skeletal remains and any associated Aboriginal Objects should be undertaken by a suitably qualified archaeological or physical anthropologist with the required experience and expertise for Aboriginal remains.
- The repatriation of the remains should then be left up to the Aboriginal stakeholders who will determine a suitable location nearby. It would be preferable if such remains could be repatriated to within the identified areas of Conservation.

4.1.5 Analysis of Aboriginal Objects

Any artefacts recovered from the procedures described above will be collected and analysed. The analysis will be designed to describe stone tool technology and typology. Dependent on assemblage size the analysis will also attempt to expand and refine regional descriptions and predictive modelling. This will also naturally allow the analysis to provide information on the types of activities undertaken in the past within the study area. The analysis will include details of stone type, manufacturing techniques and varieties of tool types. As there has previously been only limited archaeological work in the region, this will enable a baseline reference for comparison against future excavations in the region.

Consultation with Tharawal Local Aboriginal Land Council and Cubbitch Barta Native Title Claimants Aboriginal Corporation is currently being undertaken to determine an appropriate Care Agreement for relocation or storage of any artefacts recovered after the completion of the works.

4.2 Contingency Triggers and Management Responses

Any contingent management strategies will be developed in consultation with the identified Aboriginal communities, BHP Billiton Illawarra Coal and DECC.

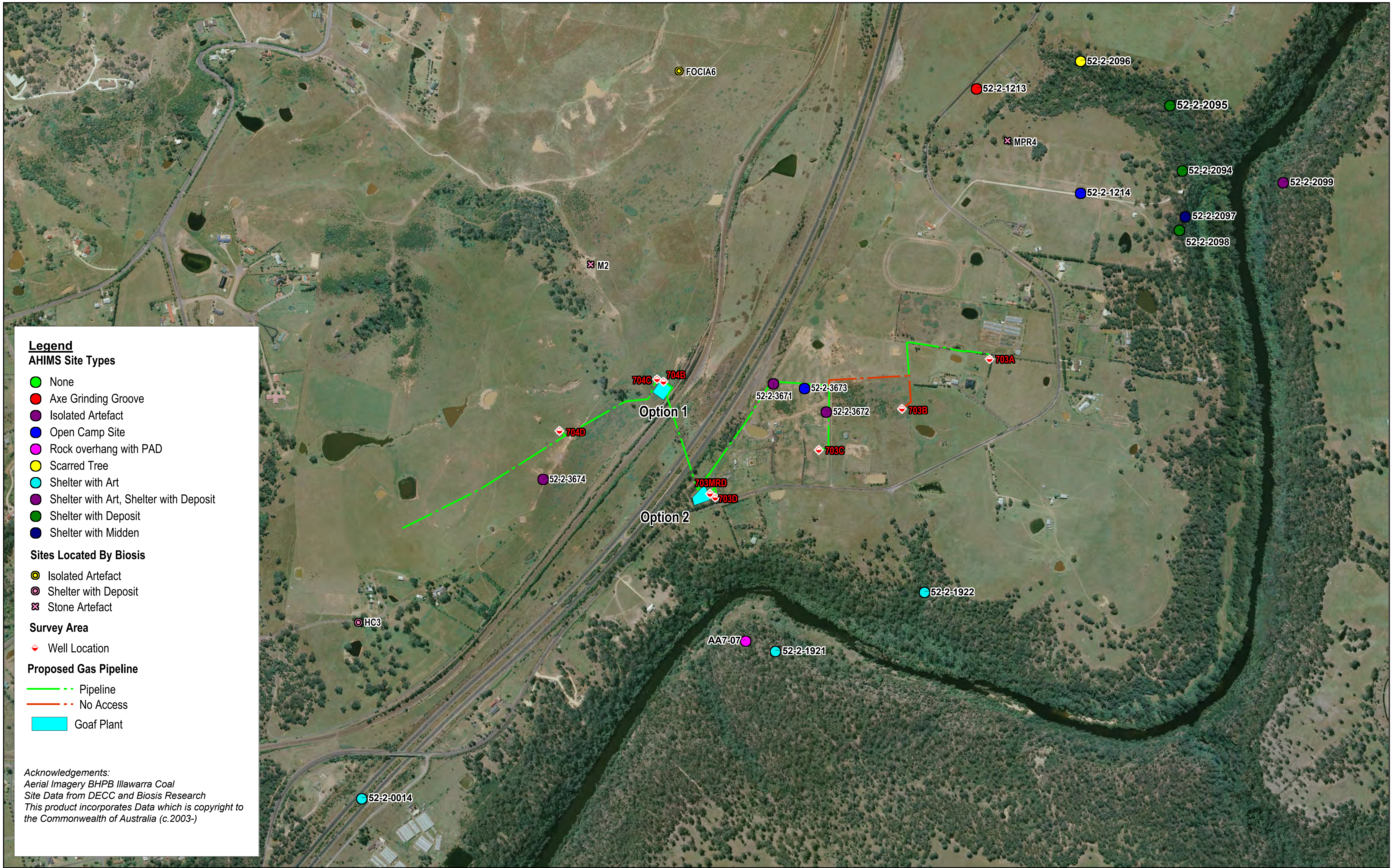
Management strategies will be implemented in accordance with current conservation practice and the conservation principles contained within the Australia International Council on Monuments and Sites (ICOMOS) *Burra Charter*, and the NSW DECC *Guidelines for Aboriginal Heritage Impact Assessment* (Draft) and the *Aboriginal Cultural Heritage Standards and Guidelines Kit*. The advice of the identified Aboriginal communities regarding appropriate management methodologies will form an integral part of the development of the management strategies.

5.0 PROCESS REVIEW AND DOCUMENTATION

This ACHMP will be reviewed:

- In conjunction with the EA for the Appin Area 7 Longwalls 703 to 704 Goaf Gas Drainage Project.
- At anytime with the mutual agreement of the Tharawal Local Aboriginal Land Council, Cubbitch Barta Native Title Claimants Aboriginal Corporation and BHP Billiton Illawarra Coal.

FIGURES



BIOSIS RESEARCH Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES 2500

Figure 4: All recorded Aboriginal sites recorded within the present Study Area

Figure 4: All recorded Aboriginal sites recorded within the present Study Area

Date: 08 May 2009

Checked by: RBR

File number: S5310

Location:-..5000\5300s\5310\Mapping\S5310 F4 Sites.WOR

APPENDICIES

APPENDIX 1

A1. Consultation Log

Aboriginal Group	Type of Consultation	Date/Time of Consultation	Response
Pre-field work			
Wadi Wadi Coomaditchie Aboriginal Corporation	DEC Part 6 advertisement in local newspapers	November 2005	No verbal or written response was received
Gandungara People	DEC Part 6 advertisement in local newspapers	November 2005	No verbal or written response was received
Tharawal Local Aboriginal Land Council	DEC Part 6 advertisement in local newspapers	November 2005	No verbal or written response was received
Northern Illawarra Aboriginal Collective (NIAC)	DEC Part 6 advertisement in local newspapers	November 2005	No verbal or written response was received
Cubbitch Barta Native Title Claimants	DEC Part 6 advertisement in local newspapers	November 2005	Registered an interest via written response on the 16 November 2005
Wadi Wadi Coomaditchie Aboriginal Corporation	Douglas Area 7 Survey Methodology forwarded via mail	9 December 2005	No verbal or written response was received
Gandungara People	Douglas Area 7 Survey Methodology forwarded via mail	9 December 2005	No verbal or written response was received
Tharawal Local Aboriginal Land Council	Douglas Area 7 Survey Methodology forwarded via mail	9 December 2005	No verbal or written response was received
Northern Illawarra Aboriginal Collective (NIAC)	Douglas Area 7 Survey Methodology forwarded via mail	9 December 2005	No verbal or written response was received

Cubbitch Barta Native Title Claimants	Douglas Area 7 Survey Methodology forwarded via mail	9 December 2005	No verbal or written response was received
Field Survey Requests (Initial Survey)			
Wadi Wadi Coomaditchie Aboriginal Corporation	Fax sent requesting field representative participation in survey	31 January 2006	No verbal or written response was received
Gandungara People	Phone call to arrange participation in fieldwork	30 January 2006	At this stage, Gundungara representatives were not available for initial survey and agreed that they would be involved in any future survey work
Tharawal Local Aboriginal Land Council	Phone call to arrange participation in fieldwork	30 January 2006	Confirmation of availability of a representative to participate in the field survey
Northern Illawarra Aboriginal Collective (NIAC)	Fax sent requesting field representative participation in survey	31 January 2006	No verbal or written response was received
Cubbitch Barta Native Title Claimants	Phone call to arrange participation in fieldwork	30 January 2006	Confirmation of availability of a representative to participate in the field survey
Field Survey Requests (Ongoing Survey)			
Wadi Wadi Coomaditchie Aboriginal Corporation	Fax sent requesting field representative participation in survey	24 May 2006	Responded via fax to confirm involvement in field survey of previously inaccessible properties
Gandungara People	Phone call to arrange participation in fieldwork	25 May 2006	No verbal or written response was received
Tharawal Local Aboriginal Land Council	Fax and phone call to arrange participation in fieldwork	25 May and 21 June 2006	Responded via telephone to confirm field work dates
Northern Illawarra Aboriginal Collective (NIAC)	Fax sent requesting field representative participation in survey	24 May 2006	Responded via fax to confirm involvement in field survey of previously inaccessible properties
Cubbitch Barta Native Title Claimants	Phone call to arrange participation in fieldwork	25 May and 21 June 2006	Responded via telephone to confirm field work dates

Field Survey Requests (Final Survey)			
Wadi Wadi Coomaditchie Aboriginal Corporation	Fax sent requesting field representative participation in survey via NIAC	14 August 2006	Responded via fax to confirm involvement in field survey of previously inaccessible properties
Gandungara People	Fax sent requesting field representative participation in survey via NIAC	14 August 2006	Responded via fax to confirm involvement in field survey of previously inaccessible properties
Tharawal Local Aboriginal Land Council	Fax sent requesting field representative participation in survey	14 August 2006	Responded via fax to confirm involvement in field survey of previously inaccessible properties
Northern Illawarra Aboriginal Collective (NIAC)	Fax sent requesting field representative participation in survey	14 August 2006	Responded via fax to confirm involvement in field survey of previously inaccessible properties
Cubbitch Barta Native Title Claimants	Phone call to request field representative for this field work	14 August 2006	Responded immediately to confirm representative to be involved in field work
Final Draft Report Comments			
Wadi Wadi Coomaditchie Aboriginal Corporation	Copy of Final Draft report sent via post for comment	September 2006	No response received
Gandungara People	Copy of Final Draft report sent via post for comment	September 2006	No response received
Tharawal Local Aboriginal Land Council	Copy of Final Draft report sent via post for comment	September 2006	No response received
Northern Illawarra Aboriginal Collective (NIAC)	Copy of Final Draft report sent via post for comment	September 2006	No response received
Cubbitch Barta Native Title Claimants	Copy of Final Draft report sent via post for comment	September 2006	No response received

THARAWAL LOCAL ABORIGINAL LAND COUNCIL

Gibbergunyah (Formerly Stonequarry Lodge)
50 Matthews Lane, Picton NSW 2571

Biosis Research
Renee Regal
8 Tate Street,
WOLLONGONG NSW 2500

26th of May 2009

Re: The proposed Goaf Gas Drainage, Douglas Park

Dear Renee,

I have read report 1 and report 2 on the Goaf Gas drainage project at Douglas Park and I am pleased with your recommendations for Aboriginal sites to be avoided if possible. However I am aware that there are a couple of sites that will be affected by the proposed Gas project and I was relived that you recommended fencing the area off and also the possible collection of artefacts till the work is completed and the re-dispersal of artefacts back in the original area after completion of the Goaf Gas project.

I support your recommendations.

Donna Whillock
Cultural and Heritage Representative
Tharawal Local Aboriginal Land Council

PO Box 20
Buxton NSW 2571
Phone: 02 4681 0059 Fax: 02 4683 1375
tharawal.lalc@bigpond.com

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Annex G

G. Noise Assessment

APPIN AREA 7 GOAF GAS DRAINAGE PROJECT

NOISE ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 08396
VERSION B

WILKINSON MURRAY

APPIN AREA 7 GOAF GAS DRAINAGE PROJECT

NOISE ASSESSMENT

REPORT NO. 08396
VERSION B

MAY 2009

PREPARED FOR

CARDNO FORBES RIGBY PTY LTD
278 KEIRA STREET
WOLLONGONG NSW 2500

Wilkinson Murray Pty Limited
ABN 41 192 548 112 • Level 1, 123 Willoughby Road, Crows Nest NSW 2065, Australia • **Asian Office: Hong Kong**
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TABLE OF CONTENTS

1 INTRODUCTION

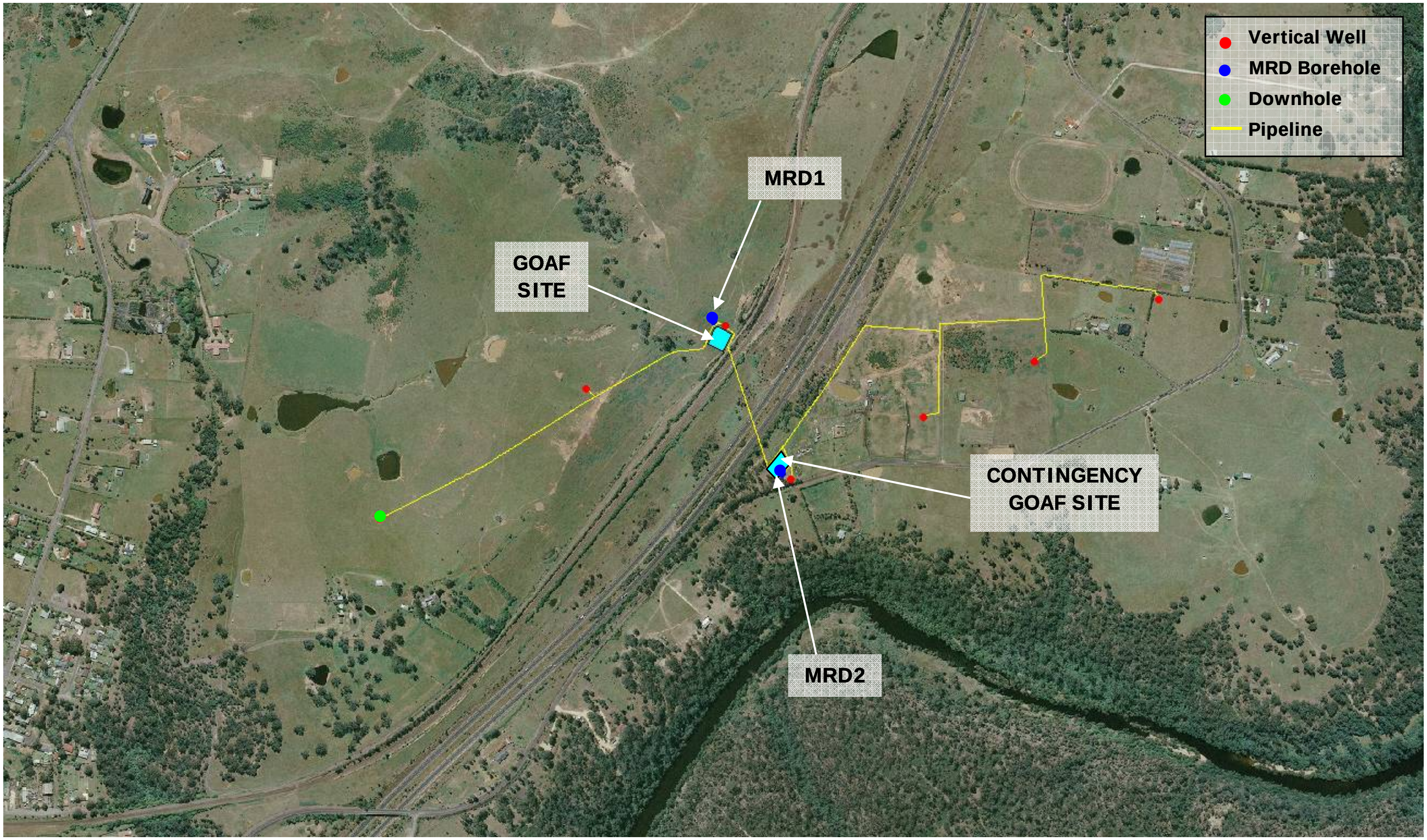
This report presents an assessment of the potential noise impact associated with the proposed Goaf Gas Drainage Project located east of Douglas Park. The proposed site locations and an aerial photograph are shown in Figure 1-1 and Figure 1-2, respectively.

Assessment has been made in general accordance with NSW Department of Environment & Climate Change (DECC) guidelines contained within either the *NSW Industrial Noise Policy (INP)* or the *Environmental Noise Control Manual (ENCM)*. This assessment considers the following issues:

- Operational Noise; and
- Construction noise;
  - Drilling boreholes; and
  - Installing pipelines including trenching works and under boring of the Hume Highway and Main Southern Rail Line

Figure 1-1 Proposed Site Locations

Figure 1-2 Aerial Photograph of Location



2 SITE DESCRIPTION & PROPOSED OPERATION

2.1 Site Layout & Operations

The proposed operation will consist of a series of boreholes drilled to a depth of ~500m through which methane gas will be drained from the goafs of Longwalls 703 and 704 via boreholes and a surface pipeline reticulation system connected to the electric or diesel powered extraction plant/s. After being extracted by the extraction plant/s, the majority of the methane gas will be piped back underground to the existing underground connection to the EDL Power Station where it will be re-used to generate electricity. A small amount of goaf gas will be vented to the atmosphere. If goaf gas cannot be continuously supplied to the underground pipe range, Illawarra Coal will investigate the use of on-site flares to abate the greenhouse gas contribution of methane emissions to the atmosphere.

For the proposed project, the preferred option is the installation of a single gas extraction plant to be implemented within Lot 2 DP576136. The proposed extraction plant will be situated in a centralised location so that it may draw gas from multiple wells for both Longwalls 703 and 704 that are connected by a surface pipeline reticulation system.

In order for the one extraction plant located on Lot 2 DP576136 to extract goaf gas from both longwalls, BHPBIC propose to under bore the Hume Highway and the Main Southern Rail Line in order to connect the extraction plant to the reticulation pipeline and wells servicing Longwall 703.

A second back up or contingency extraction plant has been proposed to be installed on the property described as Lot 7 DP250231 should under boring the Hume Highway and Main Southern Rail Line prove unreliable or unfeasible.

The proposed extraction plant locations are shown in Figure 1-1.

The preferred extraction plant site is immediately surrounded by paddocks on three sides and the railway line followed by the Hume Hwy on the remaining eastern side. The nearest residences are on the opposite side of the Hume Hwy. Other residences are several hundred meters away.

The contingency plant location is bounded by the Hume Hwy, Moreton Park Rd and an adjoining residential property to the north. The nearest receivers are located on the adjoining property to the north and also across Moreton Park Rd.

The location of surrounding residences are indicated in Figure 2-1.

The proposed project includes the construction of a Goaf Gas Drainage Plant on the property described as Lot 2 DP576136 and a back up or contingency extraction plant to potentially be constructed on the property described as Lot 7 DP250231 if required, and associated boreholes and pipelines. The drainage of goaf gas is an integral part of longwall mining activities in the Appin Colliery. The gas extraction plant/s consists of the following:

- Vacuum pump with electric motor, and inlet/outlet manifolds;
- Gas/water separator;
- Flow control recirculation;
- Discharge gas pipe work to discharge point;
- Discharge stack; and
- Associated diesel powered electricity generator or direct connection to mains electrical

power.

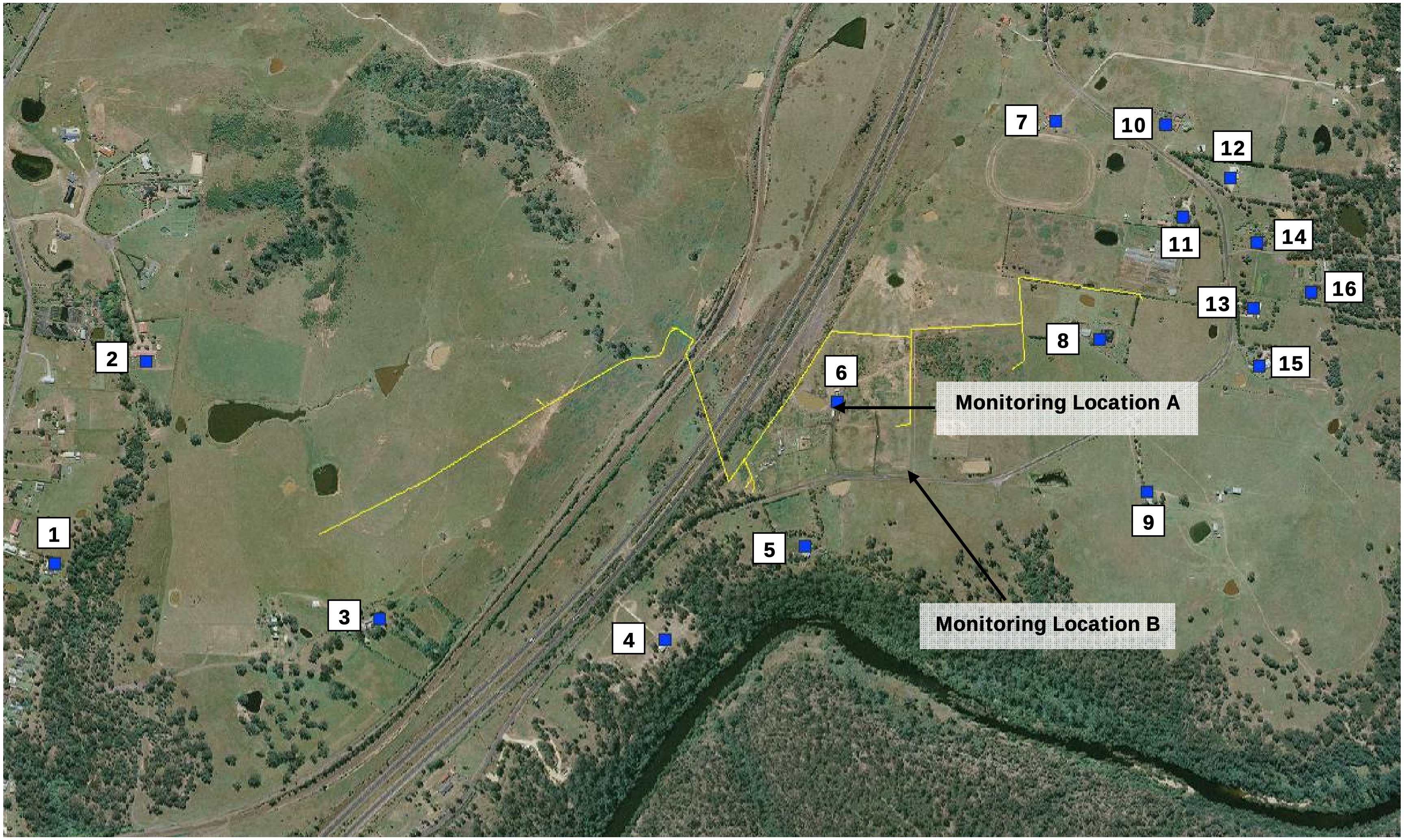
The Goaf Gas Drainage Plant/s will operate 24 hours, seven days a week.

Table 2-1 shows the identified surrounding receivers and the approximate distances to the nearest drill site (borehole) and the Goaf Plant/s. The receiver numbers correspond to the numbers in Figure 2-1.

Table 2-1 Surrounding Residential Receivers

Receiver #	Distance to Goaf Plant (m)	Distance to Nearest Drilling Site (m)	Distance to Contingency Goaf Plant (m)
1	1200	500	1500
2	1000	500	1400
3	850	215	770
4	610	360	400
5	500	205	215
6	350	125	280
7	900	410	1000
8	875	90	800
9	1000	390	830
10	1100	360	1150
11	1100	200	1050
12	1200	330	1200
13	1200	250	1100
14	1200	290	1150
15	1200	300	1100
16	1300	370	1200

Figure 2-1 Aerial Photograph showing Residence Locations



3 EXISTING NOISE LEVELS

Existing noise levels were monitored at the following locations, being representative of the existing noise levels at residences most likely to be affected by noise from the proposed project:

- Monitoring Location A — Lot 1, DP 838568, near the house; and
- Monitoring Location B — Lot 1, DP 838568, near Moreton Park Rd.

These monitoring locations are shown in Figure 2-1.

Unattended noise monitoring was conducted continuously from the 8th April to the 20th April 2009 at both monitoring locations.

The noise monitoring equipment used for these unattended measurements consisted of an environmental noise logger set to A-weighted, fast response, continuously monitoring over 15-minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift occurred.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Appendix A for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional passby of a heavy vehicle. This is used for the assessment of sleep disturbance.

The L_{A90} level is normally taken as the background noise level during the relevant period. The L_{Aeq} level is the Equivalent Continuous Sound Level and has the same sound energy over the sampling period as the actual noise environment with its fluctuating sound levels. The L_{Aeq} is used for the assessment of operational noise and traffic noise. The L_{A10} is used for the assessment of construction noise.

These noise levels were recorded every 15-minutes during the monitoring period. Monitored noise levels are shown in graphical form in Appendix B.

The Rating Background Levels (RBLs) are shown in Table 3-1. The RBLs for the standard periods of daytime, evening and night time are presented.

Table 3-1 Measured L_{A90} Noise Levels (RBL)

Monitoring Location (Figure 2-1)	**Day**[1]	**Evening**[1]	**Night**[1]
A	45	48[2]	38
B	40	44[2]	36

Note: 1) Daytime 7.00am–6.00am; Evening 6.00pm–10.00pm; and Night 10.00pm-6.00am.
2) DECC Application notes state if evening background noise levels are higher than daytime levels then criteria should be derived from daytime background levels

Observations during installation and collection of the noise loggers identified the Hume Hwy as the primary noise source in the area.

Attended measurements during placement and collection of the logger also showed that there was no existing significant industrial noise in the area.

The LAeq, period noise Levels are shown in Table 3-2.

Table 3-2 Measured $L_{Aeq, period}$ Noise Levels

Monitoring Location (Figure 2-1)	Day[1]	Evening[1]	Night[1]
A	56	55	53
B	55	54	52

Note: 1) Daytime 7.00am–6.00am; Evening 6.00pm–10.00pm; and Night 10.00pm-6.00am.

4 OPERATIONAL NOISE CRITERIA

4.1 Operational Noise Criteria

This section of the report discusses noise criteria for the assessment of operational noise. The main noise sources within the Goaf Plant/s are a diesel generator and a pump. There is potential for the preferred extraction plant, located on the property described as Lot 2 DP576136, to be mains powered. If this is the case then the diesel generator would not be required and noise emissions from this extraction plant would be greatly reduced. If the contingency extraction plant is required to be implemented it will be powered by a diesel generator.

This assessment has been based on a “worst case scenario” to provide a conservative assessment of the predicted noise impacts from the proposed project, and thus has assumed that both extraction plants (if required) are powered by diesel generators.

These operational noise sources have been assessed in terms of the requirements of the *Industrial Noise Policy (INP)* to consider amenity and intrusiveness.

The *INP* sets out two forms of noise criterion. In assessing noise levels at residences, the criteria should be assessed at the most-affected point on or within the residential property boundary or, if this is more than 30m from the residence, at the most-affected point within 30m of the residence. The two criteria are described below. Both noise criteria need to be considered, but in most cases, only the one will become the limiting criterion and form the Project Specific Noise Levels (PSNL) for the project.

4.1.1 Intrusiveness Criterion

The intrusiveness criterion specifies that the $L_{Aeq\ 15\ minute}$ noise level from the proposed source should not exceed the RBL by more than 5dBA. The RBL is defined as the overall single-figure background level representing each measurement period (day, evening and night) over the whole monitoring period.

The *INP* requires where noise sources contain certain characteristics, such as tonality, impulsiveness, intermittency or dominant low frequency content a modifying factor should be applied because this type of noise typically causes greater annoyance to the community.

This criterion should be assessed under specific meteorological conditions, which are detailed in the *INP.* Definition of appropriate meteorological conditions is discussed in detail in section 5.3.

4.1.2 Amenity Criterion

The second type of criterion is an amenity criterion, and is intended to ensure that the total L_{Aeq} noise level from all industrial sources does not exceed specified levels. For rural residences, the relevant recommended “Acceptable” Noise Levels (ANL) are:

- Daytime (7.00am-6.00pm) 50dBA L_{Aeq}
- Evening (6.00pm-10.00pm) 45dBA L_{Aeq}
- Night Time (10.00pm-7.00am) 40dBA L_{Aeq}

To set the amenity criteria for any project the INP has a sliding scale based on the existing industrial noise. As there is no significant source of industrial noise in this area the ANL becomes the amenity criteria.

In areas where traffic flows exist and where the $L_{Aeq,\ (period),\ traffic}$ noise level is more than 10 dB above the ANL presented above, the ANL is replaced by $L_{Aeq,\ (period),\ traffic}$ minus 10 dB. This becomes the new ANL for the receiver area.

The amenity and intrusive noise criteria for potentially affected receivers are presented in Table 4-1. Where practicable, noise levels should be controlled to below these limits.

Table 4-1 Noise Level Criteria

Receiver #	Intrusive Noise Criteria (dBA) $L_{Aeq,\ 15minutes}$			Amenity Criteria $L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
1	45	45	41	55	50	42
2	45	45	41	55	50	42
3	50	50	43	55	50	43
4	50	50	43	55	50	43
5	45	45	41	55	50	42
6	50	50	43	55	50	43
7	45	45	41	55	50	42
8	45	45	41	55	50	42
9	45	45	41	55	50	42
10	45	45	41	55	50	42
11	45	45	41	55	50	42
12	45	45	41	55	50	42
13	45	45	41	55	50	42
14	45	45	41	55	50	42
15	45	45	41	55	50	42
16	45	45	41	55	50	42

Note: 1) Daytime 7.00am–6.00am; Early Morning 6.00am–7.00am; Evening 6.00pm–10.00pm; and Night 10.00pm-6.00am.
2) Locations are shown in Figure 1-2.

4.2 Sleep Disturbance

For the night time period it is also necessary to consider the potential impact of sleep arousal from activities at the loading dock. The DECC recommends that the $L_{A1,1min}$ or L_{Amax} noise level should not exceed the background L_{A90} level by more than 15dBA.

As the operation of the plant/s is constant, with no significant variation in noise level, there is no potential for sleep disturbance. As such this is not discussed further.

4.3 Project Specific Noise Level

The limiting noise criteria for the project are the intrusive noise criteria which therefore become the PSNL as presented in Table 4-2.

Table 4-2 Project Specific Noise Level

Receiver #	Project Specific Noise Level (dBA) $L_{Aeq, 15minutes}$		
	Day	**Evening**	**Night**
1	45	45	41
2	45	45	41
3	50	50	43
4	50	50	43
5	45	45	41
6	50	50	43
7	45	45	41
8	45	45	41
9	45	45	41
10	45	45	41
11	45	45	41
12	45	45	41
13	45	45	41
14	45	45	41
15	45	45	41
16	45	45	41

5 PREDICTED NOISE LEVELS

5.1 Goaf Plant Source Noise Levels

In order to establish the source noise levels of the proposed Goaf Gas plant/s, noise measurements of a similar, existing goaf gas extraction plant at West Cliff Mine Area 5 were conducted on 8 April 2009 as part of the fieldwork for this project.

Noise measurements were conducted with a Bruel and Kjaer Type 2260 Sound Level Meter (SLM). The SLM holds current NATA calibration and has been internally laboratory calibrated within the past three months in accordance with Wilkinson Murray Quality Assurance procedures. Additionally the calibration was checked in the field before and after the measurements and no significant drift was observed. Spectra were measured in standard third-octave bandwidths.

From these measurements the diesel generator was identified as the dominant noise source. There was also some notable noise emission from the vacuum pump. These sources were shielded in some directions by associated equipment, thus the noise level varied with direction.

As the orientation of the proposed Goaf Plant/s is unknown at this stage the highest measured noise level has been applied to all directions. The assumed sound power level is shown in Table 5-1.

Table 5-1 Sound Power Level (dB) – Goaf Gas Plant

Octave Band Centre Frequency (Hz)								dBA
31.5	63	125	250	500	1k	2k	4k	
105	117	98	94	92	87	80	79	95

The measured noise level also showed a tonal characteristic in the 80Hz third-octave. This tone has been assessed in accordance with the INP and was judged to not be tonal as the level in third octave containing the tone does not exceed the adjacent bands by 15dB or more.

5.2 Noise Level Prediction

Noise levels experienced by a receiver at relatively large distances from a source can vary considerably under different meteorological conditions, particularly at night. Prevailing wind and air temperature gradients will change over the course of the night time period, and hence noise levels at receivers will change, even when the source noise level is constant.

The *INP* generally directs the use of a single set of adverse meteorological data to use in the assessment of noise impacts; however Wilkinson Murray has adopted a more rigorous approach in past assessments where noise levels at residences are calculated under a varied set of existing meteorological conditions. Measured statistical occurrences of these conditions over a period of one year are then applied to the results, and a 10th percentile exceedance level calculated, which is then compared with relevant criteria. This approach is generally more conservative than one using a single set of meteorological data as it accounts for the directional distribution of prevailing winds for each residence surrounding the site.

This alternative assessment procedure involves significantly greater computational complexity than the use of a single set of meteorological conditions, but provides a much more direct and comprehensible description of noise impacts at a receiver. This approach of using the 10th percentile calculated noise level as a measure of noise impacts on residences has been considered acceptable by the DECC for previous similar assessments.

5.3 Measured Meteorological Data

Meteorological data for Appin Bureau of Meteorology Weather Station for the period May 2007 to May 2008 was available for this assessment. The data includes wind speed, wind direction, temperature, relative humidity, and sigma theta data from which Pasquill stability class and subsequently temperature inversion strengths are calculated.

The full methodology of calculation of temperature inversion strengths for the proposal can be found in Appendix E of the INP.

Operational noise levels at residences are calculated using the Environmental Noise Model (ENM) prediction model. This model has been endorsed by the DECC for environmental noise assessment. The ENM model takes account of noise attenuation due to geometric spreading, atmospheric absorption, shielding and the effect of acoustically soft ground. It can also be used to predict noise levels under various meteorological conditions, defined by a combination of temperature gradient, wind speed and wind direction.

Noise levels were calculated using the ENM model for each of the scenarios under a total of 97 meteorological conditions. A statistical data set representing the proportional occurrence of these conditions at Appin over a year was then applied to the calculated noise levels. The noise level exceeded for 10% during each of the day, evening and night time periods was then calculated.

It should be noted that the calculations described above rely on predictions produced by the ENM model. This model is based on simple assumed vertical profiles of temperature and wind speed, and does not accurately model more complex situations. In particular, there are times when a combination of non-linear vertical temperature and wind speed profiles can result in “focussing” of noise in a small area. In these events, increases in noise level of 10-20dBA can occur over periods of minutes to hours. The frequency of these events, and the level of noise enhancement occurring, cannot be accurately predicted using ENM or any other known model. However, the validation of the model used has shown good correlation between measured and predicted noise levels as a 10th percentile exceedance level.

5.3.1 Preferred Goaf Plant Predicted Level

The predicted 10th percentile receiver noise levels are presented in Table 5-2. Levels exceeding the relevant criteria are highlighted.

The model predicts minor exceedances of 1-2dB at receivers 5 and 6. This is addressed by constructing an earth mound adjacent to the Goaf Plant on the side facing the railway line. The mound would need to extend above the height of the generator/vacuum pump by at least 1m and be located as close as possible to the source. A 5m earth mound, located 10m from the generator was modelled. The results of the revised modelling are presented in Table 5-3. Noise contours of the preferred Goaf Plant are shown in Figure 5-1.

With the inclusion of the earth mound described above the 10th percentile noise level is predicted to be within criteria at all surrounding receivers.

5.3.2 Contingency Goaf Plant Predicted Level

The predicted 10^{th} percentile receiver noise levels are presented in Table 5-4. Levels exceeding the relevant criteria are highlighted.

The model predicts exceedances of up to 10dB at receiver 5 and lesser exceedances at receivers 4 and 6. This is addressed by constructing a noise barrier adjacent to the Goaf Plant on all sides except that facing the Hume Hwy. The barrier would need to extend above the height of the generator/vacuum pump by at least 2m and be located as close as possible to the source. Subject to site specific geometric restrictions the barrier could consist of an earth mound, a purpose build masonry (or similar) noise wall, or a combination of the two.

A 5.5m barrier, located 10m from the generator was modelled. The results of the revised modelling are presented in Table 5-5. Noise contours of the preferred Goaf Plant are shown in Figure 5-2.

With the inclusion of the noise barrier described above the 10^{th} percentile noise level is predicted to be within criteria at all surrounding receivers.

Table 5-2 Summary of Predicted Receiver Levels without the Earth Mound

#	Predicted Level (dBA)												Criteria (dBA)		
	Autumn			Spring			Summer			Winter					
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	15	16	17	15	13	17	15	13	17	14	15	16	45	45	41
2	17	18	19	17	16	19	17	16	19	16	17	18	45	45	41
3	27	28	28	27	26	28	27	26	28	26	27	28	50	50	43
4	39	40	39	39	36	39	39	36	39	36	39	39	50	50	43
5	42	42	**42**	42	40	41	42	40	41	41	42	**42**	45	45	41
6	44	45	**45**	44	43	**44**	44	43	**44**	44	45	**45**	50	50	43
7	30	33	34	29	27	32	29	27	32	31	34	33	45	45	41
8	29	31	31	29	26	30	29	26	30	30	32	31	45	45	41
9	34	35	35	34	30	35	34	30	34	34	35	35	45	45	41
10	25	26	27	23	20	26	24	20	26	26	27	27	45	45	41
11	26	28	28	25	22	27	26	22	27	27	29	28	45	45	41
12	25	27	27	24	21	26	25	21	26	27	27	27	45	45	41
13	24	25	25	24	22	25	24	22	24	25	25	25	45	45	41
14	27	28	28	26	25	27	27	25	27	27	28	28	45	45	41
15	26	27	27	26	24	27	26	24	27	27	28	27	45	45	41
16	23	25	25	23	20	24	23	20	24	24	25	25	45	45	41

Table 5-3   Summary of Predicted Receiver Levels with the Earth Mound

#	Predicted Level (dBA)												Criteria (dBA)		
	Autumn			Spring			Summer			Winter					
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	15	16	17	15	13	17	15	13	17	14	15	16	45	45	41
2	17	18	19	17	16	19	17	16	19	16	17	18	45	45	41
3	27	28	28	27	26	28	27	26	28	26	27	28	50	50	43
4	39	40	39	39	36	39	39	36	39	36	39	39	50	50	43
5	30	31	30	30	29	30	30	29	30	29	31	31	45	45	41
6	34	34	34	34	33	34	34	33	34	34	35	34	50	50	43
7	30	33	34	29	27	32	29	27	32	31	34	33	45	45	41
8	29	31	31	29	27	30	29	27	30	30	31	31	45	45	41
9	26	28	28	26	24	27	26	24	26	26	28	28	45	45	41
10	25	27	28	24	21	27	24	21	27	27	28	27	45	45	41
11	26	27	28	25	22	27	26	22	27	27	28	28	45	45	41
12	25	27	27	24	21	26	25	21	26	27	27	27	45	45	41
13	25	26	26	25	24	25	25	24	25	25	26	26	45	45	41
14	26	27	28	26	25	27	26	25	27	27	28	28	45	45	41
15	25	26	26	25	23	26	25	23	26	26	27	26	45	45	41
16	24	25	25	24	23	25	24	23	25	25	26	25	45	45	41

Table 5-4 Summary of Predicted Receiver Levels without the Barrier

#	Predicted Level (dBA)												Criteria (dBA)		
	Autumn			Spring			Summer			Winter					
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	17	19	21	18	15	21	17	15	22	15	18	19	45	45	41
2	16	18	19	16	14	19	16	14	19	15	17	18	45	45	41
3	33	35	36	33	31	36	33	31	37	32	32	34	50	50	43
4	43	44	**44**	43	43	**44**	43	43	**44**	43	43	**44**	50	50	43
5	**51**	**51**	**51**	**51**	**50**	**51**	**51**	**50**	**50**	**50**	**51**	**51**	45	45	41
6	48	48	**48**	48	47	**48**	48	47	**48**	48	48	**48**	50	50	43
7	23	24	25	22	20	24	22	20	24	24	25	25	45	45	41
8	38	39	39	38	31	39	38	31	39	39	39	39	45	45	41
9	35	38	39	35	31	38	35	31	36	37	39	39	45	45	41
10	25	27	28	24	20	27	24	20	26	26	27	27	45	45	41
11	26	28	28	25	21	28	25	21	27	27	28	28	45	45	41
12	24	27	27	23	20	26	24	20	26	26	27	27	45	45	41
13	27	28	28	26	25	28	27	25	28	28	28	28	45	45	41
14	26	27	28	25	23	27	25	23	27	27	28	27	45	45	41
15	28	29	29	28	26	29	28	26	29	29	29	29	45	45	41
16	26	27	28	26	24	27	26	24	27	27	28	28	45	45	41

Table 5-5 Summary of Predicted Receiver Levels with the 5.5m Barrier

#	Predicted Level (dBA)												Criteria (dBA)		
	Autumn			Spring			Summer			Winter					
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	17	19	21	18	15	21	17	15	22	15	18	19	45	45	41
2	16	18	19	16	14	19	16	14	19	15	17	18	45	45	41
3	30	31	32	30	29	32	30	29	32	29	30	31	50	50	43
4	33	34	34	33	32	34	33	32	34	32	33	33	50	50	43
5	41	41	41	41	41	41	41	41	41	41	41	41	45	45	41
6	41	41	42	41	40	41	41	40	41	41	41	41	50	50	43
7	21	22	23	21	19	22	21	19	22	22	23	22	45	45	41
8	32	33	34	31	29	33	32	29	33	33	34	33	45	45	41
9	29	30	30	29	27	30	29	27	30	30	31	30	45	45	41
10	23	24	25	23	20	24	23	20	24	24	25	25	45	45	41
11	23	25	25	23	21	25	23	21	24	24	25	25	45	45	41
12	23	24	24	22	20	24	22	20	24	23	25	24	45	45	41
13	25	26	26	25	23	26	25	23	26	26	27	26	45	45	41
14	25	26	26	24	22	26	24	22	25	26	26	26	45	45	41
15	26	27	27	26	24	26	26	24	26	26	27	27	45	45	41
16	25	26	26	24	22	25	24	22	25	25	26	26	45	45	41

Figure 5-1 Noise Contours of the Preferred Goaf Plant with the Earth Mound

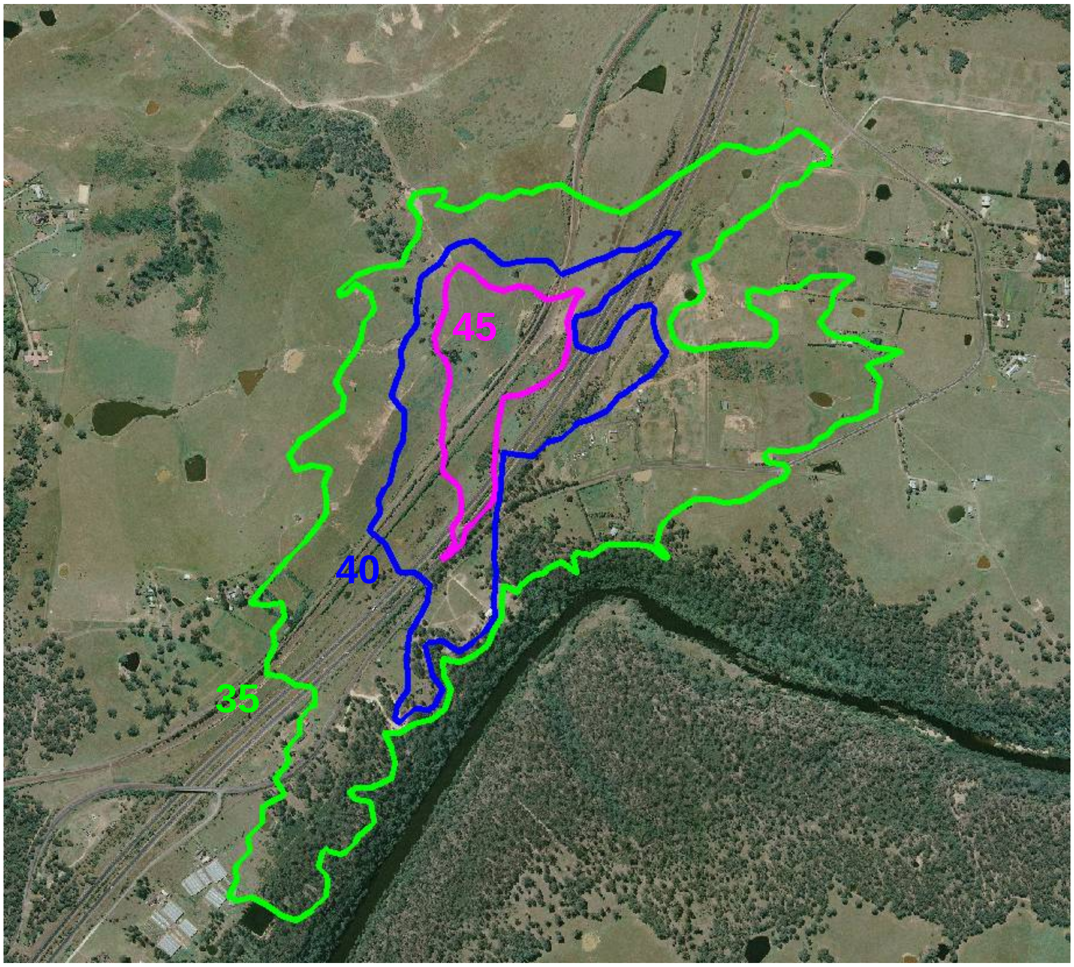
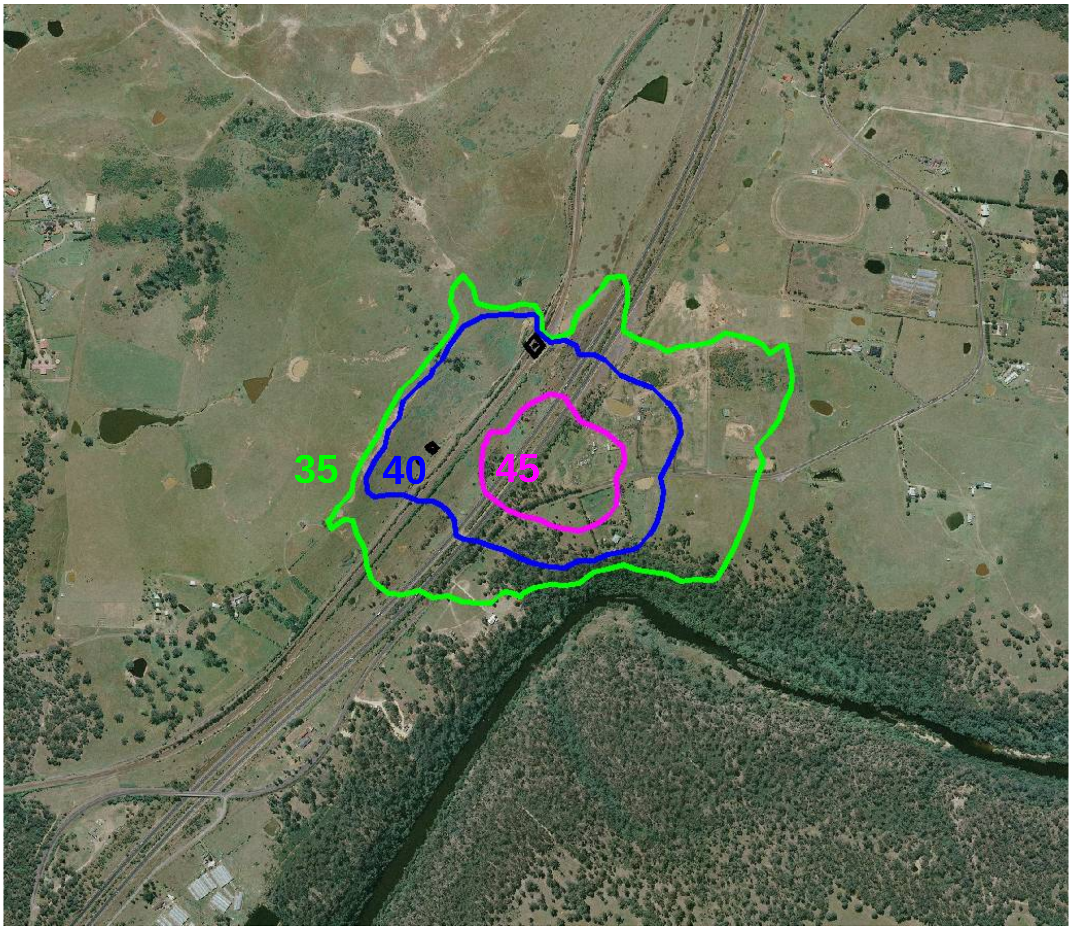


Figure 5-2 Noise Contours of the Contingency Goaf Plant with the Noise Barrier



6 CONSTRUCTION NOISE ASSESSMENT

This section of the report assesses the potential impact of noise during the construction and drilling phase of works.

Construction involves the installation of pipelines connecting the wells/boreholes to the Goaf Plant/s, under boring of the Hume Highway and Main Southern Rail Line and construction of the goaf plant and drilling compounds. This will require some shallow excavation and trenching works and is likely to involve the use of an excavator and one or two trucks.

A total of six vertical wells and one vertical downhole will be drilled. Additionally two MRD boreholes will be drilled. The vertical wells and vertical downhole will be drilled during daylight hours, Monday to Saturday. It is expected that each vertical well will take approximately two weeks to drill with a total duration of approximately 14 weeks. Due to the nature of directional drilling the MRD boreholes will be drilled 24 hours, seven days a week. Drilling the MRD boreholes is expected to take six weeks for each borehole. The total construction timeframe is anticipated to be within 26 weeks.

6.1 Construction Noise Goals

Noise and groundborne vibration will be generated during construction and installation of the plant/s and associated pipelines.

6.1.1 Construction Noise Criteria

The requirements outlined in Chapter 171 of DECC's *Environmental Noise Control Manual (ENCM)* are typically applied and this approach is detailed below.

Level Restrictions

(i) *Construction period of 4 weeks and under.*
The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A) at residential receivers.

(ii) *Construction period greater than 4 weeks and not exceeding 26 weeks.*
The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A) at residential receivers.

Time Restrictions

Monday to Friday	*7am–6pm*
Saturday	*7am–1pm (if inaudible at residential premises)*
	8am–1pm (if audible at residential premises)

No construction work to take place on Sundays or Public Holidays

Silencing

All possible steps should be taken to silence construction site equipment. It is particularly important that silenced equipment should be used on road or rail works where 24 hour operation is necessary.

There is no suggested criterion for projects that require out of hours construction. However, the following criterion is typically used:

> *The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 5 dB(A) at residential receivers.*

Construction, including drilling each of the wells and boreholes, is anticipated to occur for up to 26 weeks. The derived construction noise criteria (assuming between 4-26 weeks of construction) for this project are given in Table 4-3.

Table 4-3 Construction Noise Criteria

Receiver #	Criteria (dBA)		
	Day	Evening	Night
1	50	50	41
2	50	50	41
3	55	55	43
4	55	55	43
5	50	50	41
6	55	55	43
7	50	50	41
8	50	50	41
9	50	50	41
10	50	50	41
11	50	50	41
12	50	50	41
13	50	50	41
14	50	50	41
15	50	50	41
16	50	50	41

Note: 1) Daytime 7.00am–6.00am; Early Morning 6.00am–7.00am; Evening 6.00pm–10.00pm; and Night 10.00pm-6.00am.
2) Locations are shown in Figure 1-2.

6.2 Predicted Construction Noise Levels

The following construction plant items and associated maximum sound pressure levels at 7m are summarised as follows:

- Excavator 84dBA
- Truck 83dBA

Based on attenuation due to distance the following range of L_{Aeq} noise levels are predicted at the nearest residences from the various activities on different parts of the site.

Table 6-1 Predicted Construction Noise Level – $L_{Aeq,15min}$

Receiver #	Closest Distance (m)	Predicted Level (dBA)	Criteria (dBA)
1	500	49	50
2	500	49	50
3	210	**56**	55
4	340	52	55
5	205	**59**	50
6	90	**64**	55
7	330	**53**	50
8	80	**65**	50
9	380	**51**	50
10	360	**52**	50
11	180	**58**	50
12	330	**53**	50
13	250	**55**	50
14	290	**54**	50
15	300	**53**	50
16	370	**52**	50

The noise level from the installation of pipelines is predicted to exceed the noise goals at most receivers when construction is at its nearest location. The maximum predicted level is 65dBA which is at a similar level to traffic $L_{Aeq,15min}$ from the Hume Hwy. Given that the construction is mobile and will only be adjacent to any one receiver for a short duration, it is not considered reasonable to implement temporary barriers. Therefore mitigation is limited to utilizing quiet and well maintained plant and also informing the potentially affected receivers of the work, which should include an indication of expected durations.

6.3 Predicted Drilling Noise Levels – Vertical Well

Based on the measured data provided to us by Cardno Forbes Rigby, the sound power level of a drill rig was calculated. Because the orientation of the rig at each location is unknown at this stage the highest sound power level has been assumed in all directions.

Receiver noise levels were calculated using the ENM computer noise model. As the drilling of the vertical wells and downhole will be done during the day, meteorological effects such as temperature inversions are considered unlikely. Therefore only a still, isothermal condition was modelled.

The predicted receiver noise levels are presented in Table 6-2.

Table 6-2 Calculated Vertical Well Drilling L_{Aeq} Noise Levels

Receiver #	Vertical Well Number							Criteria (dBA)
	1	2	3	4	5	6	7	
1	**52**	47	26	24	23	22	20	50
2	**54**	49	26	23	24	22	19	50
3	**59**	49	35	46	44	42	33	55
4	32	40	52	**58**	48	48	33	55
5	30	40	**54**	**65**	**57**	**54**	37	50
6	29	39	**57**	**61**	**67**	52	39	55
7	22	27	38	28	32	36	56	50
8	26	34	39	45	**56**	**63**	**63**	50
9	25	32	46	47	**54**	**58**	47	50
10	22	27	40	26	32	37	**57**	50
11	22	29	41	28	34	41	**63**	50
12	20	28	40	25	31	37	**56**	50
13	22	30	34	30	36	40	**58**	50
14	21	27	38	27	32	39	**58**	50
15	23	30	33	33	39	43	**55**	50
16	21	29	35	29	34	39	**56**	50

At most surrounding residences the drilling is predicted to exceed the relevant construction noise goals. Given the short duration of works at each site, typically two weeks, the implementation of temporary noise barriers is not considered feasible.

It is recommended that the following noise control measures be considered:

- Drilling should be limited to the DECC's recommended standard hours of 7.00am-6.00pm Monday to Friday and 8.00am-1.00pm Saturday, with no audible work on Sunday or Public Holidays;
- Use of the quietest available plant, which is regularly maintained and fitted with appropriate mufflers;
- The plant should, if possible, be oriented so that the loudest side is not facing the nearest receivers; and
- Impacted neighbours should be contacted and informed of likely duration of work.

6.4 Predicted Drilling Noise Levels – MRD Borehole (directional)

Receiver noise levels for the drilling of the two MRD boreholes have been calculated using the ENM computer noise model. As the drilling is required to operate 24 hours, metrological effects are considered to have a potentially significant impact. The 10^{th} percentile level (i.e. the level exceeded 10% of the time) was calculated for each time period. Works are anticipated to commence in August 2009, therefore met data for the winter months was used. The calculated MRD Borehole Drilling Noise Levels are shown in Table 6-3.

Table 6-3 Calculated MRD Borehole Drilling L_{Aeq} Noise Levels

Receiver	Predicted Level (dBA)						Criteria (dBA)		
	MRD1			MRD2					
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	26	27	28	24	27	29	50	50	41
2	26	27	28	24	26	27	50	50	41
3	34	35	36	47	48	**51**	55	55	43
4	**51**	53	**53**	**57**	**58**	**59**	55	55	43
5	**54**	**56**	**55**	**63**	**64**	**64**	50	50	41
6	**58**	**59**	**59**	**62**	**63**	**62**	55	55	43
7	45	46	**46**	33	35	34	50	50	41
8	**47**	**51**	**50**	**52**	**53**	**52**	50	50	41
9	**47**	49	**49**	**51**	**53**	**52**	50	50	41
10	**47**	48	**48**	35	37	37	50	50	41
11	**48**	49	**49**	36	38	38	50	50	41
12	**49**	**50**	**50**	33	36	35	50	50	41
13	39	41	40	35	36	35	50	50	41
14	41	42	**42**	32	33	33	50	50	41
15	37	40	39	37	38	38	50	50	41
16	42	44	**43**	34	36	35	50	50	41

The receiver noise levels resulting from drilling the MRD boreholes are predicted to exceed the relevant construction noise goals at some residences. In general noise levels from MRD1 project further than those from MRD2 due to the relative heights and surrounding topography of the two drill sites.

As the work is required to be conducted 24 hours a day, and the duration is expected to be six weeks at each MRD drill site, the implementation of temporary noise barriers is required.

Figure 6-1 shows the indicative locations of the required barriers. Each barrier should be located as close as possible to the drill rig and extend above the height of the rig engine/pumps by at least 1m. An example of a suitable construction of these barriers is locating shipping containers or other suitable noise attenuation barriers in the required positions, though the required height may require some minor earthworks to mount each barrier. The calculated MRD Borehole Drilling Noise Levels with barriers in place are shown in Table 6-4.

Note that MRD1 and MRD2 will be located adjacent to both of the proposed preferred and contingency extraction plant locations which require barriers to be situated as per Figure 6-1. It may be practical to utilize these barriers to mitigate the drilling noise, however additional height may be required due to the relative topography.

Figure 6-1 Indicative Location of MRD Borehole Drilling Barriers

Table 6-4 Calculated MRD Borehole Drilling L_{Aeq} Noise Levels

Receiver	Predicted Level (dBA)						Criteria (dBA)		
	MRD1			MRD2					
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1	26	27	28	24	27	29	50	50	41
2	26	27	28	24	26	27	50	50	41
3	32	33	34	44	45	**47**	55	55	43
4	34	36	36	46	47	**48**	55	55	43
5	37	38	38	**53**	**54**	**54**	50	50	41
6	41	42	42	**57**	**58**	**57**	55	55	43
7	36	37	36	33	35	35	50	50	41
8	35	36	36	**49**	**50**	**50**	50	50	41
9	33	35	35	45	48	**47**	50	50	41
10	35	36	35	34	36	35	50	50	41
11	35	36	36	33	35	35	50	50	41
12	34	35	35	32	34	34	50	50	41
13	31	32	32	36	37	36	50	50	41
14	34	35	35	32	33	33	50	50	41
15	31	32	31	39	40	39	50	50	41
16	31	32	31	35	36	36	50	50	41

With the implementation of temporary barriers around the drill sites the criteria is predicted to be satisfied at most receivers, however moderate exceedances remain at the closest residences to MRD2.

Given that night time works are necessary to successfully drill the MRD boreholes it is recommended that the potentially affected receivers be contacted and an agreement negotiated. BHPBIC have consulted with and obtained written agreements from all landowners on whos' land the proposed works including night time drilling of the MRD boreholes is occurring. It should be noted that the predicted levels are generally similar to traffic noise levels in the area and thus the subjective annoyance of surrounding residents may be reduced.

Additional mitigation could be achieved by orienting the drill rig so that the quietest side faces the receivers. Placing water tanks or other drill rig infrastructure on the Hume Hwy side will also reduce the impact to the nearest receivers. Measured data indicates that these measures are likely to reduce the emission level by up to 9dB.

7 CONCLUSION

Operational and construction noise impacts associated with the proposed Goaf Gas Drainage Plant/s near Douglas Park have been assessed in accordance with criteria recommended by the NSW Department of Environment & Climate Change (DECC-EPA).

7.1 Operational Noise

The following noise mitigation measures are recommended:

- Construction of noise barriers at each of the proposed extraction plant locations as per Figure 6-1, if the contingency extraction plant is required. If the contingency extraction plant is not required, a single noise barrier constructed on Lot 2 DP576136 should be installed as per Figure 6-1. The barrier/s should be located as close as possible to the generator/vacuum pump and extend above the height of the generator/vacuum pump by at least 1m at the preferred site and 2m at the contingency plant site. An earth mound constructed out of the excavated material from the construction of the extraction plant compound or the use of shipping containers would be suitable for this application.
- Should the preferred extraction plant, located on the property described as Lot 2 DP576136, be powered by mains power and thus not require a diesel generator, the noise emissions from this extraction plant will be greatly reduced. Should this be the case it is expected that noise mitigation barriers at this location will not be required for the operation of this extraction plant.

With the implementation of the above noise mitigation the operational noise emissions from the Goaf Plant/s are predicted to satisfy criteria at all receivers.

7.2 Construction of Pipelines, Drilling Vertical Wells and Under Boring of the Hume Highway and Main Southern Rail Line

Noise levels from construction are predicted to exceed relevant goal levels when works are nearest the residences. Due to the mobile nature of the works and the short duration the implementation of temporary noise barriers is considered unreasonable.

It is recommended that the following noise control measures be considered:

- Drilling should be limited to the DECC's recommended standard hours of 7.00am-6.00pm Monday to Friday and 8.00am-1.00pm Saturday, with no audible work on Sunday or Public Holidays;
- Use of the quietest available plant, which is regularly maintained and fitted with appropriate mufflers;
- Impacted neighbours should be contacted and informed of likely duration of work.

7.3 Drilling MRD Boreholes

Drilling the two MRD boreholes requires 24 hour, seven days a week operation. Noise levels during this drilling are predicted to exceed relevant criteria at some receivers, even with the implementation of reasonable barriers surrounding the drill rig. It is therefore recommended that the following mitigation measures be applied:

- Use of the quietest available plant, which is regularly maintained and fitted with appropriate mufflers;
- Orient the drill rig and equipment so that the quietest side (identified as being up to 9dB quieter than the loudest side) is faced toward the nearest receivers;
- Place temporary barriers around the drill rig on three sides. The barriers must extend above the height of the drill rig engine and any pumps by at least 1m and be located as close as possible to these noise sources;
- Impacted neighbours should be contacted and informed of likely duration of work, noise mitigation works to be installed, and provided contact details of the Illawarra Coal Operations Manager- Exploration to provide feedback on any noise impacts.

Note
All materials specified by Wilkinson Murray Pty Limited have been selected solely on the basis of acoustic performance. Any other properties of these materials, such as fire rating, chemical properties etc. should be checked with the suppliers or other specialised bodies for fitness for a given purpose.

Quality Assurance
We are committed to and have implemented AS/NZS ISO 9001:2000 "Quality Management Systems – Requirements". This management system has been externally certified and Licence No. QEC 13457 has been issued.

AAAC
This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Version	Status	Date	Prepared by	Checked by
A	Draft	1 May 2009	Adam Bioletti	John Wassermann
B	Final	22 May 2009	Adam Bioletti	

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph overleaf, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

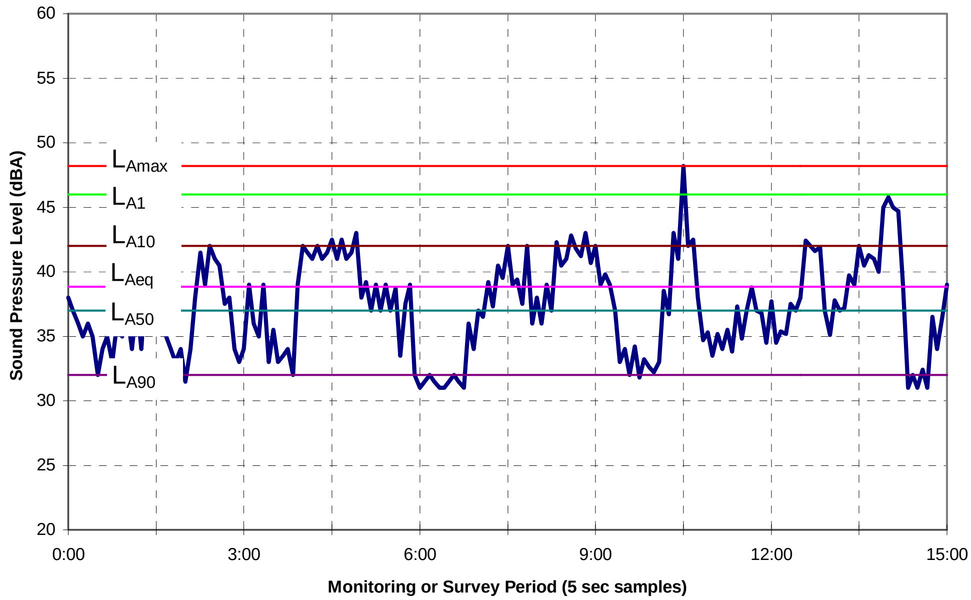
L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period **–** daytime, evening and night time.


60
55
50
45
40
35
30
25
20
Sound Pressure Level (dBA)
L_{Amax}
L_{A1}
L_{A10}
L_{Aeq}
L_{A50}
L_{A90}
0:00
3:00
6:00
9:00
12:00
15:00
Monitoring or Survey Period (5 sec samples)

APPENDIX B

NOISE MEASUREMENT RESULTS

Location: 1. Lot 1, Near the house

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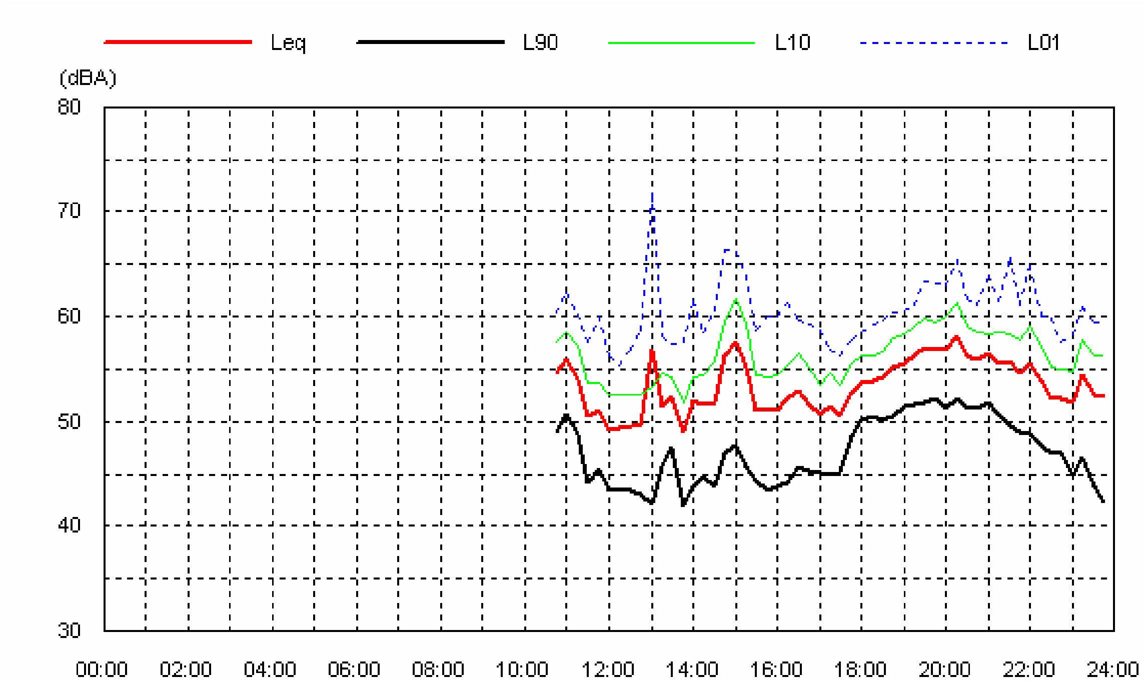

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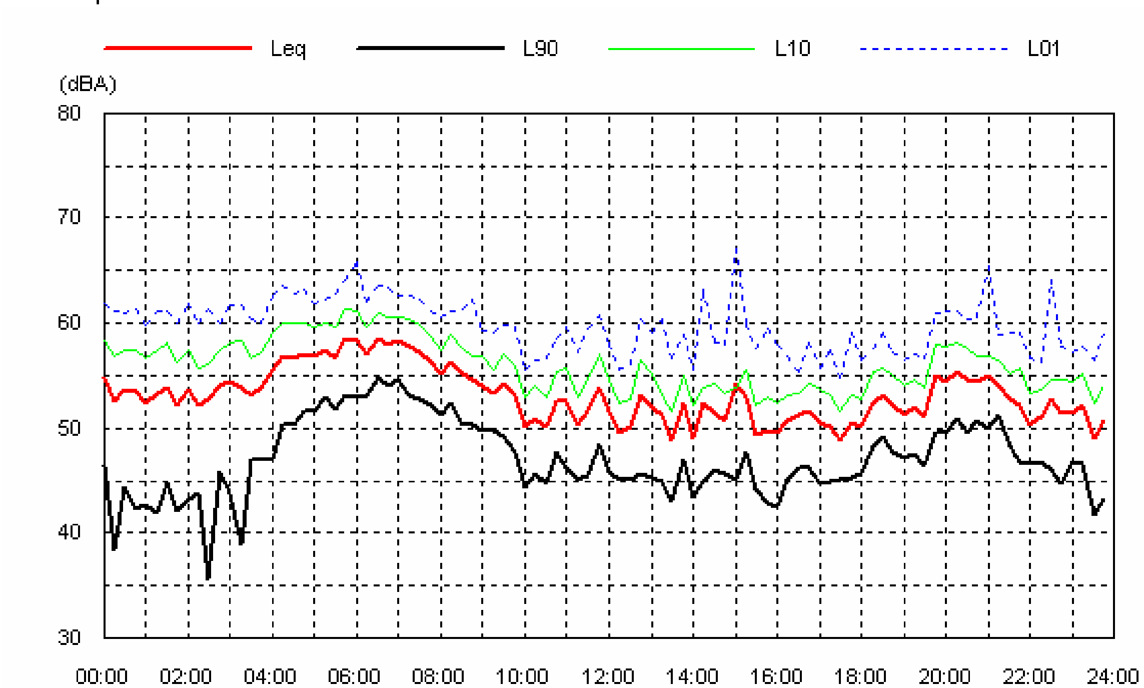

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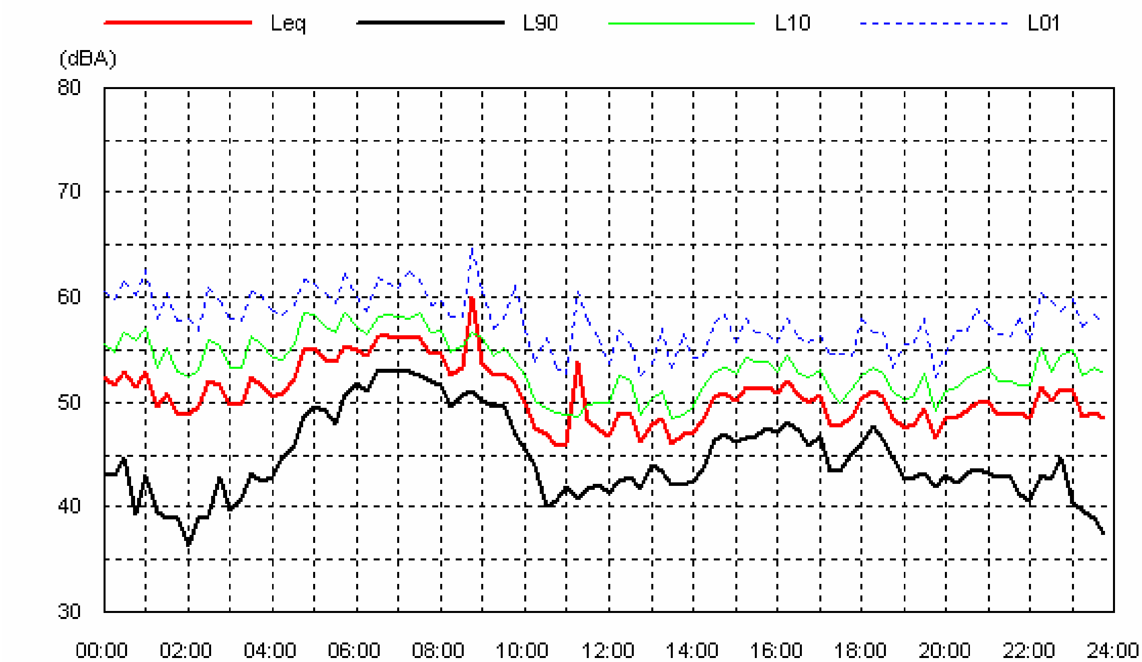

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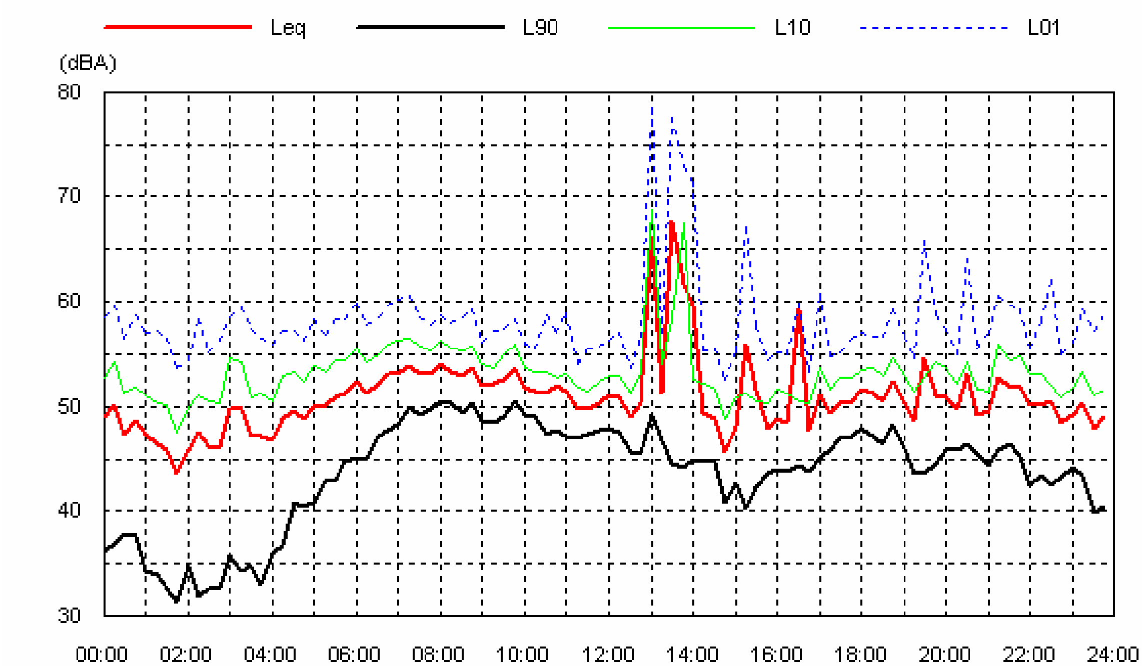

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Location: 1. Lot 1, Near the house

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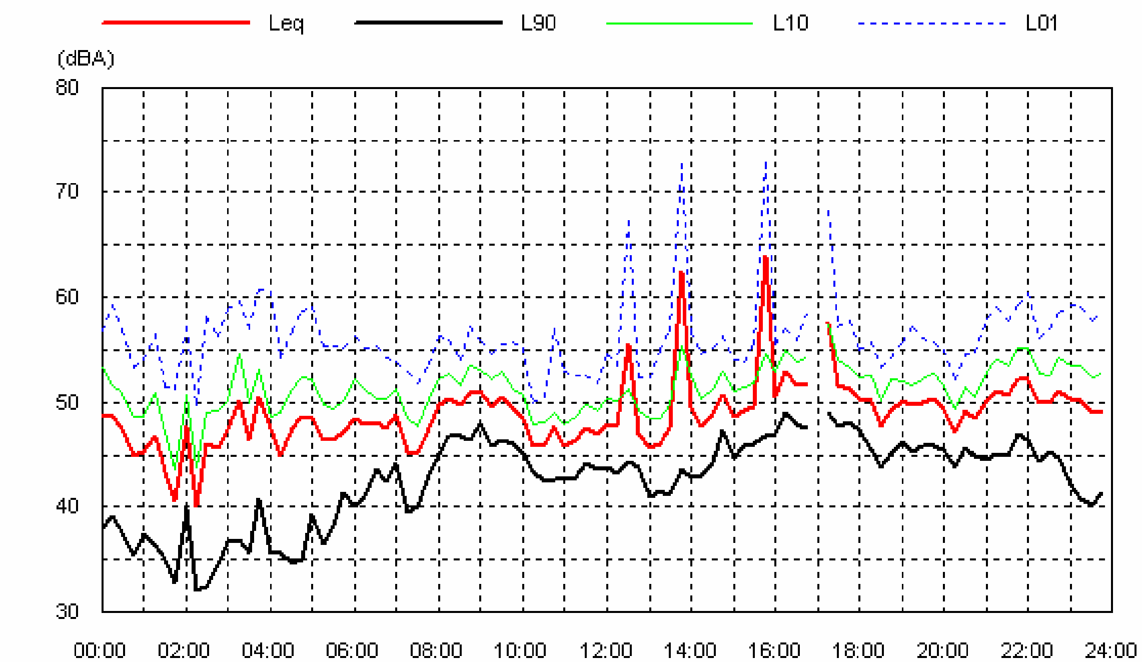

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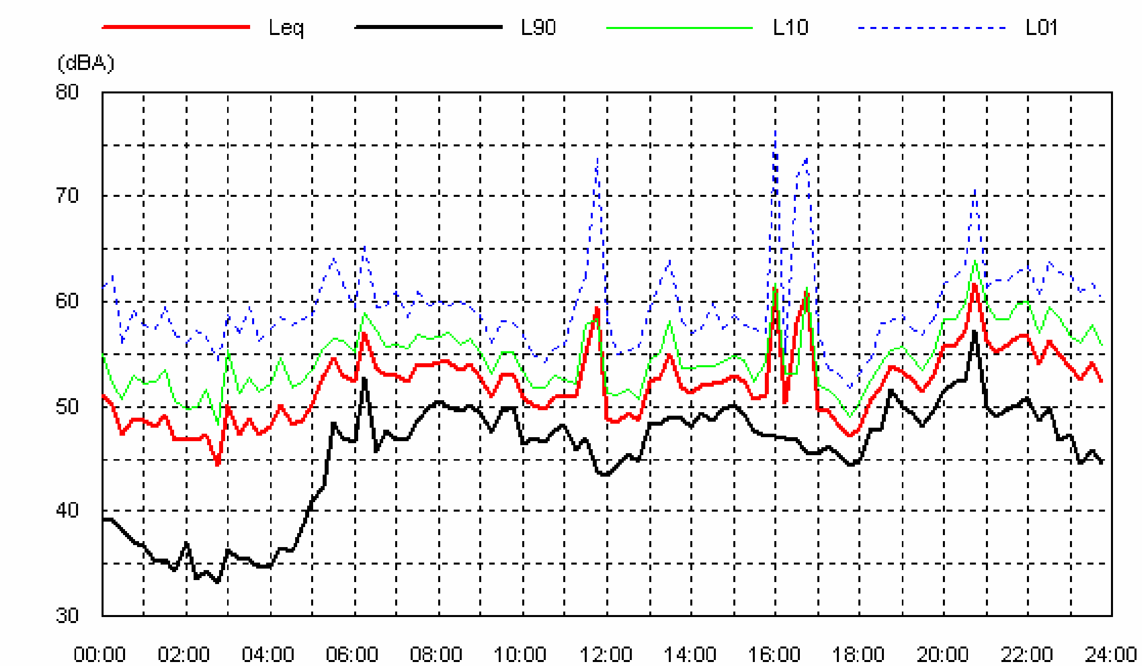

Location: 1. Lot 1, Near the house

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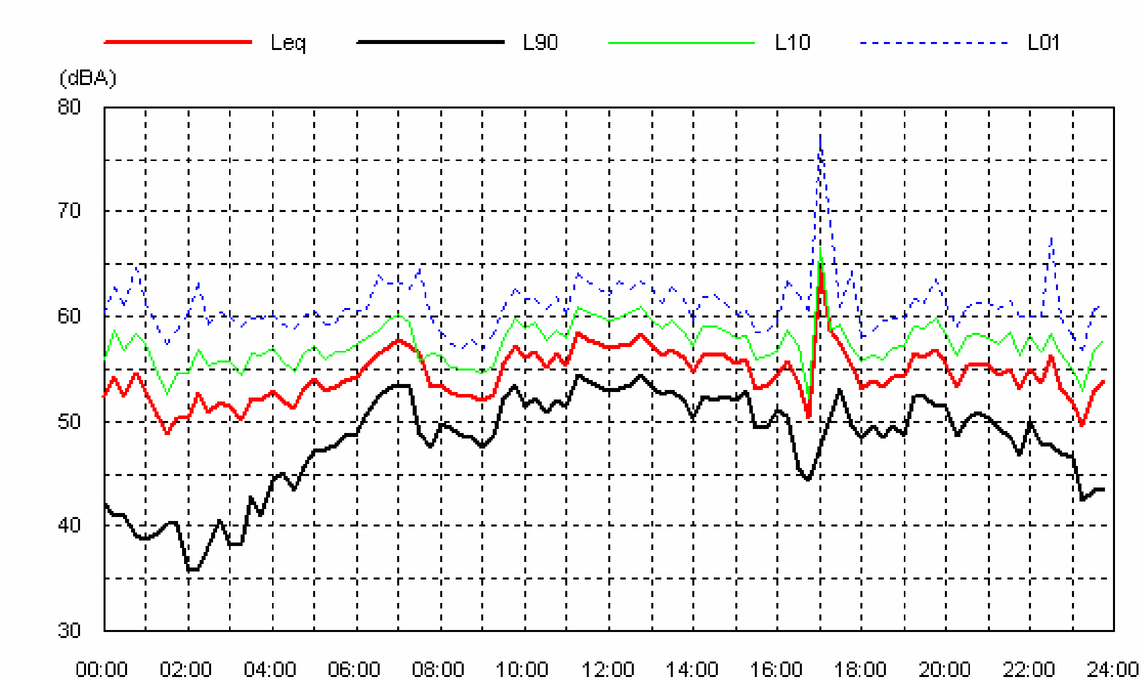

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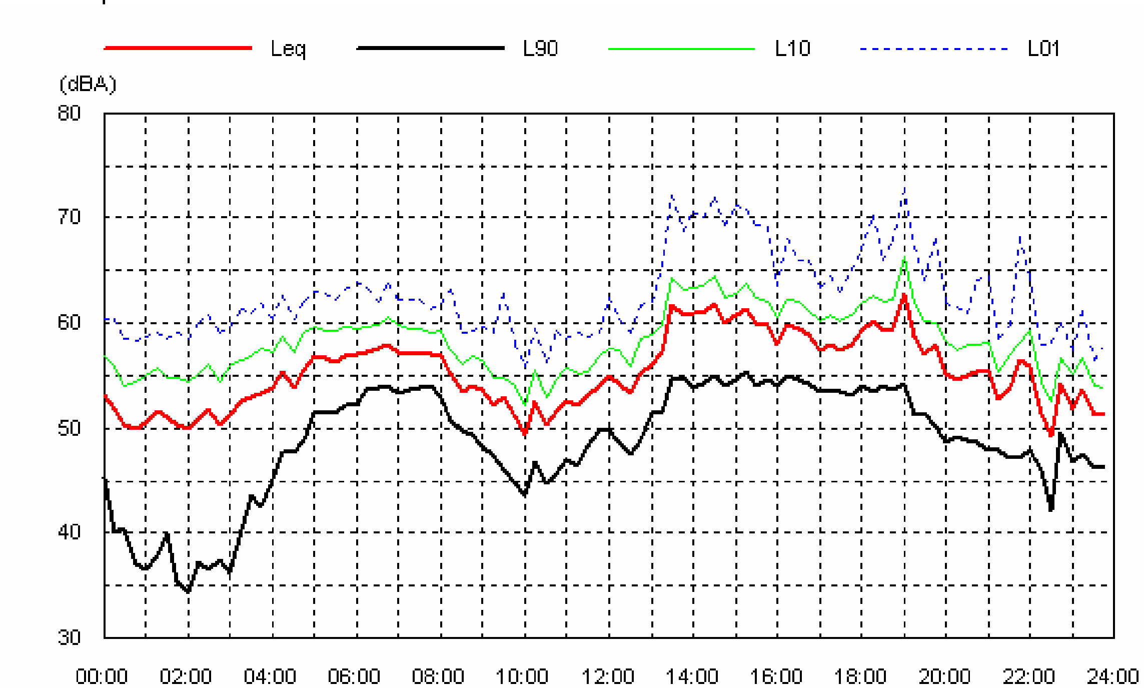

Location: 1. Lot 1, Near the house

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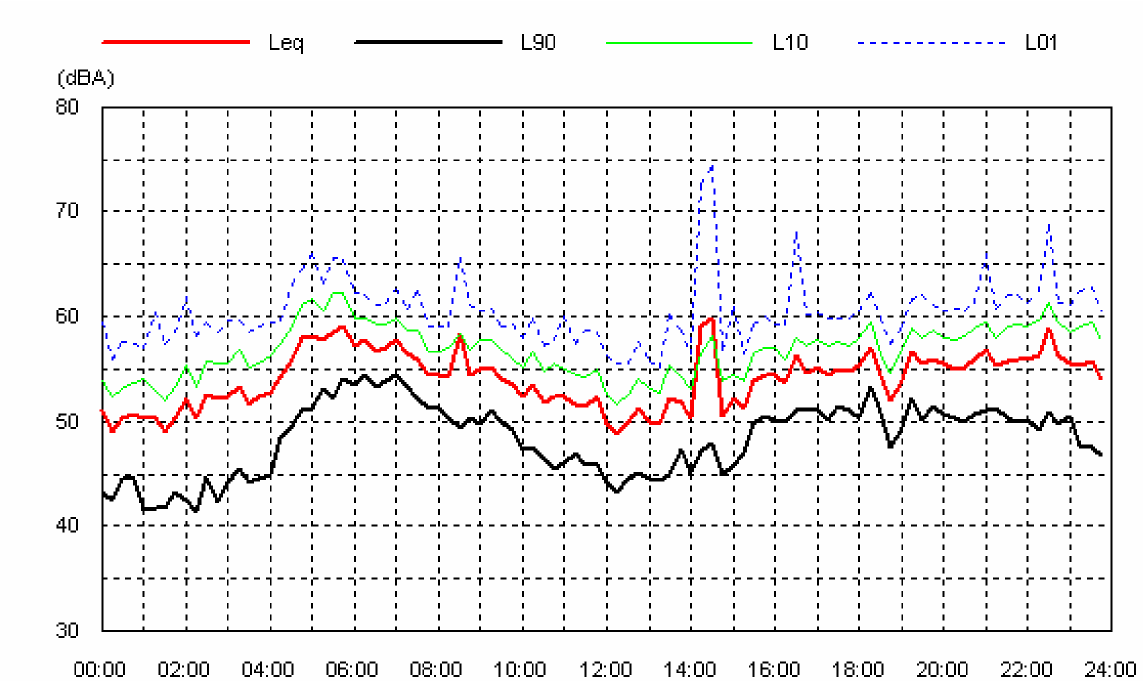

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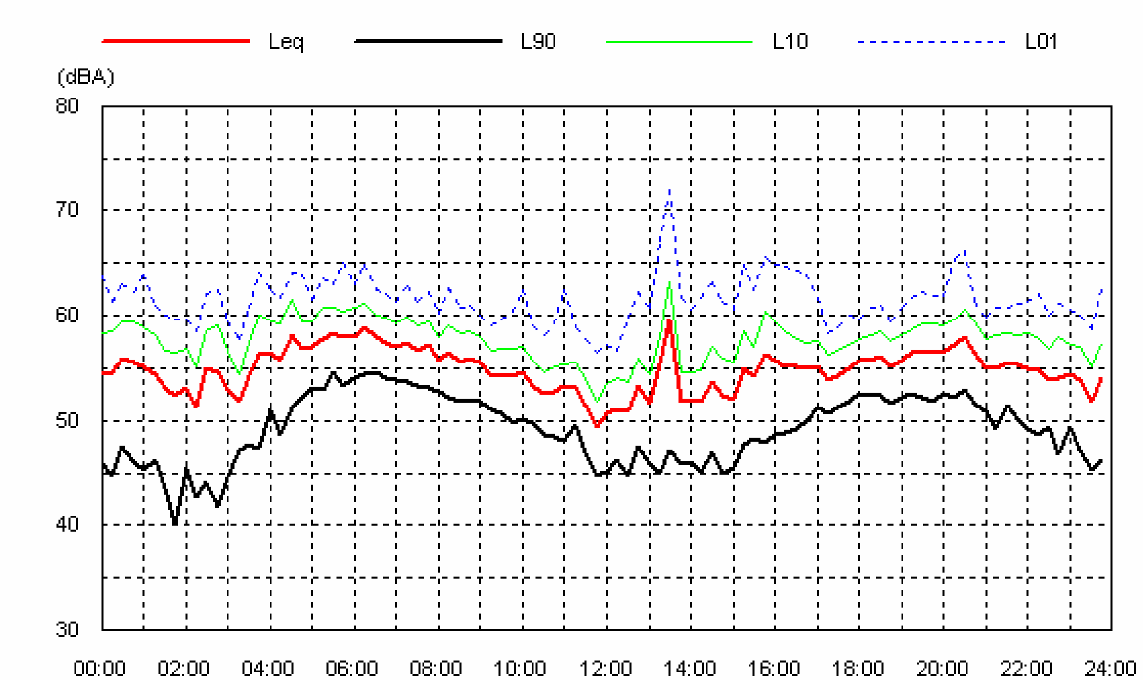

Location: 1. Lot 1, Near the house

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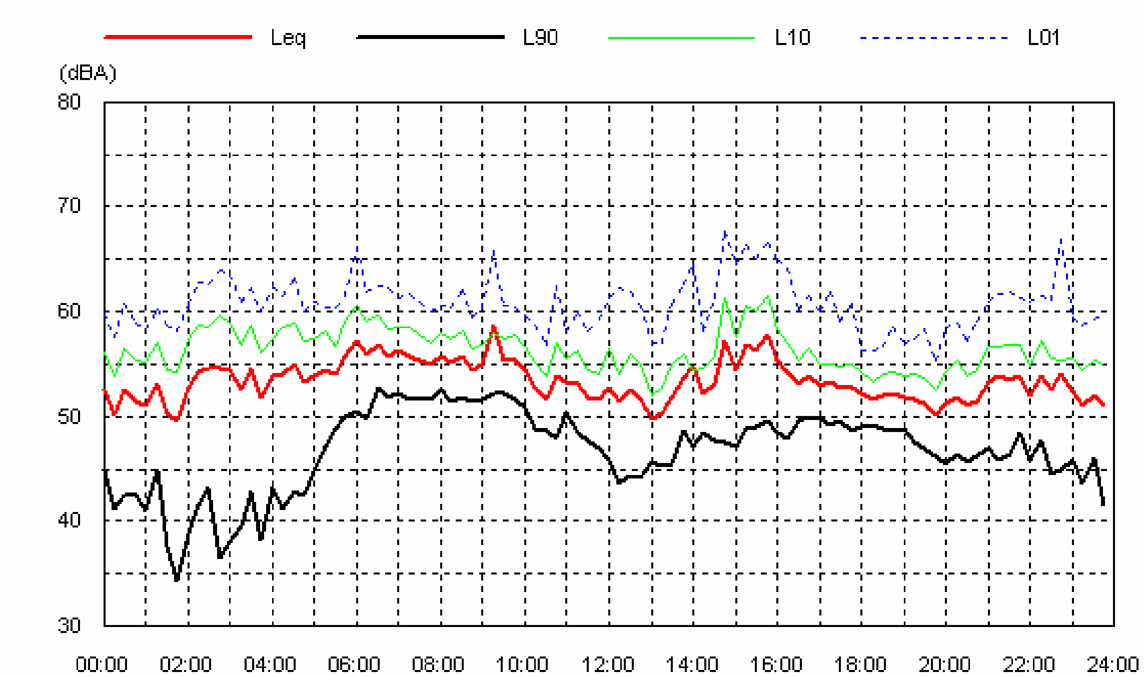

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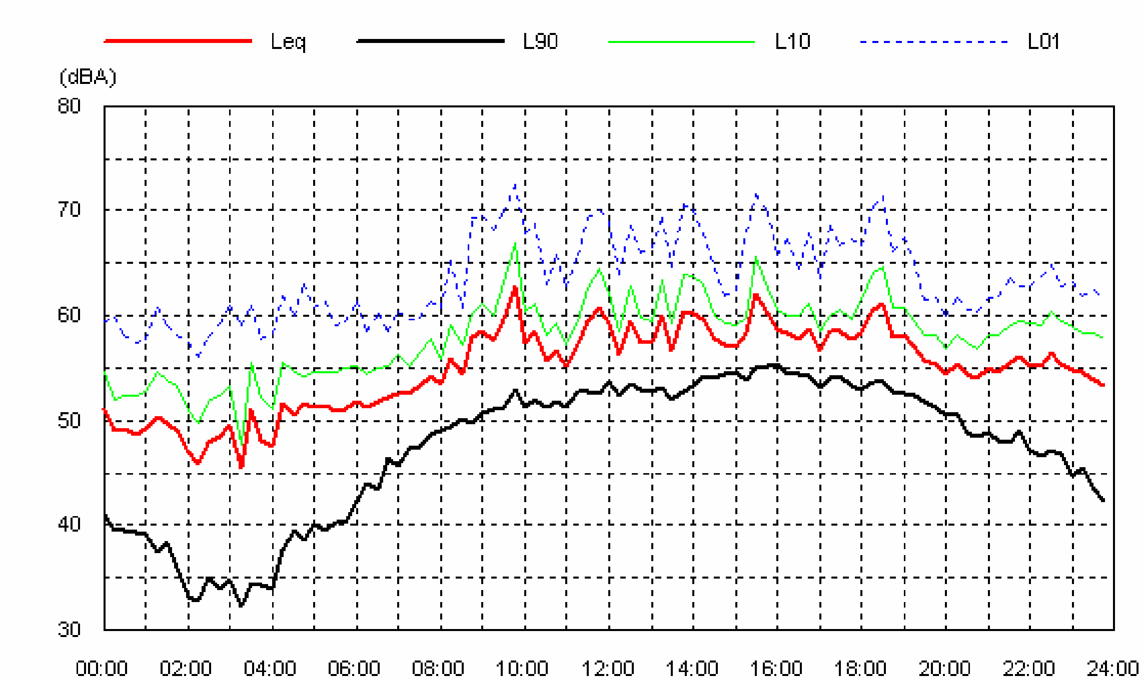

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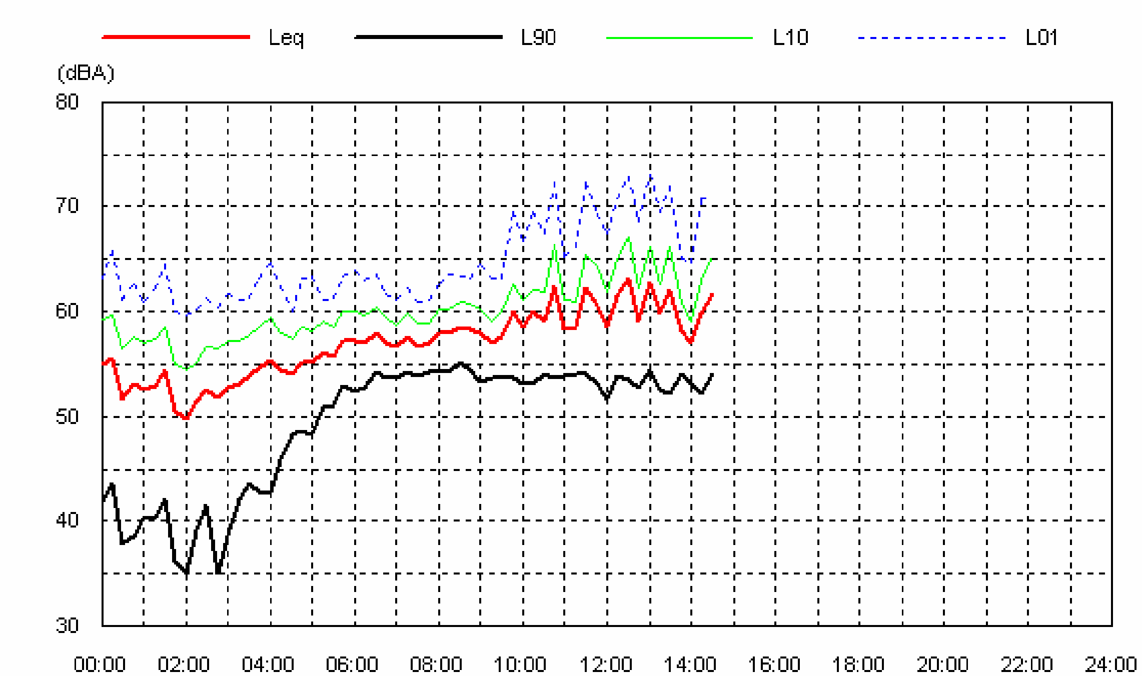

Location: 2. Lot 1, Near Moreton Park Rd

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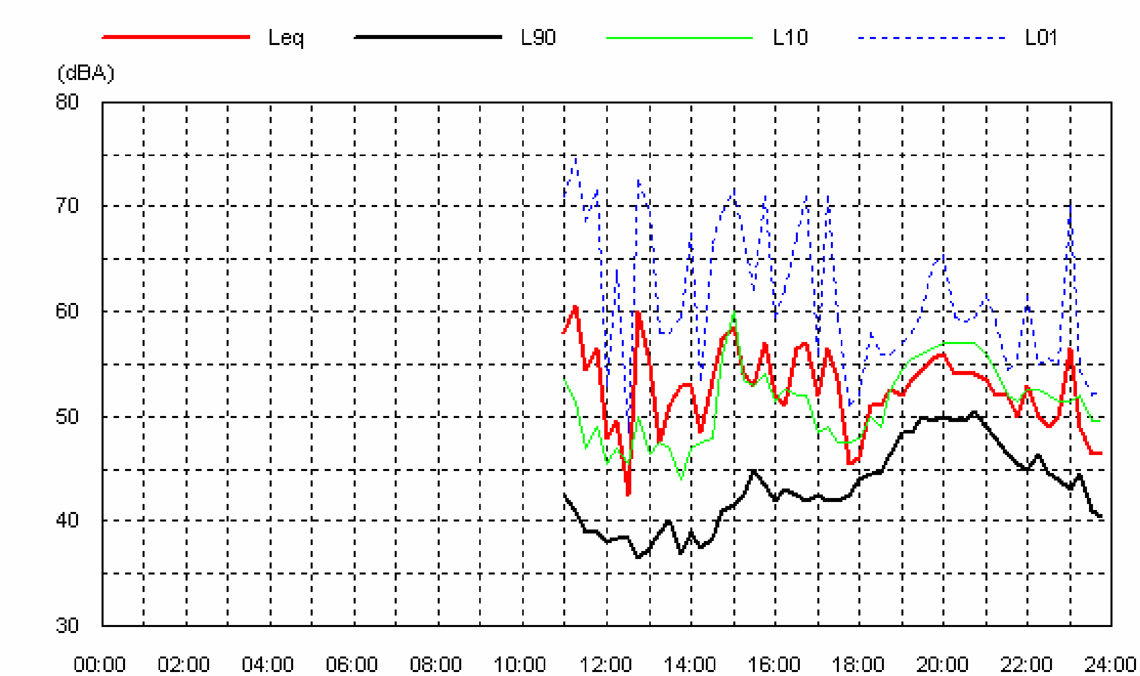

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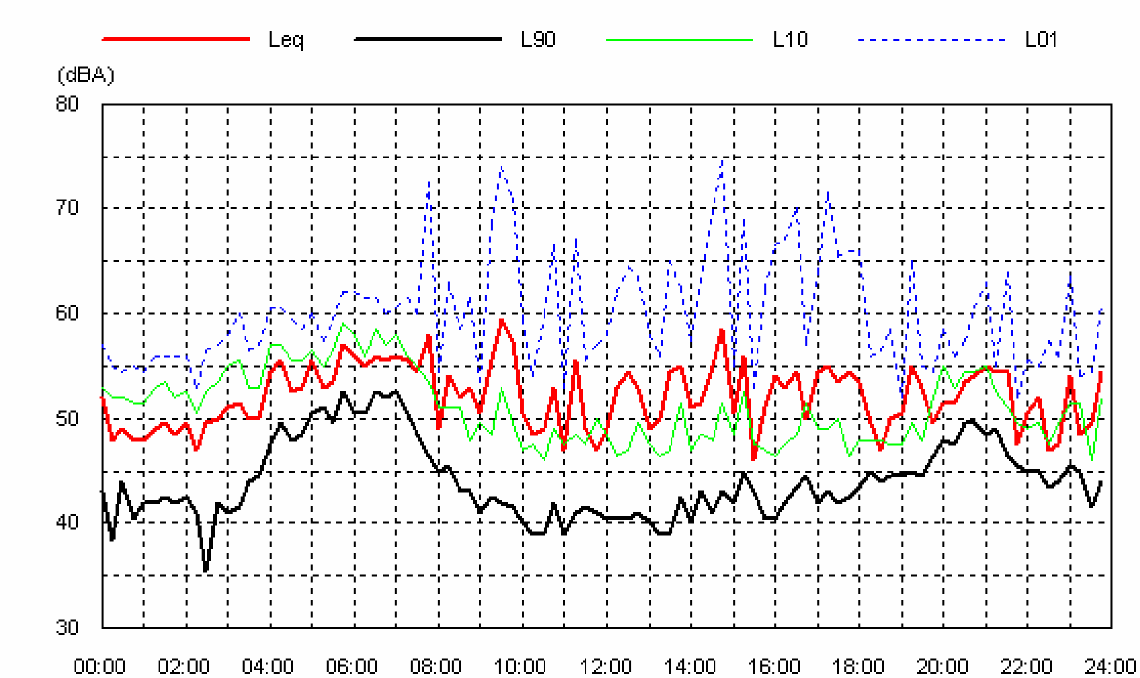

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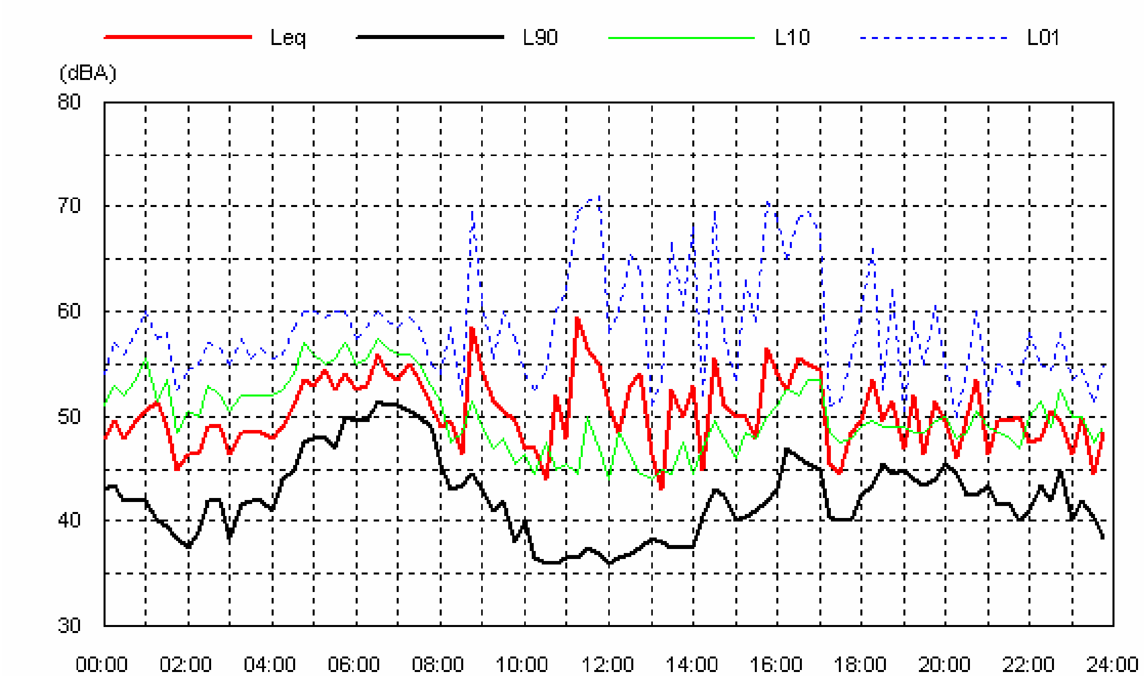

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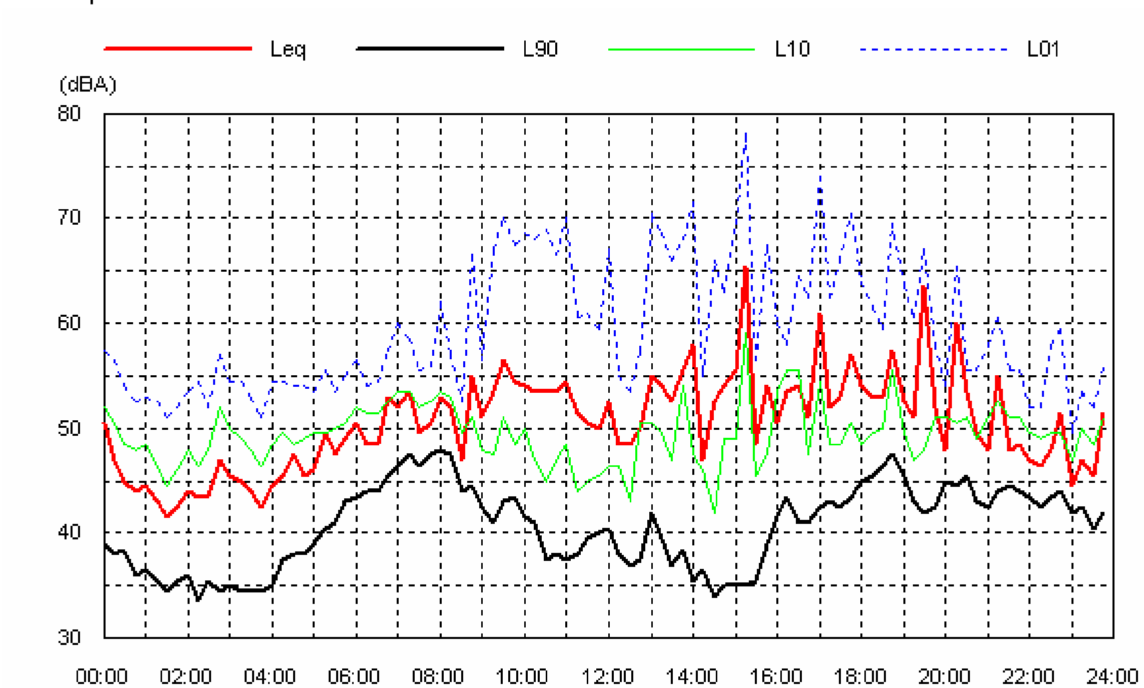

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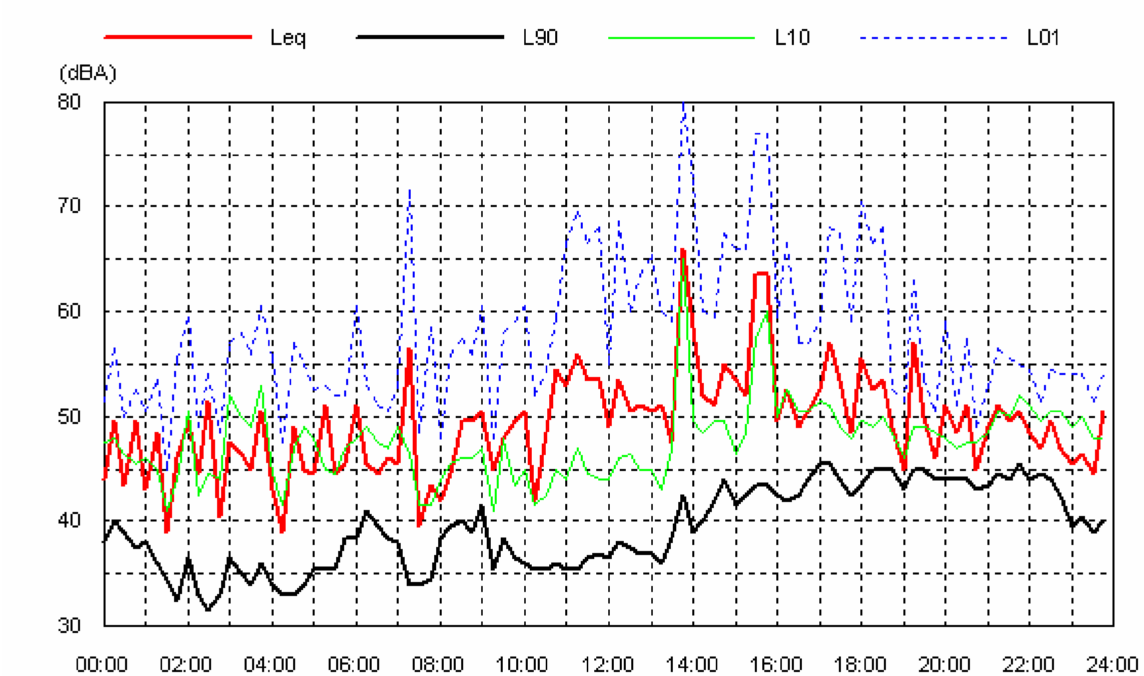

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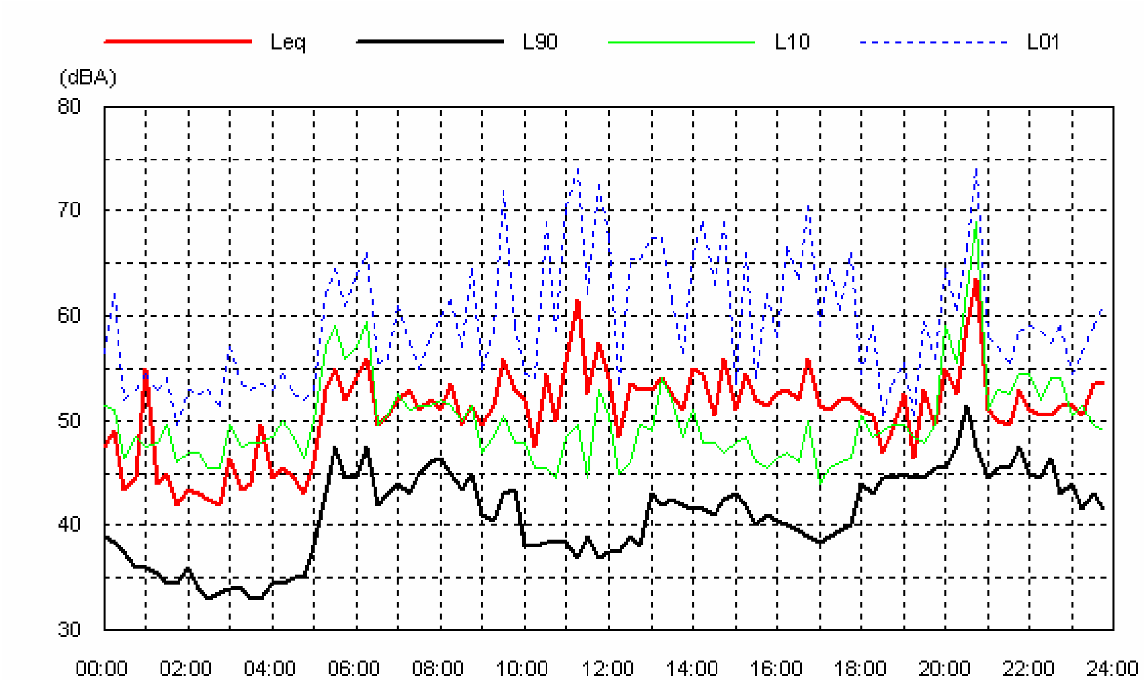

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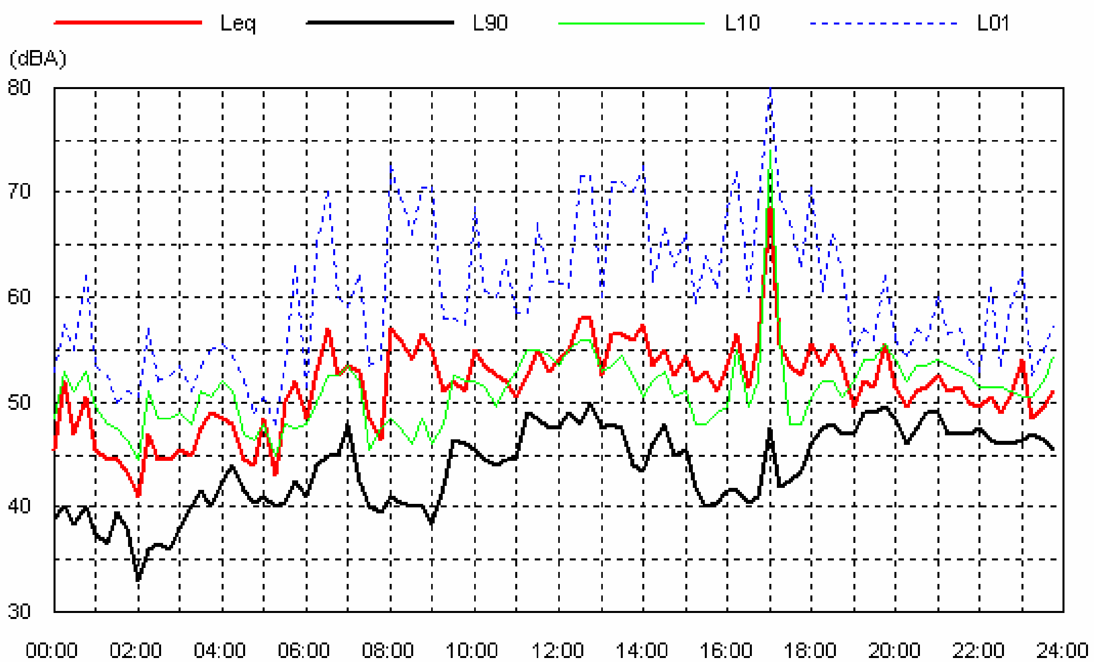

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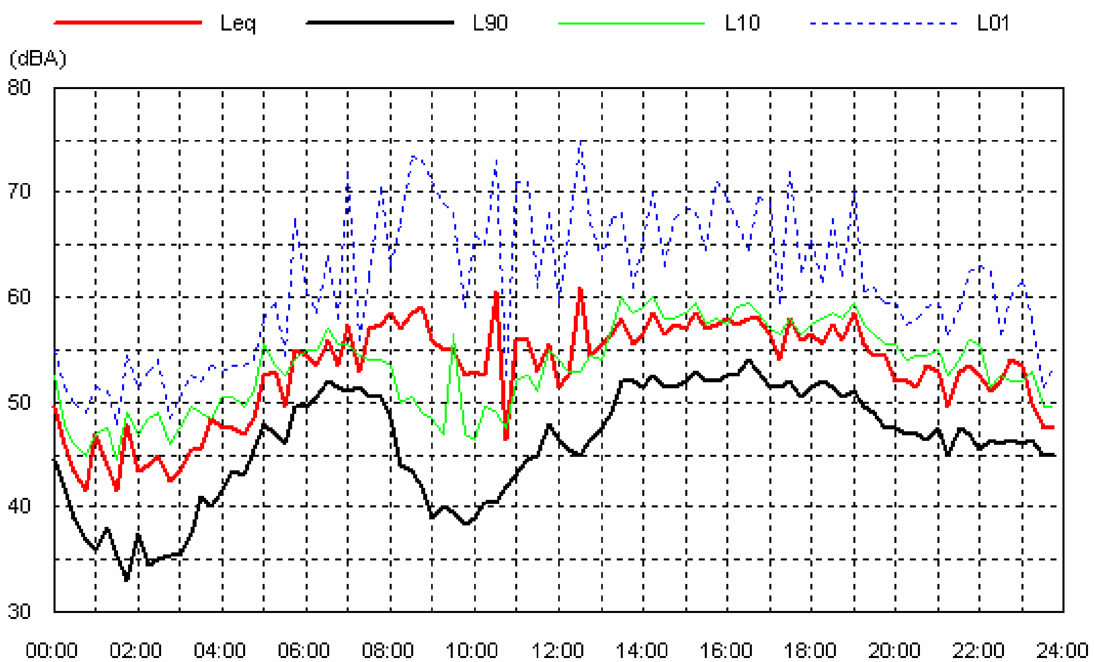

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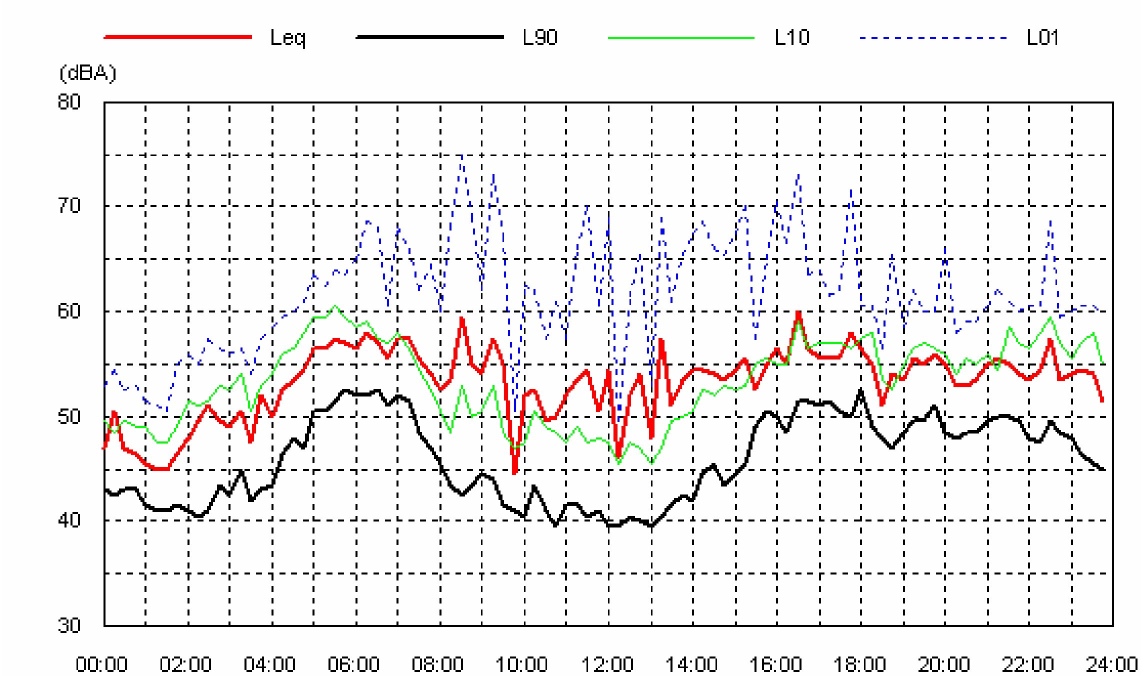

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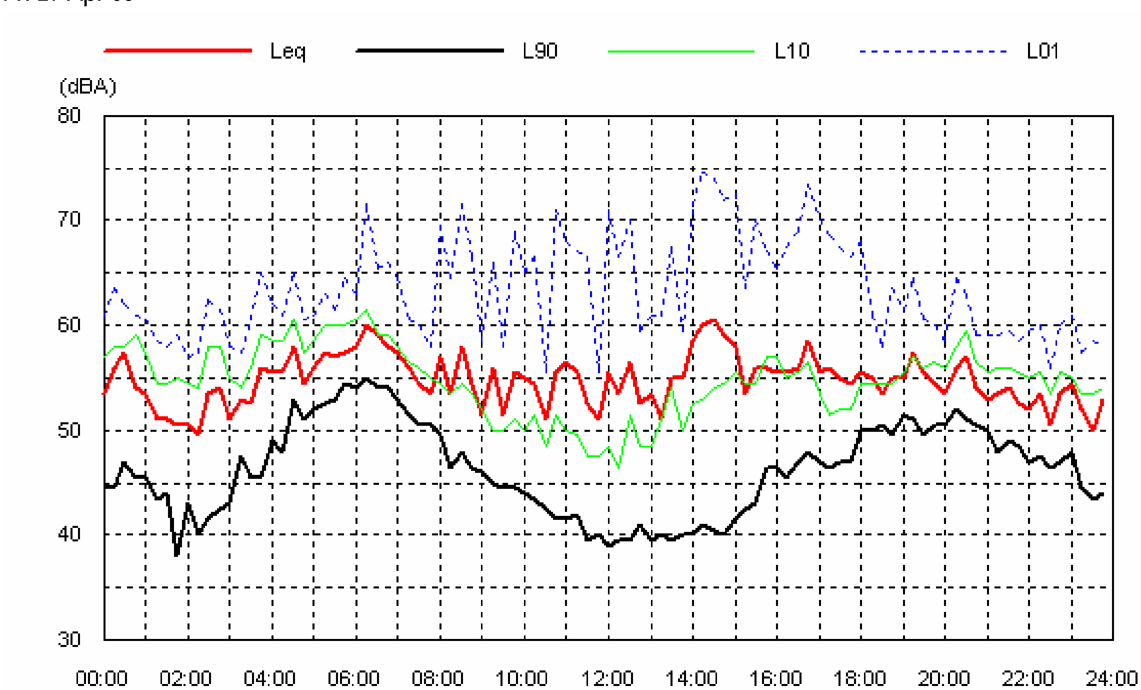

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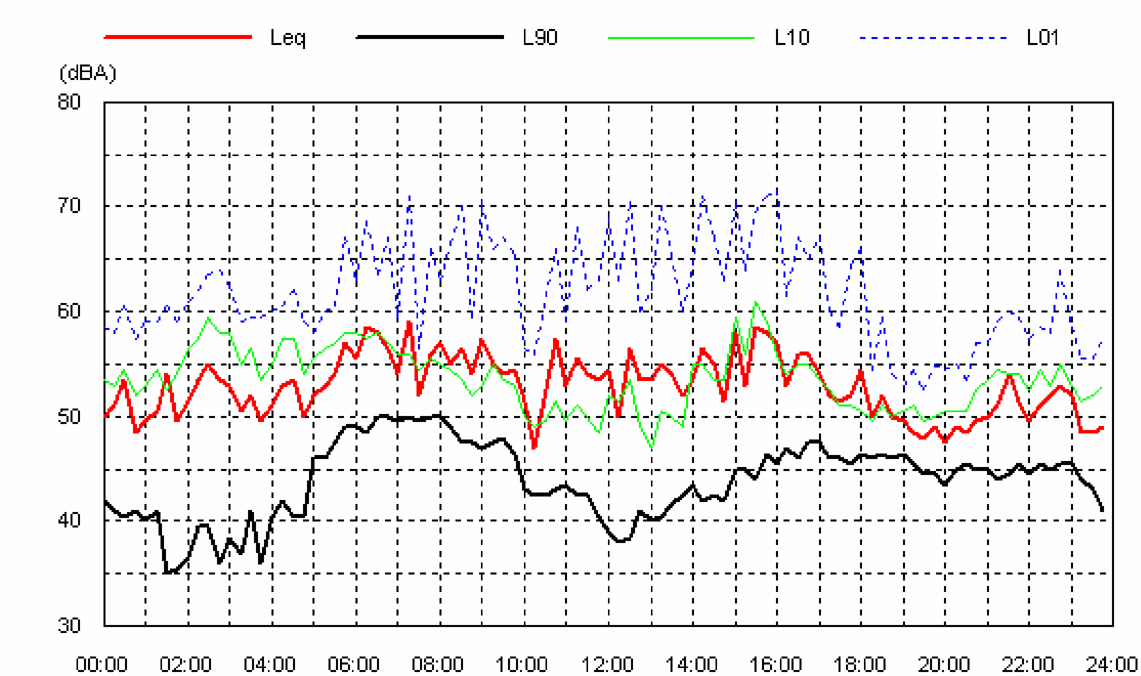

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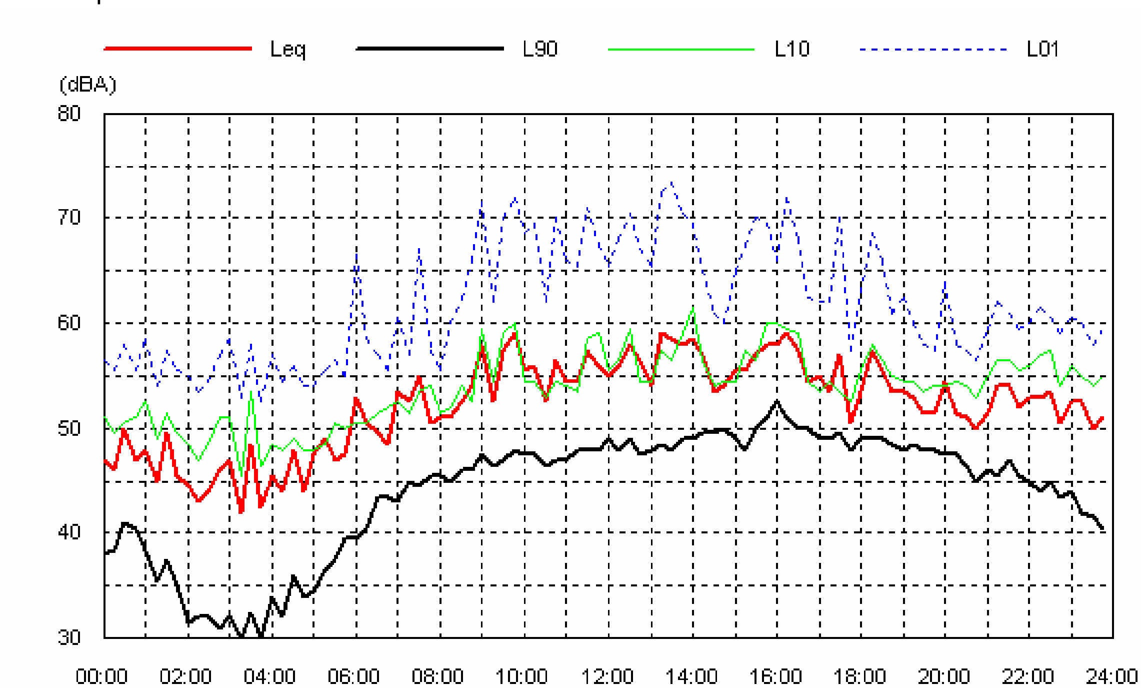

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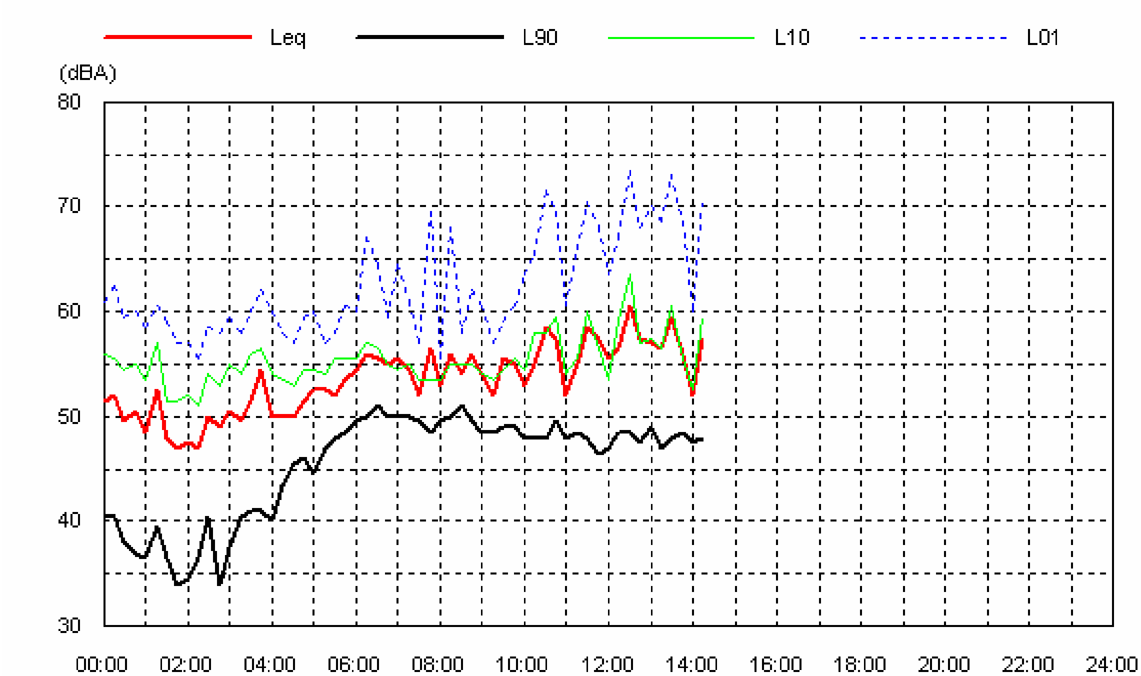

Annex H

H. Air Quality Assessment

AIR QUALITY IMPACT ASSESSMENT

AIR QUALITY IMPACT ASSESSMENT:
APPIN MINE AREA 7 GOAF GAS DRAINAGE PROJECT

BHPBilliton

Job No: 3275

May 2009

A PEL Company

PROJECT TITLE:	***AIR QUALITY IMPACT ASSESSMENT: APPIN MINE AREA 7 GAS DRAINAGE PROJECT***
JOB NUMBER:	**3275**
PREPARED FOR:	Mr Peter Chudleigh CARDNO FORBES RIGBY PTY LTD
PREPARED BY:	Cynthia Isley
QA PROCEDURES CHECKED BY:	Kerry Holmes
APPROVED FOR RELEASE BY:	Kerry Holmes
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VERSION	**DATE**	**PREPARED BY**	**REVIEWED BY**
Draft	28/4/09	Cynthia Isley	Kerry Holmes
Revision	7/5/09	Cynthia Isley	Kerry Holmes

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1 INTRODUCTION

This report has been prepared by PAEHolmes for Cardno Forbes Rigby Pty Ltd on behalf of BHPBilliton-Illawarra Coal (BHPBIC). As part of the ongoing operations of the Appin Mine, BHPBIC plans to implement a program to extract gas from the goaf area remaining after longwall extraction has occurred. The goaf area is defined as the void left after extraction in an underground longwall coal mine has finished. The gas extraction program is referred to as the Appin Mine Area 7 Goaf Gas Drainage Project (the "Project"). Cardno Forbes Rigby are preparing the Environmental Assessment (EA). The purpose of this report is to quantitatively assess the air quality impacts of the Project.

This air quality assessment is based on the use of a computer-based dispersion model, AUSPLUME, to predict off-site impacts due to the proposed site operations. To assess the effect the potential pollutants have on existing air quality, the dispersion model predictions have been compared to relevant regulatory air quality criteria.

The assessment is based on a conventional approach following the procedures outlined in the NSW Department of Environment and Climate Change's (DECC) document titled "Approved Methods for the Modelling and Assessment in NSW" **(DECC, 2005).**

In summary, this report provides information on the following:

- Proposed surface activities related to the Appin Area 7 Goaf Gas Drainage Project;
- Air quality criteria relevant for the Project;
- Climatic and meteorological conditions in the area;
- Existing air quality;
- Emissions to air, including odour and dust;
- Methods used to predict off-site pollution levels from expected emissions from the site; and
- Expected dispersion patterns and predicted impacts.

2 PROJECT DESCRIPTION

2.1 The Site

Figure 2.1 shows the location of the study area, showing the preferred and alternative Goaf Plant locations.

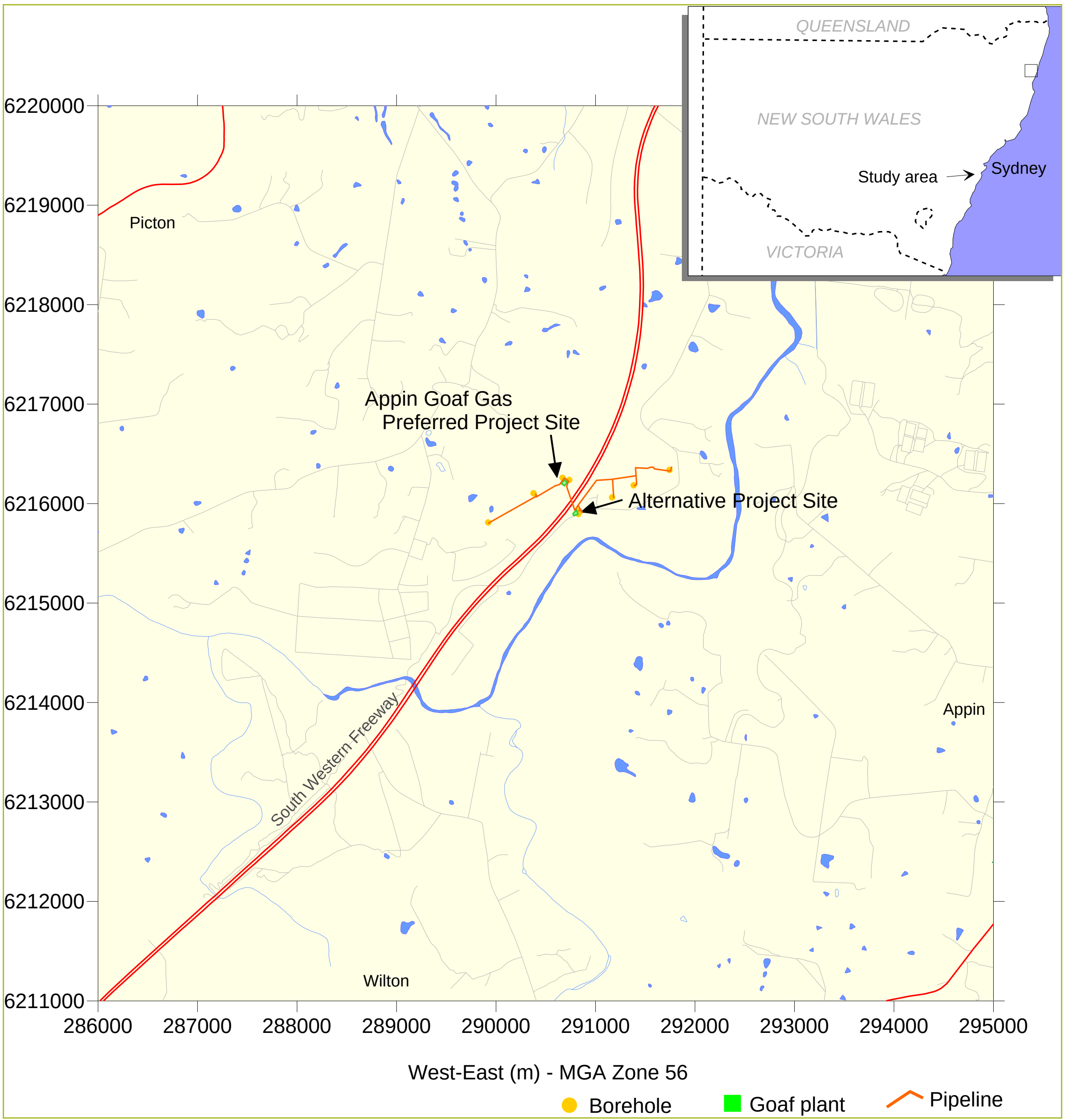


Figure 2.1: Location of study area

Land use in the study area consists of agriculture (grazing and farming) and scattered rural residential properties. The closest township is Douglas Park. Local topography (see **Figure 2.2**) shows that the area comprises rolling hills.

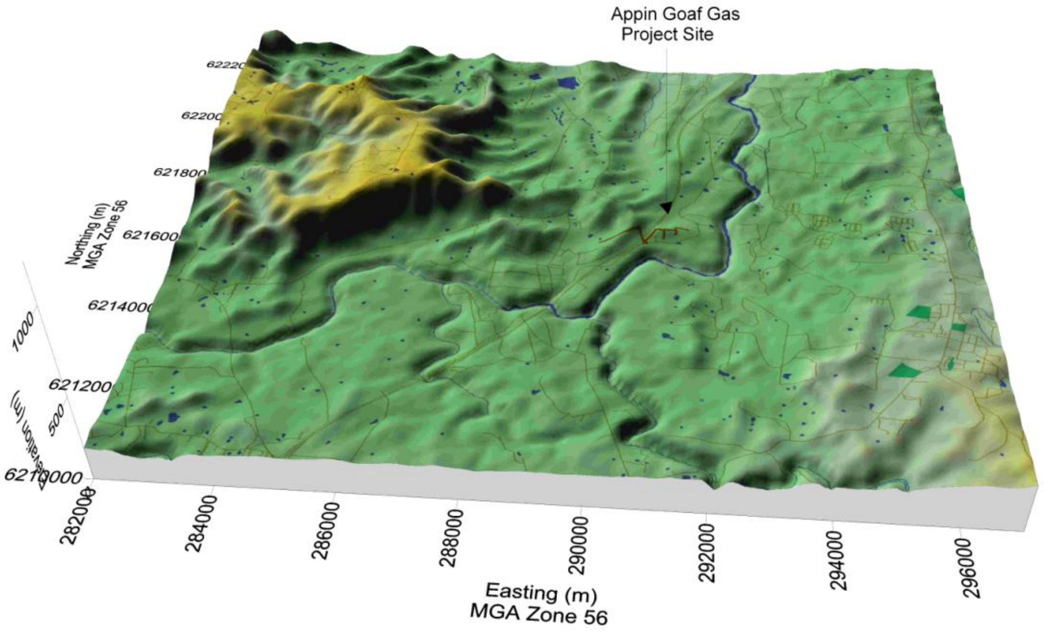


Figure 2.2: Topography of local area

2.2 Proposed development

BHPBIC are proposing to extract gas from the goaf area remaining after longwall mining has occurred. Gas will be transferred to the surface via several cased boreholes installed prior to mining. Once at the surface, one or more of the following scenarios will occur (in order of priority):

- gas will be utilised at Appin West or Appin Power Station (operated by Energy Developments Ltd (EDL)) for use in power generation where air emissions must comply with the requirements of Environment Protection Licences No. 5482 and No. 5357. EDL currently have excess capacity available to utilise the goaf gas collected by this Project. The supply of the goaf gas from Appin Area 7 will not increase air emissions above the already permitted air pollutant load and concentration limits specified in their Environment Protection Licences; or
- gas may be flared adjacent to the on-site goaf plants if it cannot be utilised by the EDL power stations for extended periods; and
- gas will be vented to the atmosphere.

The Project involves the installation and operation of 8 boreholes over Appin Area 7 Longwalls 703 – 704 in order to extract gas from the goaf. The gas will be collected in a reticulation system and directed underground to be incorporated into the pipe range supplying gas to the EDL power stations.

The locations of the goaf gas drainage infrastructure and the nearest privately-owned residential properties are shown in **Figure 2.3**.

The proposed extraction plant will be in a centralised location remote from the individual well heads. The plant may draw gas from multiple wells that are connected by a reticulation system as required by the mining operation. There will be a diesel-powered generator (175 kVA) to generate the power necessary to operate the equipment. Where goaf gas cannot be reticulated underground for incorporation into the pipe range to supply EDL power stations, a 9 m high vent stack will be used to emit gas to the atmosphere to ensure the safe operation of the system. This circumstance will only occur rarely during operational emergency stoppage of the underground gas range infrastructure, equipment failures and the like. If goaf gas cannot be continuously supplied to the underground pipe range, Illawarra Coal will investigate the use of on-site flares to abate the greenhouse gas contribution of methane emissions to the atmosphere. It has been conservatively assumed in this study that a diesel generator will operate continuously.

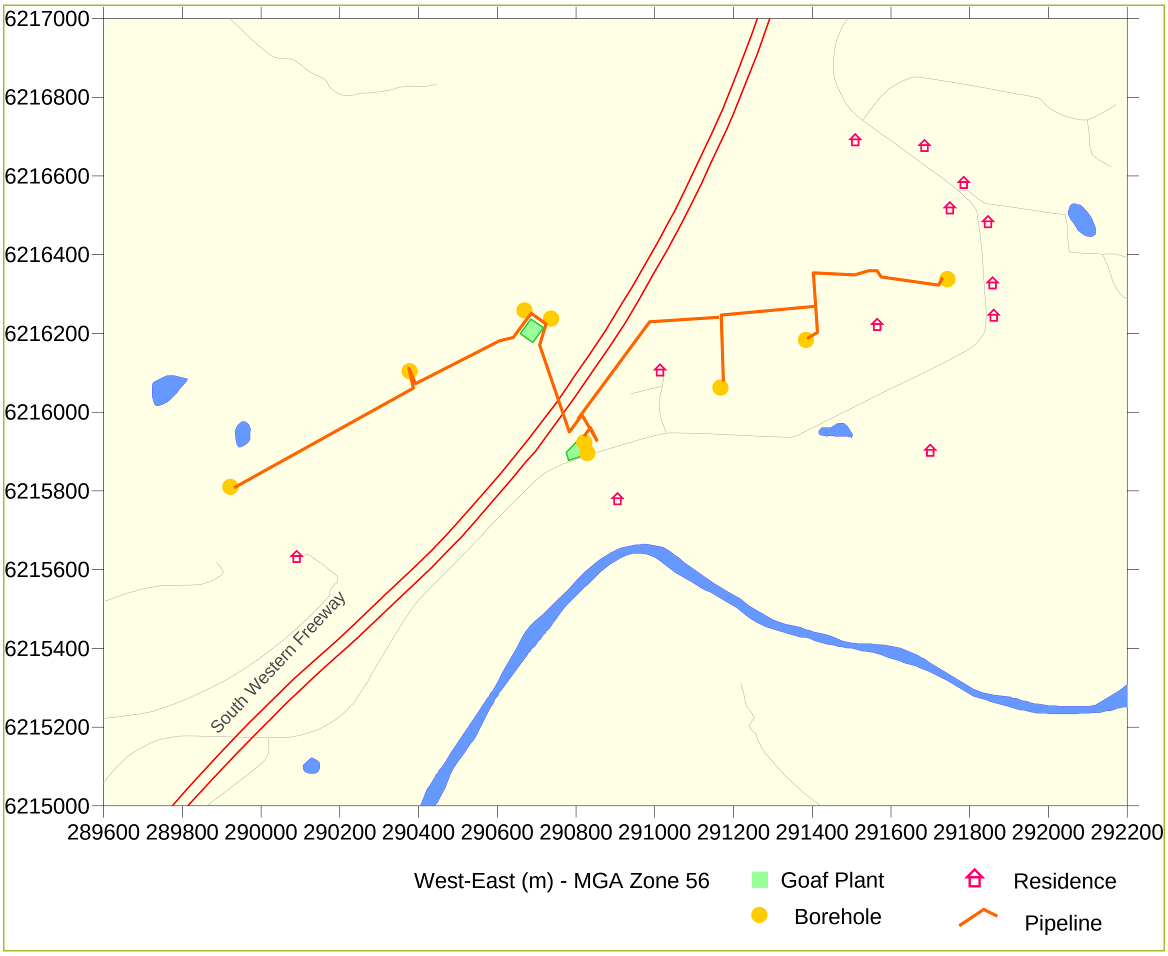


Figure 2.3: Location of nearest residences

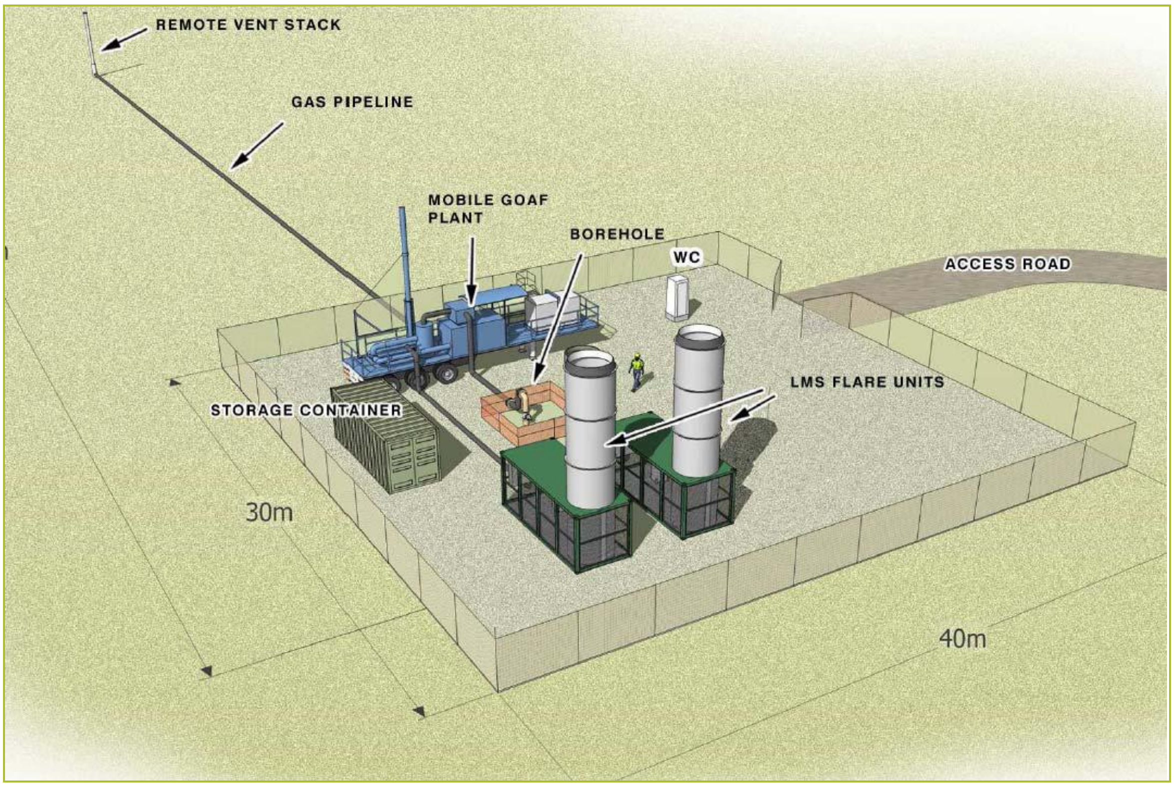
Maximum goaf gas flows are predicted to be of the order of 800 litres per second (L/s). The goaf gas will be utilised at the EDL power stations located at Appin West pit top and Appin No 1 shaft.

Flaring units which can process up to 800 L/s of gas may be considered if the proposed EDL utilisation management system is not effective or cannot be maintained routinely. An artist's impression of a typical goaf gas management compound is shown in **Figure 2.4**.

The potential air quality impacts of the Project are identified as follows:

- Emissions from the flaring stacks;
- Odour from the gas vent stacks;
- Dust generated during the construction phase; and
- Pollutant emissions from the diesel generator.

The items listed above are the focus of this air quality assessment.



Source: Maurice Hayler & Associates Architects

Figure 2.4: Artist's impression of a typical goaf gas management compound

3 AIR QUALITY ISSUES

3.1 Odour

This section evaluates odour in terms of measurement and air quality criteria that relate to odour. There is still considerable debate in the scientific community about appropriate odour criteria as determined by dispersion modelling.

3.1.1 Measurement of Odour

Odour is measured using panels of people who are presented with samples of odorous gas diluted with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. Odour in the air is then quantified in terms of odour units which is the number of dilutions required to bring the odour to a level at which 50% of the panellists can just detect the odour. This process is known as olfactometry.

Olfactometry can involve a "forced-choice" end point or a "free choice" endpoint. The "forced-choice" method is where panellists identify from multiple sniffing ports, the one port where odour is detected, regardless of whether they are sure they can detect odour. The "free choice" endpoint is a "yes/no" decision where panellists are required to say whether or not they can detect odour from one sniffing port. Forced-choice olfactometry generally detects lower odour levels than free choice olfactometry.

In both the "forced-choice" and "free choice" cases, odorous air is presented to the panellists in increasing concentrations. For the forced-choice method, where there are multiple ports for each panellist, the concentration is increased until all panellists consistently distinguish the port with the sample from the blanks. For a yes/no olfactometer (which has only one sniffing port) one method used is to increase the concentration of odour in the sample until all panellists respond. The sample is then shut off and once all panellists cease to respond, the sample is introduced again at random dilutions and the panellists are asked whether they can detect the odour.

There are variations in the literature in the terminology for odour thresholds. The DECC has used the definition of the ***detection*** threshold as the lowest concentration which will elicit a response, but where the panellist is essentially guessing correctly. This corresponds to the first end point in the forced-choice olfactometry method. The odour ***recognition*** threshold is, by definition, the minimum concentration at which the panellist is certain they can detect the odour. This is also referred to as the certainty threshold and is the second endpoint in forced-choice olfactometry and similar to the first end point in yes/no olfactometry.

An Australian Standard (AS/NZS 4323.3.2001) for olfactometry has been developed which is consistent with the European Standard, CEN. This enables results between laboratories to be more uniform. These standards have adopted the certainty threshold as the odour standard and referencing this to a concentration of butanol (40 ppb). The odour levels referred to in this report are the certainty odour levels (odour detected by 50% of panellists using the recognition threshold).

As with all sensory methods of identification there is variability between individuals. Consequently the results of odour measurements depend on the way in which the panel is selected and the way in which the panel responses are interpreted. The process by which these imprecise measurements are translated into regulatory criteria is still being refined. However, the DECC has recently published a Technical Framework for the assessment of odour from stationary sources, which includes recommendations for odour criteria (**DEC, 2006**). These are explained below and have been used for this assessment.

3.1.2 Odour Criteria

The determination of air quality criteria for odour and their use in the assessment of odour impact is recognised as a difficult topic in air pollution science. The topic has received considerable attention in recent years and the procedures for assessing odour impacts using dispersion models have been refined considerably.

The DECC has in recent times refined odour criteria and the way in which they should be applied with dispersion models to assess the likelihood of nuisance impact arising from the emission of odour. However, as discussed above these procedures are still being developed and odour criteria are likely to be revised in the future.

There are two factors that need to be considered:

1. what "level of exposure" to odour is considered acceptable to meet current community standards in NSW and
2. how can dispersion models be used to determine if a source of odour meets the criteria which are based on this acceptable level of exposure.

The term "level of exposure" has been used to reflect the fact that odour impacts are determined by several factors. The most important factors (the so-called **FIDOL** factors) are:

- the **F**requency of the exposure
- the **I**ntensity of the odour
- the **D**uration of the odour episodes
- the **O**ffensiveness of the odour, and
- the **L**ocation of the source

In determining the offensiveness of an odour it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

In summary, whether or not an individual considers an odour to be a nuisance will depend on the FIDOL factors outlined above and although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable. Odour criteria need to take account of these factors.

The DECC Technical Framework includes some recommendations for odour criteria. The criteria have been refined by DECC to take account of population density in the area. **Table 3:1** lists the odour certainty thresholds, to be exceeded not more than 1% of the time, for different population densities.

The difference between odour criteria is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The criteria assume that 7 odour units at the 99^{th} percentile would be acceptable to the average person, but as the number of exposed people increases there is a chance that sensitive individuals would be exposed. The criterion of 2 odour units at the 99^{th} percentile is considered to be acceptable for the whole population.

Table 3:1: DECC odour assessment criteria

Population of affected community	Odour performance criteria (nose response odour certainty units at the 99th percentile)
Rural single residence (≤2)	7
~10	6
~30	5
~125	4
~500	3
Urban (>2000) and/or schools and hospitals	2

It is common practice to use dispersion models to determine compliance with odour criteria. This introduces a complication because Gaussian dispersion models are only able to directly predict concentrations over an averaging period of 3-minutes or greater. The human nose, however, responds to odours over periods of the order of a second or so. During a 3-minute period, odour levels can fluctuate significantly above and below the mean depending on the nature of the source.

To determine more rigorously the ratio between the one-second peak concentrations and three-minute and longer period average concentrations (referred to as the peak-to-mean ratio) that might be predicted by a Gaussian dispersion model, the DECC (then EPA) commissioned a study by Katestone Scientific Pty Ltd (see **Katestone 1995** and **1998**). This study recommended peak-to-mean ratios for a range of source types. The ratio is also dependent on atmospheric stability and the distance from the source. A summary table of these ratios is presented in **Appendix A**.

The DECC Technical Framework (**DEC, 2006**) takes account of this peaking factor and the criteria shown in **Table 3:1** are based on nose-response time.

3.2 Dust

Table 3:2 summarises the air quality assessment criteria for dust concentration. The air quality criteria relate to the total dust burden in the air and not just the dust from the project. In other words, some consideration of background levels needs to be made when using these criteria to assess impacts. The estimation of appropriate background levels will be discussed further in **Section 4.3**.

Table 3:2 : DECC criteria for particulate matter concentrations

Pollutant	Criteria	Averaging period	Agency
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	National Health & Medical Research Council
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	DECC
	30 $\mu g/m^3$	Annual mean	DECC long-term reporting goal
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Council

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3:3** shows the maximum acceptable increase in dust deposition over the existing dust levels. The criteria for dust fallout levels are set to protect against nuisance impacts (**DEC, 2005**).

Table 3:3: **DECC criteria for dust fallout**

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

3.3 Oxides of Nitrogen

The key pollutant released, both from flaring of the goaf gas and from the diesel-powered generator will be oxides of nitrogen (NO_x). NO_x is comprised of nitric oxide (NO) and nitrogen dioxide (NO_2) however NO is much less harmful to humans than NO_2 and is not generally considered a pollutant with health impacts at the concentrations normally found in urban environments. **Table 3:4** shows the DECC air quality assessment criteria for NO_2. The air quality criteria relate to the total burden of NO_2 in the air and not just that from the sources being modelled.

Table 3:4 : DECC criteria for nitrogen dioxide

Pollutant	Criterion*	Averaging period	Agency
Nitrogen dioxide (NO_2)	0.12 ppm or 246 $\mu g/m^3$ 0.03 ppm or 62 $\mu g/m^3$	1-hour maximum Annual mean	DECC DECC

** ppm = parts per million.*

3.4 Carbon Monoxide

CO is another combustion product that will be released both from flaring of the goaf gas and from the diesel-powered generator. **Table 3:5** shows the DECC air quality assessment criteria for NO_2. The air quality criteria relate to the total burden of CO in the air and not just that from the sources being modelled.

Table 3:5: DECC criteria for carbon monoxide µg/m^3

Pollutant	Criteria	Averaging period	Agency
Carbon monoxide (CO)	100 000	15 minutes	DECC
	30 000	1 hour	DECC
	10 000	8 hours	DECC

4 EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing air quality in the Project area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment (AUSPLUME) requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[a] and mixing height[b]. Suitable meteorological data, from 1995, are available from a weather station operated by the DECC at Appin. The station was approximately six kilometres to the east of the Project area but has since been decommissioned. Data for 2008 has also been made available by Energy Development Limited at Appin, approximately 5 km southeast of the Project area.

Figure 4.1 shows the annual and seasonal wind roses for Appin from 1995 and 2008.

The Appin data included hourly records of temperature, wind speed, wind direction and sigma-theta (the standard deviation of the horizontal wind direction) and have been processed into a form suitable for the AUSPLUME dispersion model.

For both 1995 and 2008, winds were predominantly from the south-southeast and this wind direction is present in all seasons. Annually, calm conditions (winds less than or equal to 0.5 m/s) were measured for 3.4% of the time in 1995 and for 0.0% of the time in 2008. Airborne pollutants disperse more slowly in calm conditions, therefore it would be anticipated that the 1995 data may return a more conservative prediction of ground level pollutant concentrations than the 2008 data.

[a] In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[b] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

A screening analysis was conducted, using AUSPLUME, with both sets of meteorological data (1995 and 2008); it was found that the 1995 data returned a more conservative prediction of ground level pollutant concentrations and therefore would be more appropriate for use in the modelling of the Project.

DECC have specified the requirements for meteorological data that are used for air dispersion modelling in their *Approved Methods* (**DEC, 2005**). The requirements are as follows:

- Data must span at least one year;
- Data must be 90% complete; and
- Data must be representative of the area in which emissions are modelled.

For the data collected in 1995, there were 8,112 hours available which represents a 93% data recovery.

As described above, to use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. A stability class was assigned to each hour of the meteorological data using sigma-theta according to the method recommended by the US EPA (**US EPA, 1986**). **Error! Reference source not found.** shows the frequency of occurrence of the stability categories expected in the area.

The most common stability class was determined to be D class. This suggests that the dispersion conditions are such that air emissions disperse rapidly for a significant proportion of the time.

Table 4:1 : Frequency of occurrence of stability classes in the study area

Stability Class	Appin, 1995 (%)	Appin, 2008 (%)
A	9.4	8.9
B	5.5	7.5
C	11.4	10.9
D	44.5	52.1
E	15.1	10
F	14.1	10.6
Total	100	100

Mixing height was determined using a scheme defined by **Powell** (**1976**) for day-time conditions and an approach described by **Venkatram**, (**1980**) for night-time conditions. These two methods provide a good estimate of mixing height in the absence of upper air data.

Joint wind speed, wind direction and stability class frequency tables for the Appin 1995 data are provided in **Appendix B**. The Appin data are considered to satisfy the requirements of the DECC.

Figure 4.1 Windroses for Appin

4.2 Local Climatic Conditions

The Bureau of Meteorology (BoM) also collects climatic information in the vicinity of the study area. The closest BoM station to the Project site is Picton, located approximately 11 km to the west. A range of climatic information collected from Picton are presented in **Table 4:2** (**Bureau of Meteorology, 2009**).

Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

Table 4:2 : Climate information for Picton

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean 9 am dry-bulb temperature (deg C)	21.8	21.5	19.9	16.8	12.2	9.4	7.7	10.4	14	17.3	19	21	15.9
Mean 3 pm dry-bulb temperature (deg C)	26.4	25.4	24.5	22.5	18.3	15.7	15.6	16.2	19	21.3	23.1	25.6	21.1
Mean daily maximum temperature (deg C)	29.3	28.6	27	23.7	20.2	17.3	16.8	18.2	21.4	24	26.3	28.5	23.4
Mean daily minimum temperature (deg C)	15.2	15.4	13.1	9.2	5.7	3.2	1.7	2.9	5.2	8.8	11.5	14	8.8
Mean rainfall (mm)	87.5	89	88.1	69.6	57.7	65.3	50.8	44.9	44.8	65.2	71.9	70.2	804.9
Mean number of rain days ≥ 1 mm	6.9	6.9	7.2	5.7	5	5.4	4.6	4.9	5.2	6.3	6.7	6.5	71.3

Climate averages for Station: 'PICTON COUNCIL DEPOT' [068052], Commenced: 1880; Last record: 2009. Latitude (deg S): -34.17; Longitude (deg E): 150.61; State: NSW. Source: ***Bureau of Meteorology (2009)*** *website.*

Temperature data show that January is typically the warmest month with a mean daily maximum of 29.3°C. July is the coldest month with a mean daily minimum of 1.7°C.

Rainfall data collected at Picton show that February is the wettest month with a mean rainfall of 89 mm over 7 rain days. Annually the area experiences, on average, 805 mm of rain.

4.3 Existing Air Quality

The DECC have previously operated an air quality monitoring station at Appin which measured NO_2. **Table 4:3** shows the measured NO_2 concentrations for the most recent year of data available (1997).

Table 4:3 : Monitoring of nitrogen dioxide at Appin in 1997

Month	Measured NO_2 concentration ($\mu g/m^3$)	
	Maximum 1-hour average	Average
Jan-97	55	6
Feb-97	35	10
Mar-97	53	8
Apr-97	78	12
May-97	66	8
Jun-97	90	12
Jul-97	62	8
Aug-97	49	8
Sep-97	53	6
Oct-97	53	10
Nov-97	33	8
Dec-97	70	10
Maximum	**90**	**-**
Average	**-**	**9**
DECC criteria	**246**	**62**

*Source: EPA quarterly air quality monitoring reports for 1997 (**EPA, 1997**)*

The monitoring data show that the area experiences NO_2 concentrations below the DECC ambient air quality criteria. The maximum 1-hour average NO_2 concentration in 1997 was 90 $\mu g/m^3$ and the annual average was 9 $\mu g/m^3$.

There are no known air quality monitoring stations close to the study area that can be used to determine the existing concentrations of oxides of nitrogen, carbon monoxide and particulate matter (PM_{10}). The DECC operate an extensive air quality monitoring network in NSW however their closest monitoring station to the site would be Macarthur (Campbelltown), approximately 20 km to the north.

Existing annual average PM_{10} concentrations for the Appin area are estimated to be of the order of 15 $\mu g/m^3$ consistent with a relatively clean semi-rural environment. The 24-hour average PM_{10} concentrations will be highly variable and, in many parts of NSW, it is common for the DECC's 50 $\mu g/m^3$ criteria to be exceeded on several occasions each year due to widespread events such as bushfires or dust storms.

5 ESTIMATED EMISSIONS

The potential air quality impacts of the Project are identified as follows:

- Pollutant emissions from gas flaring stacks;
- Pollutant emissions from the diesel generator;
- Odour and pollutant emissions from the gas vent stacks; and
- Dust generated during the construction phase.

For stack sources, the AUSPLUME dispersion model requires information on the source location, the source height, internal source tip diameter, temperature of emissions, exit velocity of emissions and the mass emission rate of the pollutants to be assessed. Temperature, exit velocity and mass emission rates can be provided to the model as hourly records for an entire year (variable emissions) or as constant emissions.

Table 5:2 summarises the stack characteristics and expected emissions for the different scenarios.

5.1 Flare Systems

In this assessment, the flaring system is modelled as a point source. Stack dimensions are listed in **Table 5:2.**

Plume emissions from flares differ from conventional stacks because of the significant amount of heat released from the stack tip and heat lost due to radiation. In conventional plumes, it is assumed all the available heat is assumed to be available for buoyancy of the plume. The AUSPLUME model used in this assessment does not accurately account for the radiative heat lost from a flare and tends to over-predict the buoyancy of the plume and hence the plume rise from the stack.

In this assessment, the heat lost through the flaring process has been calculated from the flare specifications provided by the manufacturer. Adjustments assuming approximately 20% and 50% heat loss due to flaring have been factored into the diameter of the stack. Details of calculations are provided in **Appendix C** (**Schultze, 1977**). The different stack diameters modelled for the 20% and 50% heat loss are 3.33 m and 2.63 m respectively.

Table 5:1 lists conservative estimates of emissions for the flaring unit, provided by the manufacturer (Energen), assuming flaring of coalmine methane gas with 90-98 percent methane content.

Table 5:1 Expected concentrations of emissions from flaring unit

Pollutant	Emission mg/Nm^3
NOx	150
CO	50

To provide a conservative estimate of the predicted emissions from this flare, it has been assumed that the flare will operate at all hours continuously and that all coalmine gas will be flared.

5.2 Diesel Generator

Emissions from the diesel-powered generator, listed in Table 5:2, were estimated using the NPI Emission Estimation Technique Manual for Combustion Engines (**NPI, 2008**). It was assumed that the generator is classed as an uncontrolled stationary diesel engine. Calculations are based on estimated diesel fuel usage of 3500 L/week and assume that the generator will operate continuously.

5.3 Vent Stack

There are limited odour emission data from gas extraction vents associated with underground mining operations. EML Air Pty Ltd were however commissioned by BHPBIC to measure odour emission rates from the Dendrobium underground mine ventilation shaft (**Holmes Air Sciences, 2005**). The measured odour emission rate was 4,600 $ou.m^3/s$ and while this may not be representative of the odour in the gas extraction vents, it provides an indicative estimate for the purposes of this assessment. Vent stack characteristics and emissions are listed in **Table 5:2**.

Table 5:2 : Stack characteristics and emissions for modelling of stack sources

	Vent stack	Flaring stack	Diesel generator*
Assumed stack location (easting and northing in MGA)	290800, 6215900	290800, 6215900	290790, 6215895
Alternate stack location	290680, 6216210	290680, 6216210	290695, 6216210
Height (m)	9	8	3.3
Diameter (m)	0.25	3.63	0.12
Stack cross-section (m^2)	0.05	10.3	0.01
Flow rate coalmine gas (Nl/s)	800	800	-
Flow rate total gas (Am^3/s)	-	-	0.67
Temperature (deg C)	25	1050	300
Exit velocity (m/s)	16	9.05	28
Pollutant emissions (g/s)			
PM_{10}	-	-	0.0294
CO	0.005	10.92	0.0923
NO_x	-	32.75	0.4155
Odour emissions ($OU.m^3/s$)			
Odour emission rate	4,600	-	-
OER (Stabilities A,B,C)	55,200	-	-
OER (Stabilities D,E,F)	115,000	-	-

** Flow rate, exhaust temperature and exhaust velocity have been estimated from an equivalent size CAT diesel-powered generator:*
http://www.cat.com/cda/components/fullArticle/?m=39280&x=7&id=538612&languageId=7

*** The vent stack will be located near to the extraction plant, the exact location has not yet been determined.*

5.4 Dust

Dust will be generated during the construction stage of the Project.

Dust generating activities anticipated during the construction stage of the project are:

- Levelling of the extraction plant site;
- Trenching works for the surface pipeline reticulation system including underboring of the Hume Highway and Main Southern Rail Line;
- Work pad construction for drilling of the boreholes; and
- Drilling of 6 vertical boreholes, 2 medium radius drilled (MRD) boreholes and one downhole (to allow gas to be directed to the EDL power station).

A 13 or 30 t excavator will be used for these activities as well as to dig the drill cuttings sump and prepare any access roads if they are required. Typical site and access road preparation time is less than 5 days and these activities will be constrained to within 7 am and 5 pm.

The total length of trenching works for the surface pipeline is 2445m. It is anticipated that trenching works will proceed at the rate of around 250m/d. Trench digging will progress in a linear way over a two week period. Stockpiles of topsoil and subsoil will be replaced as soon as practicable and stabilised if necessary.

Underboring of the Hume Highway and Main Southern Rail Line will require approximately 280m of boring and is anticipated to take 4 days to complete. Underboring is done where an open trench is not possible (for example under a road) and is not a major source of dust emissions.

Vertical boreholes will be drilled during daylight hours 6 days per week. It is estimated that each borehole will take up to 2 weeks to complete. Two MRD boreholes will be also be drilled 24 hours per day, 7 days per week. It is anticipated that each MRD borehole will require 3 weeks to complete. Dust from borehole drilling will be suppressed with watersprays.

The two major dust generating activities are identified as the stripping of topsoil and general construction work by excavators and drill rigs and wind erosion from exposed areas. An estimate of the dust emissions due to these activities has been made and the calculations are provided below in **Table 5.3**.

Table 5:3 : Estimated dust emissions during construction

Activity	Intensity	Emission factor	TSP (kg/y)	TSP (kg/d)
Stripping topsoil and general construction work.	8 h/d	14.0 kg/h	40,880	112
Wind erosion from exposed areas of site	0.3 ha	0.4 kg/ha/h	876	2.4
Total emissions (kg)	-	0	**41,756**	**114**

The dust emissions presented above are conservative estimates as they assume that an excavator will be working for 8 hours per day and emitting at a rate equivalent to bulldozers (14 kg/h). Therefore, it is estimated that up to 114 kg of dust would be generated per day due to construction activities.

6 APPROACH TO ASSESSMENT

In August 2005, the DECC published guidelines for the assessment of air pollution sources using dispersion models (**DEC, 2005**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data, emissions data and relevant air quality criteria. The approach taken in this assessment follows as closely as possible the approaches suggested by the guidelines.

This assessment focuses on odour, dust (PM_{10}) and NO_x concentrations arising from goaf well activities and concentrations of these pollutants have been predicted using AUSPLUME. AUSPLUME (Version 6.0) is an advanced Gaussian dispersion model developed on behalf of the Victorian EPA (**VEPA, 1986**) and is based on the United States Environmental Protection Agency's Industrial Source Complex (ISC) model. It is widely used throughout Australia and is regarded as a "state-of-the-art" model. AUSPLUME is the model required for use by the DECC unless project characteristics dictate otherwise (**DEC, 2005**).

Odour, PM_{10} and NO_x, levels have been modelled over an area of 9 km by 11 km, however a smaller area of predictions, approximately 2 km by 2.6 km, is displayed in this report. The modelling has considered activities at one surface goaf well location and one extraction plant location, on the property described as Lot 7 DP250231; the extent of the predicted impact zone has been taken to be representative of the impact zone around each of the other surface goaf well locations. This location has been used in the modelling as it is closer to most nearby residences and therefore provides a conservative estimate of impacts.

The modelling has been performed using the meteorological data discussed in **Section 4** and the emission estimates from **Section 5**. Model predictions have also been made at 16 discrete receptors around the emission source.

6.1 Odour

The way in which the model has been used in the odour assessment has been to predict the maximum 1-hour average odour levels corrected to nose response times (expressed in odour units) at each receptor. 1-hour averaging times have been used for consistency with the DECC odour criteria and odour levels at the 99th percentile have been presented to relate to these criteria.

6.2 Dust

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The modelling has been based on the use of three particle-size categories (0 to 2.5 μm - referred to as $PM_{2.5}$, 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA.

The distribution of particles has been derived from measurements published by the **SPCC (1986)**. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was done using three AUSPLUME source groups with each group corresponding to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 μm. The predicted concentration in the three output files for each group were then combined according to the weightings in the dot points above to determine the concentration of PM_{10} and TSP.

The AUSPLUME model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions at operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, the construction activities for a particular site were represented by a volume source. Estimates of emissions were developed on an hourly time-step taking into account the activities that would take place at that location.

Wind erosion was modelled for 24 hours per day, while other activities were modelled between 7 am and 5 pm. The dust modelling is considered to be worst-case since emissions were simulated for every day in the meteorological data file and the worst-case day for each receptor was extracted, even though the construction activities will only occur for a limited period.

6.3 Oxides of Nitrogen

Maximum 1-hour average NO_x concentrations have been predicted due to emissions from the diesel-powered generator and flaring stack.

Generally, at the point of emission NO will comprise the greatest proportion of the emission with 95% by volume of the NO_x. The remaining 5% will be mostly NO_2. Ultimately, however, all nitric oxides emitted into the atmosphere are oxidised to NO_2 and then further to other higher oxides of nitrogen. Generally, for plumes impacting close to the source, the time interval for oxidation is not sufficient to have converted a large proportion of the plume to the more harmful NO_2.

For the purposes of this report it was conservatively assumed that 20% of the NO_x was NO_2 at the point of maximum ground-level concentration.

6.4 Carbon Monoxide

Maximum 1-hour average and maximum 8-hour average CO concentrations have been predicted due to emissions from the diesel-powered generator and flaring stack.

7 ASSESSMENT OF IMPACTS

7.1 Odour

Figure 7.1 shows the predicted maximum ground-level odour levels (corrected for nose response times), assuming the extraction plant to be located on the property described as Lot 7 DP250231.

The extraction plant location modelled is the closest of the two extraction plant options to residences, therefore odour levels at the most-affected residences would be expected to be less than those shown in **Figure 7.1** if the goaf plant were in the preferred location (Lot 2 DP576136).

For a single rural residence (that is, with population of 2 or less) the relevant odour criterion is 7 odour units at the 99th percentile (**DEC, 2006**). **Figure 7.1** shows that odour levels at the most affected residence are around 5 odour units at the 99th percentile. This complies with the DEC goal.

It is important to recognise also the uncertainty associated with the odour emissions data used in the modelling. The assumptions used for this assessment could be confirmed with odour emission measurements from the gas vent stacks, although considering that gases will only be vented when the underground connection to the EDL Power Station or flaring stacks fail to operate or during maintenance periods, impacts are expected to be low.

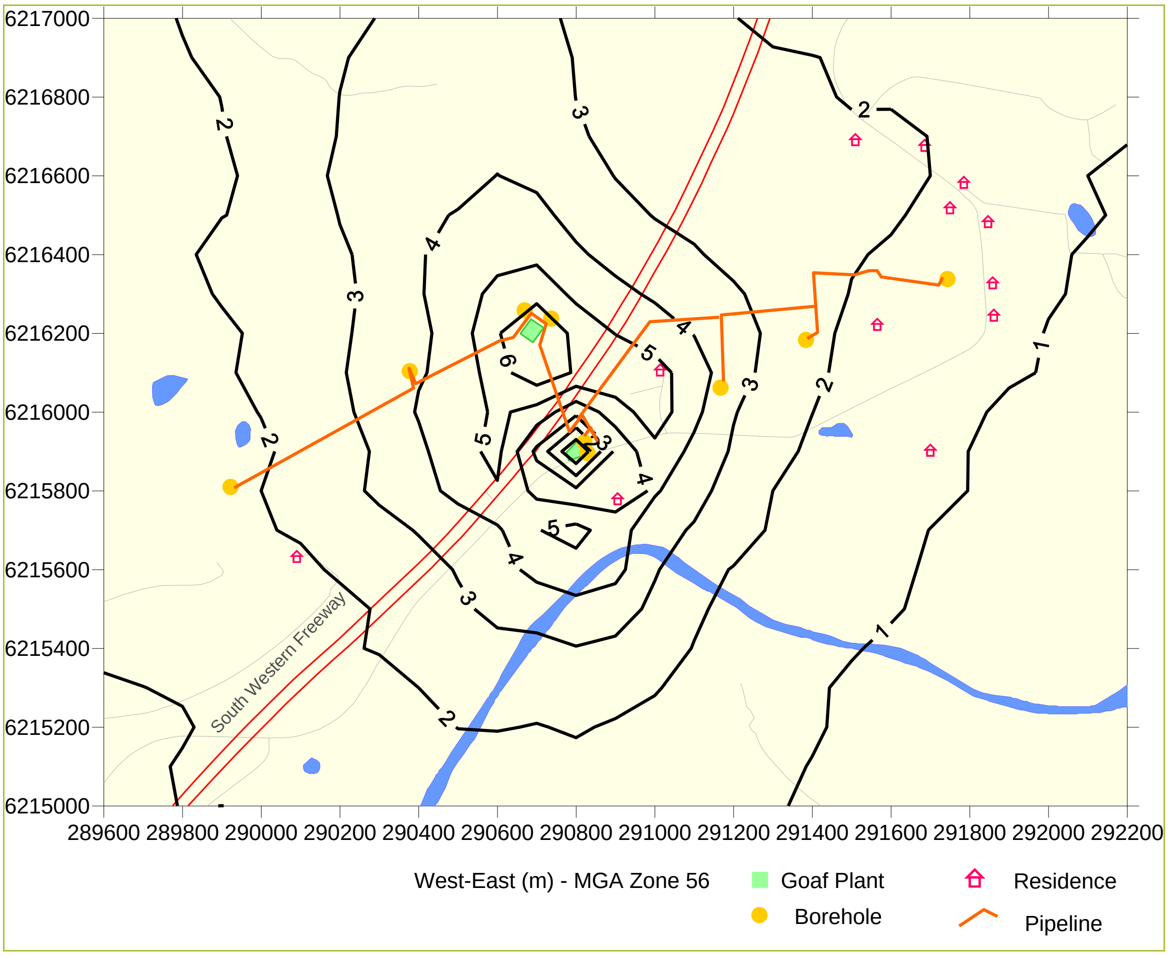


Figure 7.1: Odour contours from vent stack at 99th percentile, in odour units

7.2 Dust

Figure 7.2 shows the predicted maximum 24-hour average PM_{10} concentrations due to construction activities, assuming the extraction plant to be located on the property described as Lot 7 DP250231. The DECC criterion is 50 $\mu g/m^3$, which represents the contribution from all sources of dust, not just the contribution from the modelled sources. Background PM_{10} concentration should be considered when examining the results in **Figure 7.2**.

It can be seen from **Figure 7.2** that the 50 $\mu g/m^3$ contour is predicted to extend between 200 to 400 m in each direction from the centre of site activities.

As discussed in **Section 4.3**, average PM_{10} concentrations are estimated to be of the order of 15 $\mu g/m^3$. The PM_{10} concentrations will vary from day to day however for the purpose of this assessment it has been assumed that the background level is 15 $\mu g/m^3$ for the days of maximum 24-hour average PM_{10} predictions. This means that the allowable contribution from site activity emissions would be 35 $\mu g/m^3$ before the 50 $\mu g/m^3$ criterion is reached. The 35 $\mu g/m^3$ contour extends between 220 m and 430 m in each direction from the centre of site activities. Approximately 8 out of the 9 boreholes are within 400 m of the nearest residences.

Given the conservative nature of the dust emission estimates and the short-term nature of construction activities, adverse PM_{10} concentrations are unlikely to be observed and the activities would not be a significant dust source. However, the following measures will ensure that dust emissions are subject to a high level of control:

- Exposed areas will be watered to prevent dust emissions;
- Dust from borehole drilling will be suppressed with water sprays;
- Stockpiles of topsoil and subsoil will be replaced as soon as practicable. Re-vegetating or stabilising disturbed areas where necessary will prevent or minimise wind-blown dust; and
- If necessary, dust-generating activities will be modified during periods of high wind.

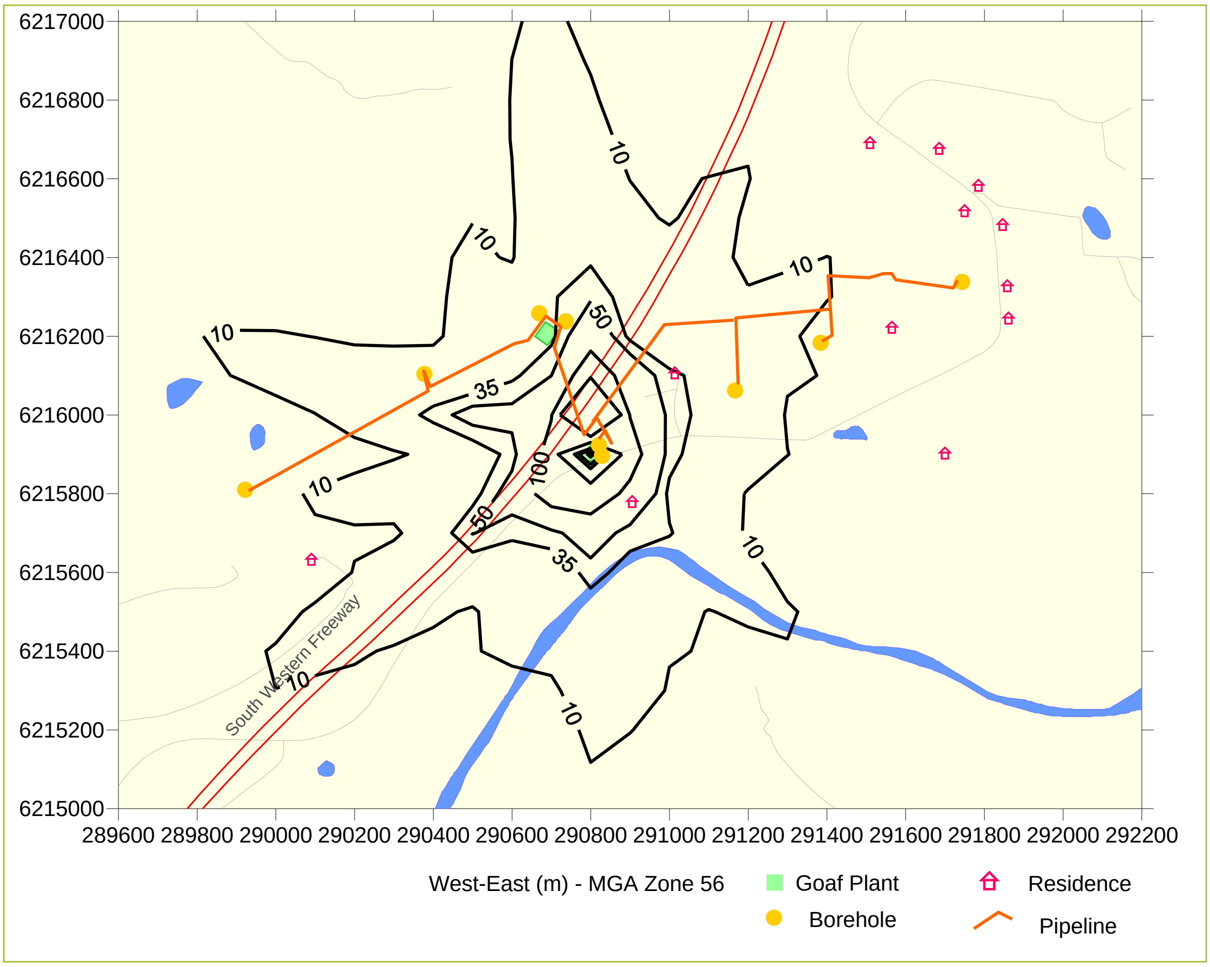


Figure 7.2: 24-hour maximum PM_{10} contours from construction activity, $\mu g/m^3$

7.3 Oxides of Nitrogen

Results from the dispersion modelling for oxides of nitrogen are presented as contour plots in **Figure 7.2** and **Figure 7.3**. The predicted levels are shown as the 1-hour maximum and annual averages. The maximum 1-hour average predicted at the most affected residence is approximately 22 μg/m^3 for both the 20% and 50% heat loss scenarios, significantly less than the criteria of 246 μg/m^3 for nitrogen dioxide. When background levels of around 90 μg/m^3 are included (see **Section 4.3**), these predicted concentrations are still within the DECC criteria.

The results for the annual average for both the 20% and 50% heat loss scenarios are also shown in **Figure 7.2** and **Figure 7.3**. They show a predicted maximum of approximately 0.6 μg/m^3 at the most affected residence, significantly lower than the criteria of 64 μg/m^3, even when background levels of 9 μg/m^3 (see **Section 4.3**) are included.

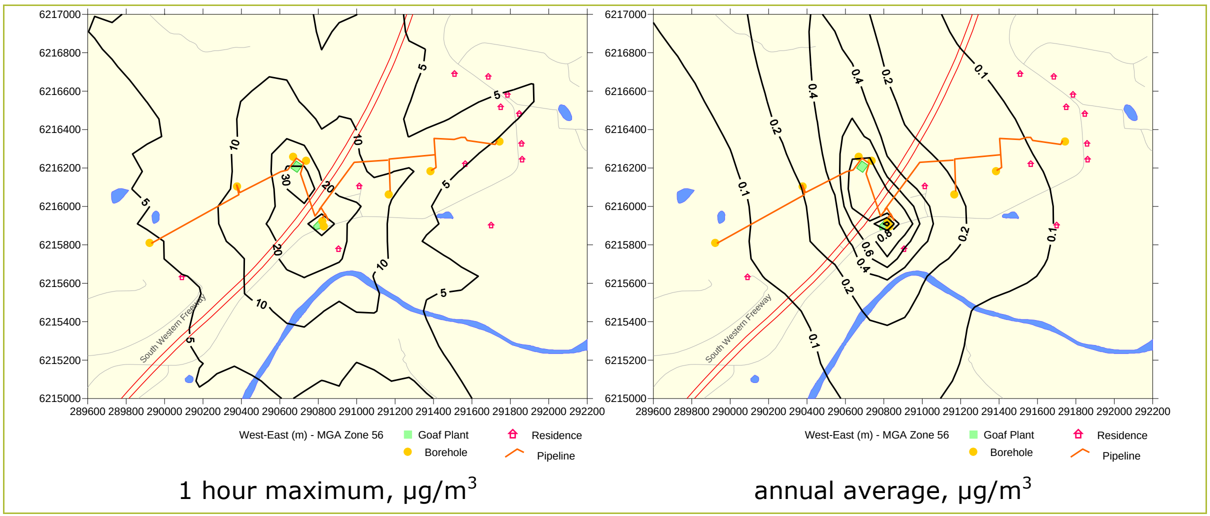


Figure 7.3: NO_2 contours from flaring, assuming 20% heat loss

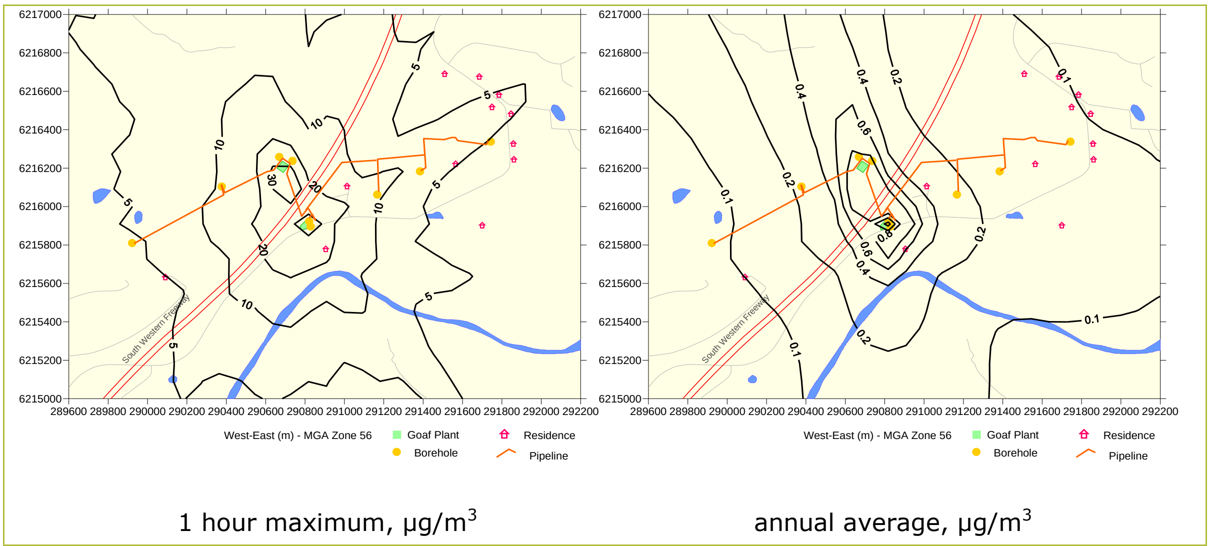


Figure 7.4: NO_2 contours from diesel generator and flare stack, assuming 50% heat loss

7.4 Carbon Monoxide

The dispersion model results are presented in **Figure 7.5** and **Figure 7.6**. The results show predicted carbon monoxide levels for 15-minute, 1-hour and 8-hour averaging times for comparison with the DECC criteria.

The results show predicted carbon monoxide levels for 15-minute, 1-hour and 8-hour averaging times for comparison with the DECC criteria.

Figure 7.5 presents results assuming the 20% heat loss due to the flare and **Figure 7.6** presents the 50% heat loss case.

For both scenarios the impact at the residences most affected by the flaring activities were below the DECC criteria (see **Section 4.3**). The 15-minute ground level concentrations for the 20% and 50% heat loss cases show predicted levels at the most affected residence to be approximately 31 µg/m^3 and 30 µg/m^3 respectively. These predictions are well below the criteria of 100 mg/m^3 (100 000 µg/m^3). The 1-hour and 8-hour impacts are also well below the criteria with predictions of approximately 24 µg/m^3 and 11 µg /m^3 (20% heat loss); 24 µg /m^3 and 10 µg /m^3 (50% heat loss).

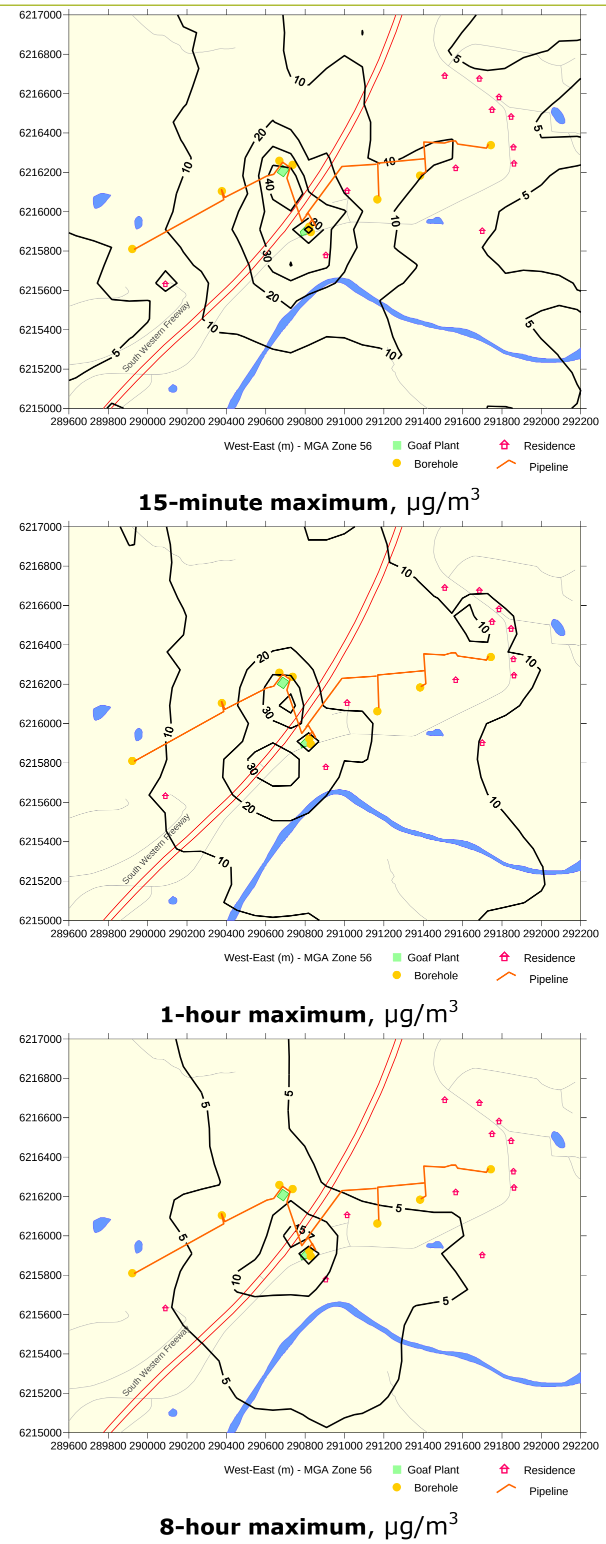
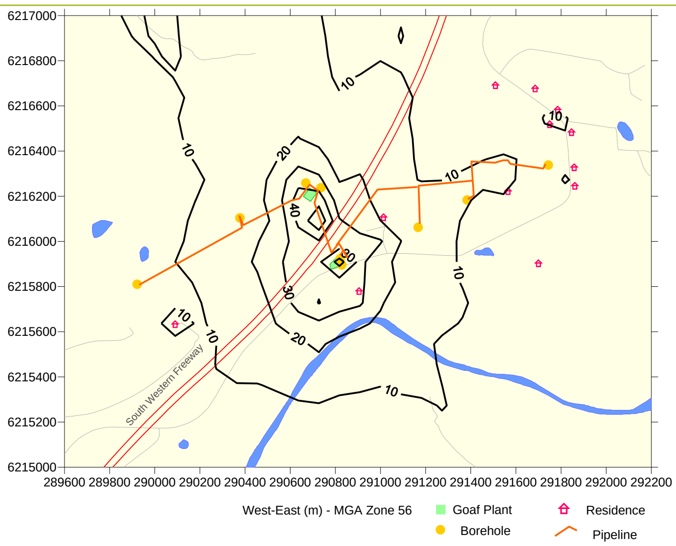
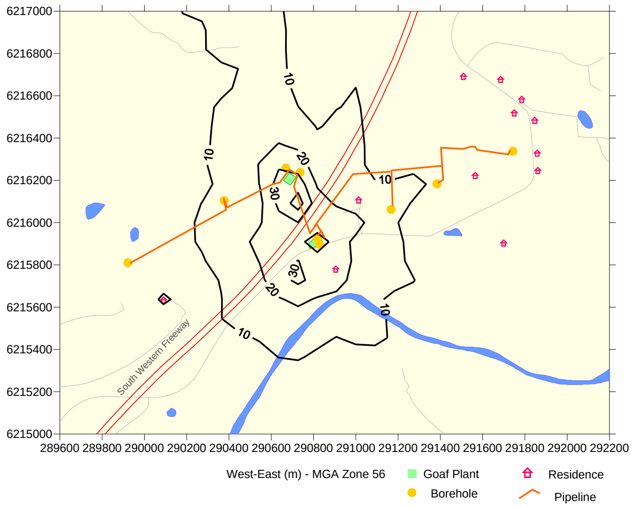


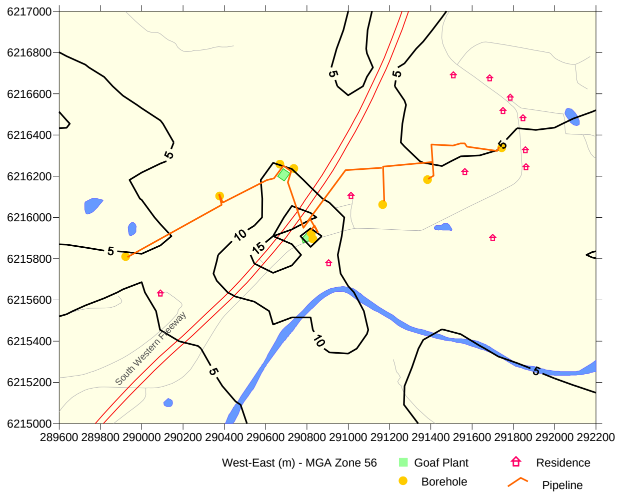
Figure 7.5: CO contours from flaring, assuming 20% heat loss



15-minute maximum, µg/m^3



1-hour maximum, µg/m^3



8-hour maximum, µg/m^3

Figure 7.6: CO contours from flaring, assuming 50% heat loss

7.5 Alternative goaf plant location

If the extraction plant was to be located on the property described as Lot 2 DP576136, as shown in **Figure 2.1**, no significant difference in impacts at nearby residences is anticipated, especially as this extraction plant location is further from most residences than the location modelled.

7.6 Emissions from EDL Power Stations

The Project aims to capture goaf gas and reticulate it to the underground gas drainage range that provides mine gas to the EDL power stations at Appin West pit top and Appin No 1 Shaft. The EDL plants are currently operating below capacity. The EDL power stations are required to operate in accordance with their Environment Protection Licences which prescribe strict emission load and concentration limits and monitoring requirements. No change to the EDL operations or permitted environmental impacts will occur. No change to the Environment Protection Licences is required to accommodate the Appin Area 7 Goaf Gas Drainage Project. The EDL Environment Protection Licences are available at:

- http://www.environment.nsw.gov.au/prpoeo/licences/L5357.pdf (for Appin West pit top)
- http://www.environment.nsw.gov.au/prpoeo/licences/L5482.pdf (for Appin No 1 Shaft)

8 CONCLUSIONS

This report has assessed the air quality impacts of the Appin Mine Area 7 Goaf Gas Drainage Project. Dispersion modelling has been used to predict odour, PM_{10}, CO and NO_x levels due to activities taking place at the proposed boreholes and the extraction plant/s.

The conclusions of the assessment are as follows:

- Predicted odour levels from vent gasses at nearest residences are within DECC criteria.
- Compliance with dust concentration criteria is predicted during the construction stage of the Project. Dust mitigation measures will ensure that dust emissions are subject to a high level of control.
- NO_2 and CO concentrations at nearby residences will be below the DECC criteria.
- Emissions at the EDL power stations will continue to comply with the existing requirements of their Environment Protection Licences.

9 REFERENCES

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APPENDIX A

Peak to mean table

Table A1 : Recommended factors for estimating peak concentrations for different source types, distances and stabilities

Source type	Stability	Near field				Far field			p
		i_{max}	x_{max}	P/M 60	P/M 3	i	P/M 60	P/M 3	
Area	Neutral, Convective	0.5	500 – 1000	2.5	1.9	0.4	2.3	1.7	0.15
	Stable	0.5	300 – 800	2.3	1.7	0.3	1.9	1.4	0.10
Line	Neutral, Convective	1.0	350	6	2.8	0.75	6	2.8	0.25
	Stable	1.0	250	6	2.8	0.65	6	2.8	0.25
Surface point	Neutral	2.5	200	25	10	1.2	5 - 7	3	0.2
	Stable	2.5	200	25	10	1.2	5 - 7	3	0.2
	Convective	2	1000	12	7	0.6	3 - 4	2.5	0.15
Tall point	Neutral, Stable	4.5	5 h	35	8	1.0	6	1.3	0.5
	Convective	2.3	2.5 h	17	4	0.5	3	1.1	0.5
Wake affected point	Neutral, Convective	0.4	-	2.3	1.4	-	2.3	1.4	0.1
Volume	Neutral, Convective	0.4	-	2.3	1.4	-	2.3	1.4	0.1

i_{max} is maximum centreline intensity of concentration
x_{max} is the approximation location of i_{max} in metres
P/M 60 is the peak-to-mean ratio for long averaging times (typically 1 hour), at a probability of 10^{-3}
P/M 3 is the best estimates of the peak-to-mean ratio for 3 minute averages, at probability 10^{-3}
p is the averaging time power law exponent
h is stack height

Source: **Katestone Scientific (1998)**

APPENDIX B

Joint wind speed, wind direction and stability class frequency tables

```
STATISTICS FOR FILE:  C:\Jobs\WestCliff\metdata\appin_1995.aus
MONTHS: All
HOURS : All
OPTION: Frequency

                     PASQUILL STABILITY CLASS 'A'

                        Wind Speed Class (m/s)

             0.50     1.50     3.00     4.50     6.00     7.50     9.00  GREATER
 WIND         TO       TO       TO       TO       TO       TO       TO     THAN
SECTOR       1.50     3.00     4.50     6.00     7.50     9.00    10.50    10.50    TOTAL
-----------------------------------------------------------------------------------------

   NNE    0.001233 0.001603 0.000370 0.000000 0.000000 0.000000 0.000000 0.000000 0.003205
    NE    0.001109 0.001356 0.000616 0.000123 0.000000 0.000000 0.000000 0.000000 0.003205
   ENE    0.001849 0.000740 0.000493 0.000247 0.000000 0.000000 0.000000 0.000000 0.003328
     E    0.000740 0.000740 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.001479
   ESE    0.000493 0.001233 0.000123 0.000000 0.000000 0.000000 0.000000 0.000000 0.001849
    SE    0.001972 0.000986 0.000247 0.000000 0.000000 0.000000 0.000000 0.000000 0.003205
   SSE    0.004191 0.001603 0.000370 0.000000 0.000000 0.000000 0.000000 0.000000 0.006164
     S    0.006040 0.001726 0.000247 0.000000 0.000000 0.000000 0.000000 0.000000 0.008013
   SSW    0.002465 0.000740 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.003205
    SW    0.001972 0.000986 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000 0.002959
   WSW    0.002835 0.000616 0.000000 0.000123 0.000000 0.000000 0.000000 0.000000 0.003575
     W    0.004438 0.000863 0.000370 0.000000 0.000000 0.000000 0.000000 0.000000 0.005671
   WNW    0.003205 0.003698 0.000616 0.000000 0.000000 0.000000 0.000000 0.000000 0.007520
    NW    0.005794 0.003205 0.000123 0.000000 0.000000 0.000000 0.000000 0.000000 0.009122
   NNW    0.003575 0.005547 0.000247 0.000000 0.000000 0.000000 0.000000 0.000000 0.009369
     N    0.003945 0.006780 0.000370 0.000000 0.000000 0.000000 0.000000 0.000000 0.011095

  CALM                                                                            0.011218
-----------------------------------------------------------------------------------------
  TOTAL   0.045858 0.032421 0.004191 0.000493 0.000000 0.000000 0.000000 0.000000 0.094181

   MEAN WIND SPEED (m/s) = 1.49
  NUMBER OF OBSERVATIONS = 764
```

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000370	0.001849	0.000863	0.000123	0.000000	0.000000	0.000000	0.000000	0.003205
NE	0.000493	0.000616	0.000863	0.000123	0.000000	0.000000	0.000000	0.000000	0.002096
ENE	0.000123	0.000740	0.000616	0.000123	0.000000	0.000000	0.000000	0.000000	0.001603
E	0.000123	0.000616	0.000616	0.000000	0.000000	0.000000	0.000000	0.000000	0.001356
ESE	0.000000	0.000863	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.001109
SE	0.000863	0.000740	0.000370	0.000000	0.000000	0.000000	0.000000	0.000000	0.001972
SSE	0.001109	0.001233	0.000616	0.000123	0.000000	0.000000	0.000000	0.000000	0.003082
S	0.002096	0.001109	0.000740	0.000123	0.000000	0.000000	0.000000	0.000000	0.004068
SSW	0.001233	0.001109	0.000616	0.000123	0.000000	0.000000	0.000000	0.000000	0.003082
SW	0.001109	0.001972	0.000863	0.000123	0.000000	0.000000	0.000000	0.000000	0.004068
WSW	0.000616	0.000986	0.000986	0.000247	0.000000	0.000000	0.000000	0.000000	0.002835
W	0.001233	0.001603	0.002219	0.000247	0.000000	0.000000	0.000000	0.000000	0.005301
WNW	0.001479	0.001233	0.000370	0.000123	0.000000	0.000000	0.000000	0.000000	0.003205
NW	0.000863	0.001233	0.000370	0.000123	0.000000	0.000000	0.000000	0.000000	0.002589
NNW	0.001479	0.003698	0.001109	0.000000	0.000000	0.000000	0.000000	0.000000	0.006287
N	0.000740	0.004561	0.003205	0.000000	0.000000	0.000000	0.000000	0.000000	0.008506
CALM									0.000863
TOTAL	0.013930	0.024162	0.014670	0.001603	0.000000	0.000000	0.000000	0.000000	0.055227

MEAN WIND SPEED (m/s) = 2.41
NUMBER OF OBSERVATIONS = 448

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000616	0.001726	0.003821	0.000247	0.000000	0.000000	0.000000	0.000000	0.006410
NE	0.000370	0.000616	0.001479	0.000616	0.000000	0.000000	0.000000	0.000000	0.003082
ENE	0.000370	0.000740	0.001233	0.001109	0.000000	0.000000	0.000000	0.000000	0.003452
E	0.000247	0.000986	0.001849	0.002465	0.000000	0.000000	0.000000	0.000000	0.005547
ESE	0.000493	0.000740	0.001233	0.002342	0.000000	0.000000	0.000000	0.000000	0.004808
SE	0.000616	0.000740	0.002835	0.001479	0.000000	0.000000	0.000000	0.000000	0.005671
SSE	0.001233	0.002096	0.001109	0.000247	0.000000	0.000000	0.000000	0.000000	0.004684
S	0.001109	0.002712	0.001972	0.001726	0.000000	0.000000	0.000000	0.000000	0.007520
SSW	0.000740	0.002219	0.003452	0.000986	0.000000	0.000000	0.000000	0.000000	0.007396
SW	0.000616	0.003452	0.002465	0.000370	0.000000	0.000000	0.000000	0.000000	0.006903
WSW	0.000740	0.001972	0.002959	0.002219	0.000000	0.000000	0.000000	0.000000	0.007890
W	0.001972	0.001479	0.001972	0.005794	0.000000	0.000000	0.000000	0.000000	0.011218
WNW	0.001479	0.001356	0.001972	0.003082	0.000000	0.000000	0.000000	0.000000	0.007890
NW	0.000616	0.001109	0.000986	0.000616	0.000000	0.000000	0.000000	0.000000	0.003328
NNW	0.000247	0.006657	0.003945	0.000740	0.000000	0.000000	0.000000	0.000000	0.011588
N	0.000000	0.003698	0.010478	0.001726	0.000000	0.000000	0.000000	0.000000	0.015902
CALM									0.000370
TOTAL	0.011464	0.032298	0.043762	0.025764	0.000000	0.000000	0.000000	0.000000	0.113659

MEAN WIND SPEED (m/s) = 3.43
NUMBER OF OBSERVATIONS = 922

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000863	0.006657	0.006534	0.000863	0.000000	0.000000	0.000000	0.000000	0.014916
NE	0.001726	0.003328	0.004191	0.003575	0.000616	0.000000	0.000000	0.000000	0.013437
ENE	0.001233	0.004808	0.008259	0.004438	0.000863	0.000123	0.000000	0.000000	0.019724
E	0.001726	0.006534	0.008383	0.001726	0.000247	0.000000	0.000000	0.000000	0.018614
ESE	0.002835	0.005671	0.008136	0.005054	0.001479	0.000000	0.000123	0.000000	0.023299
SE	0.004931	0.009615	0.010602	0.015656	0.010725	0.004068	0.001479	0.000247	0.057322
SSE	0.011834	0.029832	0.012081	0.017382	0.010848	0.005178	0.002589	0.000616	0.090360
S	0.004315	0.019847	0.006657	0.005917	0.004315	0.000863	0.000000	0.000000	0.041913
SSW	0.001233	0.012574	0.005424	0.001972	0.000740	0.000000	0.000000	0.000000	0.021943
SW	0.000616	0.013314	0.008136	0.000123	0.000000	0.000000	0.000000	0.000000	0.022189
WSW	0.000247	0.008752	0.007396	0.003328	0.002342	0.000986	0.000247	0.000000	0.023299
W	0.000370	0.002342	0.006903	0.007396	0.010232	0.004191	0.001109	0.000000	0.032544
WNW	0.000247	0.002959	0.004068	0.004315	0.005671	0.002712	0.001603	0.000123	0.021696
NW	0.000370	0.003082	0.003452	0.002219	0.000616	0.000740	0.000123	0.000000	0.010602
NNW	0.000616	0.005547	0.004931	0.001726	0.000247	0.000123	0.000000	0.000000	0.013190
N	0.001233	0.006780	0.008013	0.001603	0.001479	0.000000	0.000000	0.000000	0.019107
CALM									0.000370
TOTAL	0.034393	0.141642	0.113166	0.077293	0.050419	0.018984	0.007273	0.000986	0.444527

MEAN WIND SPEED (m/s) = 4.00
NUMBER OF OBSERVATIONS = 3606

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000863	0.002096	0.000247	0.000123	0.000000	0.000000	0.000000	0.000000	0.003328
NE	0.000863	0.002835	0.000616	0.000000	0.000000	0.000000	0.000000	0.000000	0.004315
ENE	0.001356	0.001603	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.003205
E	0.001972	0.001603	0.000740	0.000000	0.000000	0.000000	0.000000	0.000000	0.004315
ESE	0.002589	0.004561	0.000740	0.000000	0.000000	0.000000	0.000000	0.000000	0.007890
SE	0.004068	0.005794	0.003945	0.000740	0.000000	0.000000	0.000000	0.000000	0.014546
SSE	0.008876	0.043393	0.005671	0.000986	0.000000	0.000000	0.000000	0.000000	0.058925
S	0.004931	0.015409	0.001849	0.000370	0.000000	0.000000	0.000000	0.000000	0.022559
SSW	0.002342	0.005178	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007520
SW	0.002959	0.005424	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008383
WSW	0.000986	0.002219	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003205
W	0.000616	0.001726	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002342
WNW	0.000247	0.001233	0.000370	0.000000	0.000000	0.000000	0.000000	0.000000	0.001849
NW	0.000370	0.000986	0.001356	0.000123	0.000000	0.000000	0.000000	0.000000	0.002835
NNW	0.000370	0.000740	0.000740	0.000123	0.000000	0.000000	0.000000	0.000000	0.001972
N	0.001479	0.001603	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.003328
CALM									0.000740
TOTAL	0.034887	0.096400	0.016765	0.002465	0.000000	0.000000	0.000000	0.000000	0.151257

MEAN WIND SPEED (m/s) = 2.13
NUMBER OF OBSERVATIONS = 1227

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002835	0.000616	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003452
NE	0.002712	0.000616	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003328
ENE	0.004191	0.000370	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004561
E	0.003945	0.000986	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004931
ESE	0.003698	0.000123	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003821
SE	0.008999	0.000863	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009862
SSE	0.010848	0.024038	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.034887
S	0.013560	0.006534	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.020094
SSW	0.007520	0.002835	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010355
SW	0.006657	0.000986	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007643
WSW	0.003945	0.001479	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005424
W	0.002219	0.001356	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003575
WNW	0.001603	0.000740	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002342
NW	0.001479	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001479
NNW	0.001849	0.001233	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
N	0.001603	0.000740	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002342
CALM									0.019970
TOTAL	0.077663	0.043516	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.141149

MEAN WIND SPEED (m/s) = 1.28
NUMBER OF OBSERVATIONS = 1145

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.006780	0.014546	0.011834	0.001356	0.000000	0.000000	0.000000	0.000000	0.034517
NE	0.007273	0.009369	0.007766	0.004438	0.000616	0.000000	0.000000	0.000000	0.029463
ENE	0.009122	0.008999	0.010848	0.005917	0.000863	0.000123	0.000000	0.000000	0.035873
E	0.008752	0.011464	0.011588	0.004191	0.000247	0.000000	0.000000	0.000000	0.036243
ESE	0.010108	0.013190	0.010478	0.007396	0.001479	0.000000	0.000123	0.000000	0.042776
SE	0.021450	0.018738	0.017998	0.017875	0.010725	0.004068	0.001479	0.000247	0.092579
SSE	0.038092	0.102194	0.019847	0.018738	0.010848	0.005178	0.002589	0.000616	0.198102
S	0.032051	0.047337	0.011464	0.008136	0.004315	0.000863	0.000000	0.000000	0.104167
SSW	0.015533	0.024655	0.009492	0.003082	0.000740	0.000000	0.000000	0.000000	0.053501
SW	0.013930	0.026134	0.011464	0.000616	0.000000	0.000000	0.000000	0.000000	0.052145
WSW	0.009369	0.016026	0.011341	0.005917	0.002342	0.000986	0.000247	0.000000	0.046228
W	0.010848	0.009369	0.011464	0.013437	0.010232	0.004191	0.001109	0.000000	0.060651
WNW	0.008259	0.011218	0.007396	0.007520	0.005671	0.002712	0.001603	0.000123	0.044502
NW	0.009492	0.009615	0.006287	0.003082	0.000616	0.000740	0.000123	0.000000	0.029956
NNW	0.008136	0.023422	0.010971	0.002589	0.000247	0.000123	0.000000	0.000000	0.045488
N	0.008999	0.024162	0.022313	0.003328	0.001479	0.000000	0.000000	0.000000	0.060281
CALM									0.033531
TOTAL	0.218195	0.370439	0.192554	0.107618	0.050419	0.018984	0.007273	0.000986	1.000000

MEAN WIND SPEED (m/s) = 2.94
NUMBER OF OBSERVATIONS = 8112

```
------------------------------------------
FREQUENCY OF OCCURENCE OF STABILITY CLASSES
------------------------------------------
  A : 9.4%
  B : 5.5%
  C : 11.4%
  D : 44.5%
  E : 15.1%
  F : 14.1%


------------------------------
STABILITY CLASS BY HOUR OF DAY
------------------------------
Hour   A    B    C    D    E    F
  01 0000 0000 0000 0138 0099 0101
  02 0000 0000 0000 0134 0101 0103
  03 0000 0000 0000 0129 0110 0099
  04 0000 0000 0000 0120 0100 0118
  05 0000 0000 0000 0125 0105 0108
  06 0008 0006 0010 0137 0090 0087
  07 0040 0016 0029 0150 0047 0056
  08 0079 0032 0044 0160 0010 0013
  09 0094 0051 0079 0114 0000 0000
  10 0096 0048 0105 0089 0000 0000
  11 0092 0046 0113 0087 0000 0000
  12 0088 0056 0098 0096 0000 0000
  13 0078 0046 0110 0104 0000 0000
  14 0080 0049 0096 0113 0000 0000
  15 0064 0047 0092 0135 0000 0000
  16 0038 0035 0089 0160 0005 0011
  17 0005 0012 0047 0238 0019 0017
  18 0002 0004 0010 0275 0035 0012
  19 0000 0000 0000 0271 0049 0018
  20 0000 0000 0000 0222 0076 0040
  21 0000 0000 0000 0172 0083 0083
  22 0000 0000 0000 0151 0101 0086
  23 0000 0000 0000 0149 0099 0090
  24 0000 0000 0000 0137 0098 0103
```

```
--------------------------------
STABILITY CLASS BY MIXING HEIGHT
--------------------------------
Mixing height     A    B    C    D    E    F
    <=500 m    0128 0063 0121 0614 1206 1120
   <=1000 m    0348 0185 0369 1220 0008 0015
   <=1500 m    0288 0200 0432 1360 0013 0010
   <=2000 m    0000 0000 0000 0262 0000 0000
   <=3000 m    0000 0000 0000 0139 0000 0000
    >3000 m    0000 0000 0000 0011 0000 0000

----------------------------
MIXING HEIGHT BY HOUR OF DAY
----------------------------
       0000  0100  0200  0400  0800  1600  Greater
        to    to    to    to    to    to   than
Hour   0100  0200  0400  0800  1600  3200  3200
  01   0081  0107  0024  0048  0066  0012  0000
  02   0082  0113  0018  0042  0066  0017  0000
  03   0082  0113  0024  0044  0056  0018  0001
  04   0100  0104  0018  0047  0053  0015  0001
  05   0129  0100  0015  0039  0044  0011  0000
  06   0093  0118  0071  0029  0019  0008  0000
  07   0090  0059  0102  0077  0007  0003  0000
  08   0000  0074  0103  0161  0000  0000  0000
  09   0000  0000  0099  0165  0074  0000  0000
  10   0000  0000  0000  0216  0122  0000  0000
  11   0000  0000  0000  0133  0205  0000  0000
  12   0000  0000  0000  0085  0253  0000  0000
  13   0000  0000  0000  0020  0318  0000  0000
  14   0000  0000  0000  0000  0338  0000  0000
  15   0000  0000  0000  0000  0338  0000  0000
  16   0000  0000  0000  0000  0338  0000  0000
  17   0004  0008  0005  0005  0294  0022  0000
  18   0011  0015  0014  0015  0244  0039  0000
  19   0016  0031  0020  0024  0187  0060  0000
  20   0036  0053  0028  0034  0136  0051  0000
  21   0066  0077  0024  0049  0092  0029  0001
  22   0077  0096  0019  0050  0074  0022  0000
  23   0072  0103  0018  0054  0070  0021  0000
  24   0079  0108  0019  0045  0062  0025  0000
```

APPENDIX C

AUSPLUME model output

```
1             ____________________________________________________

                Appin Surace Gas Drainage - flare emissions. NOx

              ____________________________________________________

 Concentration or deposition                          Concentration
 Emission rate units                                  grams/second
 Concentration units                                  microgram/m3
 Units conversion factor                              1.00E+06
 Constant background concentration                             0.00E+00
 Terrain effects                                      Egan method
 Smooth stability class changes?                      No
 Other stability class adjustments ("urban modes")    None
 Ignore building wake effects?                        No
 Decay coefficient (unless overridden by met. file)   0.000
 Anemometer height                                    10 m
 Roughness height at the wind vane site               0.400 m
 Averaging time for sigma-theta values                 60 min.

                   DISPERSION CURVES
 Horizontal dispersion curves for sources <100m high  Sigma-theta
 Vertical  dispersion  curves for sources <100m high  Pasquill-Gifford
 Horizontal dispersion curves for sources >100m high  Briggs Rural
 Vertical  dispersion  curves for sources >100m high  Briggs Rural
 Enhance horizontal plume spreads for buoyancy?       Yes
 Enhance  vertical  plume spreads for buoyancy?       Yes
 Adjust horizontal P-G formulae for roughness height? Yes
 Adjust  vertical  P-G formulae for roughness height? Yes
 Roughness height                                     0.400m
 Adjustment for wind directional shear                None

                    PLUME RISE OPTIONS
 Gradual plume rise?                                  Yes
 Stack-tip downwash included?                         Yes
 Building downwash algorithm:                        Schulman-Scire method.
 Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
 Partial penetration of elevated inversions?          No
 Disregard temp. gradients in the hourly met. file?   No

 and in the absence of boundary-layer potential temperature gradients
 given by the hourly met. file, a value from the following table
 (in K/m) is used:

    Wind Speed                Stability Class
     Category       A      B      C      D      E      F
   ________________________________________________________
        1         0.000  0.000  0.000  0.000  0.020  0.035
        2         0.000  0.000  0.000  0.000  0.020  0.035
        3         0.000  0.000  0.000  0.000  0.020  0.035
        4         0.000  0.000  0.000  0.000  0.020  0.035
        5         0.000  0.000  0.000  0.000  0.020  0.035
        6         0.000  0.000  0.000  0.000  0.020  0.035

 WIND SPEED CATEGORIES
 Boundaries between categories (in m/s) are:  1.54,  3.09,  5.14,  8.23, 10.80

 WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

 AVERAGING TIMES
  1 hour

 _____________________________________________________________________________
```

```
1              ____________________________________________________

                Appin Surace Gas Drainage - flare emissions. NOx

                             SOURCE CHARACTERISTICS

               ____________________________________________________


                    STACK SOURCE: GEN1

   X(m)     Y(m)    Ground Elev.  Stack Height  Diameter Temperature  Speed
 290790  6215895       125m            3m        0.12m      300C    20.0m/s

                           No building wake effects.
                (Constant) emission rate = 4.15E-01 grams/second
                    No gravitational settling or scavenging.


                    STACK SOURCE: FLARE1

   X(m)     Y(m)    Ground Elev.  Stack Height  Diameter Temperature  Speed
 290800  6215900       125m            8m        2.63m     1000C     9.1m/s

                           No building wake effects.
                (Constant) emission rate = 1.40E+01 grams/second
                    No gravitational settling or scavenging.

 _____________________________________________________________________________

1              ____________________________________________________

                Appin Surace Gas Drainage - flare emissions. NOx

                               RECEPTOR LOCATIONS

               ____________________________________________________

 The Cartesian receptor grid has the following x-values (or eastings):
 286000.m  286100.m  286200.m  286300.m  286400.m  286500.m  286600.m
 286700.m  286800.m  286900.m  287000.m  287100.m  287200.m  287300.m
 287400.m  287500.m  287600.m  287700.m  287800.m  287900.m  288000.m
 288100.m  288200.m  288300.m  288400.m  288500.m  288600.m  288700.m
 288800.m  288900.m  289000.m  289100.m  289200.m  289300.m  289400.m
 289500.m  289600.m  289700.m  289800.m  289900.m  290000.m  290100.m
 290200.m  290300.m  290400.m  290500.m  290600.m  290700.m  290800.m
 290900.m  291000.m  291100.m  291200.m  291300.m  291400.m  291500.m
 291600.m  291700.m  291800.m  291900.m  292000.m  292100.m  292200.m
 292300.m  292400.m  292500.m  292600.m  292700.m  292800.m  292900.m
 293000.m  293100.m  293200.m  293300.m  293400.m  293500.m  293600.m
 293700.m  293800.m  293900.m  294000.m  294100.m  294200.m  294300.m
 294400.m  294500.m  294600.m  294700.m  294800.m  294900.m  295000.m

 and these y-values (or northings):
6211000.m 6211100.m 6211200.m 6211300.m 6211400.m 6211500.m 6211600.m
6211700.m 6211800.m 6211900.m 6212000.m 6212100.m 6212200.m 6212300.m
6212400.m 6212500.m 6212600.m 6212700.m 6212800.m 6212900.m 6213000.m
6213100.m 6213200.m 6213300.m 6213400.m 6213500.m 6213600.m 6213700.m
6213800.m 6213900.m 6214000.m 6214100.m 6214200.m 6214300.m 6214400.m
6214500.m 6214600.m 6214700.m 6214800.m 6214900.m 6215000.m 6215100.m
6215200.m 6215300.m 6215400.m 6215500.m 6215600.m 6215700.m 6215800.m
6215900.m 6216000.m 6216100.m 6216200.m 6216300.m 6216400.m 6216500.m
6216600.m 6216700.m 6216800.m 6216900.m 6217000.m 6217100.m 6217200.m
6217300.m 6217400.m 6217500.m 6217600.m 6217700.m 6217800.m 6217900.m
6218000.m 6218100.m 6218200.m 6218300.m 6218400.m 6218500.m 6218600.m
6218700.m 6218800.m 6218900.m 6219000.m 6219100.m 6219200.m 6219300.m
6219400.m 6219500.m 6219600.m 6219700.m 6219800.m 6219900.m 6220000.m


 DISCRETE RECEPTOR LOCATIONS (in metres)

 No.      X        Y     ELEVN  HEIGHT       No.      X        Y     ELEVN  HEIGHT
  1  290905 6215780   120.0    0.0          9  291685 6216677   130.0    0.0
  2  291861 6216246   130.0    0.0         10  291784 6216583   130.0    0.0
  3  291858 6216328   130.0    0.0         11  290090 6215633   130.0    0.0
  4  291846 6216484   130.0    0.0         12  289383 6215812   140.0    0.0
  5  291699 6215903   120.0    0.0         13  289453 6216114   120.0    0.0
  6  291564 6216223   130.0    0.0         14  289500 6216273   120.0    0.0
  7  291749 6216519   130.0    0.0         15  289911 6217092   120.0    0.0
  8  291509 6216692   130.0    0.0         16  291013 6216107   125.0    0.0
```

METEOROLOGICAL DATA : AUS to AUS Extended records (Met MANAGER)

1 Peak values for the 100 worst cases (in microgram/m3)
Averaging time = 1 hour

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	2.50E+02	07,22/02/95	(290700, 6216100, 0.0)
2	1.75E+02	07,16/10/95	(290700, 6216200, 0.0)
3	1.66E+02	07,05/10/95	(290700, 6216200, 0.0)
4	1.62E+02	09,12/08/95	(290700, 6216200, 0.0)
5	1.61E+02	08,12/03/95	(290700, 6216100, 0.0)
6	1.61E+02	08,12/05/95	(290700, 6216200, 0.0)
7	1.58E+02	07,28/09/95	(290700, 6216200, 0.0)
8	1.54E+02	08,11/10/95	(290700, 6216100, 0.0)
9	1.54E+02	09,25/08/95	(290700, 6215700, 0.0)
10	1.53E+02	07,09/02/95	(290700, 6216200, 0.0)
11	1.52E+02	06,07/12/95	(290700, 6216200, 0.0)
12	1.51E+02	10,10/06/95	(290700, 6215800, 0.0)
13	1.51E+02	08,30/04/95	(290700, 6216100, 0.0)
14	1.45E+02	06,16/01/95	(290700, 6216100, 0.0)
15	1.44E+02	08,20/08/95	(290700, 6216200, 0.0)
16	1.43E+02	09,25/07/95	(290800, 6216000, 0.0)
17	1.43E+02	08,21/07/95	(290800, 6216000, 0.0)
18	1.42E+02	09,21/07/95	(290800, 6216000, 0.0)
19	1.41E+02	09,26/04/95	(290700, 6216200, 0.0)
20	1.41E+02	21,19/09/95	(290800, 6215800, 0.0)
21	1.38E+02	09,13/08/95	(290700, 6216200, 0.0)
22	1.37E+02	08,22/09/95	(290800, 6216000, 0.0)
23	1.36E+02	06,03/01/95	(290600, 6216200, 0.0)
24	1.35E+02	08,11/05/95	(290700, 6216100, 0.0)
25	1.35E+02	09,07/07/95	(290800, 6216000, 0.0)
26	1.33E+02	07,04/01/95	(290700, 6216100, 0.0)
27	1.31E+02	24,08/02/95	(290700, 6216000, 0.0)
28	1.31E+02	01,10/05/95	(290700, 6215800, 0.0)
29	1.30E+02	23,18/01/95	(290700, 6215900, 0.0)
30	1.30E+02	06,06/01/95	(290600, 6216200, 0.0)
31	1.30E+02	22,14/11/95	(290800, 6215800, 0.0)
32	1.30E+02	19,13/08/95	(290700, 6215900, 0.0)
33	1.29E+02	23,02/07/95	(290905, 6215780, 0.0)
34	1.28E+02	21,03/01/95	(290700, 6215900, 0.0)
35	1.28E+02	06,16/12/95	(290700, 6216200, 0.0)
36	1.27E+02	05,07/04/95	(290800, 6215800, 0.0)
37	1.27E+02	09,07/06/95	(290700, 6216100, 0.0)
38	1.27E+02	08,14/11/95	(290700, 6216100, 0.0)
39	1.27E+02	10,29/05/95	(290700, 6216200, 0.0)
40	1.26E+02	24,08/03/95	(290700, 6216000, 0.0)
41	1.25E+02	07,06/11/95	(290800, 6215800, 0.0)
42	1.25E+02	07,26/05/95	(290905, 6215780, 0.0)
43	1.25E+02	06,18/01/95	(290600, 6215900, 0.0)
44	1.25E+02	07,11/10/95	(290700, 6216200, 0.0)
45	1.24E+02	08,28/04/95	(290700, 6216100, 0.0)
46	1.23E+02	22,30/11/95	(290800, 6215800, 0.0)
47	1.23E+02	20,19/04/95	(290700, 6216000, 0.0)
48	1.21E+02	07,14/11/95	(290700, 6216100, 0.0)
49	1.21E+02	07,30/01/95	(290700, 6216200, 0.0)
50	1.20E+02	07,02/02/95	(290700, 6216100, 0.0)
51	1.19E+02	06,27/11/95	(290700, 6216100, 0.0)
52	1.19E+02	24,21/05/95	(290900, 6216000, 0.0)
53	1.19E+02	02,09/08/95	(290800, 6216000, 0.0)
54	1.19E+02	07,12/03/95	(290700, 6216200, 0.0)
55	1.18E+02	07,18/10/95	(290700, 6216100, 0.0)
56	1.18E+02	21,10/05/95	(290700, 6216000, 0.0)
57	1.18E+02	18,23/04/95	(290800, 6215800, 0.0)
58	1.18E+02	09,11/03/95	(290905, 6215780, 0.0)
59	1.18E+02	10,07/05/95	(290900, 6215900, 0.0)
60	1.17E+02	10,06/06/95	(290700, 6216100, 0.0)
61	1.17E+02	18,14/08/95	(290700, 6215800, 0.0)
62	1.17E+02	04,18/01/95	(290700, 6216000, 0.0)
63	1.17E+02	21,24/10/95	(290700, 6216000, 0.0)
64	1.17E+02	18,21/11/95	(290700, 6215900, 0.0)
65	1.17E+02	19,28/08/95	(290700, 6215900, 0.0)
66	1.17E+02	07,05/01/95	(290600, 6216200, 0.0)
67	1.16E+02	08,05/04/95	(290700, 6216200, 0.0)

68	1.16E+02	07,21/01/95	(290700,	6216100,	0.0)
69	1.16E+02	13,22/10/95	(290700,	6215900,	0.0)
70	1.15E+02	09,24/06/95	(290700,	6216300,	0.0)
71	1.15E+02	09,30/03/95	(290800,	6216000,	0.0)
72	1.15E+02	13,09/06/95	(290800,	6215800,	0.0)
73	1.15E+02	07,17/03/95	(290700,	6216100,	0.0)
74	1.15E+02	05,19/11/95	(290700,	6216100,	0.0)
75	1.15E+02	08,26/04/95	(290700,	6216200,	0.0)
76	1.15E+02	05,22/01/95	(290800,	6216000,	0.0)
77	1.14E+02	18,18/09/95	(290905,	6215780,	0.0)
78	1.14E+02	20,23/08/95	(290900,	6215800,	0.0)
79	1.14E+02	08,13/09/95	(290700,	6216200,	0.0)
80	1.14E+02	08,19/06/95	(290900,	6215800,	0.0)
81	1.13E+02	23,28/03/95	(290800,	6216000,	0.0)
82	1.13E+02	18,09/05/95	(290700,	6215900,	0.0)
83	1.13E+02	06,25/08/95	(290800,	6215800,	0.0)
84	1.13E+02	08,02/11/95	(290700,	6216100,	0.0)
85	1.13E+02	05,20/11/95	(290700,	6216000,	0.0)
86	1.13E+02	01,21/01/95	(290900,	6215800,	0.0)
87	1.13E+02	07,25/12/95	(290700,	6216000,	0.0)
88	1.13E+02	10,04/12/95	(290800,	6215800,	0.0)
89	1.13E+02	23,15/09/95	(290700,	6216000,	0.0)
90	1.13E+02	07,30/12/95	(290700,	6216100,	0.0)
91	1.13E+02	24,21/10/95	(290700,	6216000,	0.0)
92	1.13E+02	08,30/03/95	(290800,	6216000,	0.0)
93	1.13E+02	22,13/01/95	(290600,	6215900,	0.0)
94	1.13E+02	07,12/01/95	(290800,	6216000,	0.0)
95	1.13E+02	06,17/09/95	(290700,	6216100,	0.0)
96	1.12E+02	23,10/02/95	(290700,	6216000,	0.0)
97	1.12E+02	22,16/09/95	(290700,	6216100,	0.0)
98	1.12E+02	21,12/05/95	(290700,	6215800,	0.0)
99	1.12E+02	02,24/07/95	(290800,	6216000,	0.0)
100	1.11E+02	03,05/02/95	(290800,	6215700,	0.0)

APPENDIX D

Calculations

Plume rise of flares (Schultze, 1977)

For the purposes of dispersion modelling, flare sources can be treated as point sources except that there are buoyancy flux adjustments associated with radiative heat and heat loss which need to be taken into account. This affects both effective stack height and stack diameter. For the purposes of this assessment, a conservative approach has been adopted in that no adjustment for stack height has been made. (Effective stack heights are higher for flares)

For this application adjustments have been made to stack diameter, taking into account radiative loss.

The effective stack radius of the flare can be determined by equating the buoyancy flux from the flare to the general buoyancy flux equation that is used by AUSPLUME.

<u>Equation 1</u>

$$F = \frac{(g * H_r)}{(\pi * \rho * T * C_p)}$$

Where,

F = buoyancy flux from the flare

H_r = net heat release (J/s)

g = acceleration due to gravity (9.81 m/s^2)

C_p = specific heat of air (1004 J/kg K)

ρ = density of air (1.2 kg/m^3)

T = ambient air temperature (20^oC = 293K)

<u>Equation 2</u>

$$F = g * V_s * (r_s{}^2) * \left[{(T_s - T)}/{T_s} \right]$$

Where,

F = buoyancy flux from a stack

g = acceleration due to gravity (9.81 m/s^2)

V_s = exit velocity (m/s)

r_s = stack inner radius (m)

T_s = stack exit temperature (K)

Dimensions of the stack:

V_s = 9.05 m/sec

T_s = 1323 K (1050°C)

Calorific value of methane = 50.1 MJ/kg

Multiplying the calorific value of methane by the flow rate of methane gas from the stack, we can calculate the heat release.

We find the heat release from the flare due to the burning of methane to be $H_r = 2.57 \times 10^7$ J/s.

Factoring 20% and 50% greater heat loss from the flaring process;

$H_{r20\%} = 1.29 \times 10^7$ J/s

$H_{r50\%} = 2.06 \times 10^7$ J/s

Setting the two equations above equal and solving for the radius of the stack, we can determine the variation to the diameter of the stack for both heat loss scenarios.

20% reduction; the diameter of the stack = <u>3.33m</u>

50% reduction; the diameter of the stack = <u>2.63 m</u>

Annex I

I. Agency Correspondence

Our reference: FIL08/18664:DOC09/7806:GN
Contact: Greg Newman, (02) 4224 4100

BHP Billiton Illawarra Coal Holdings Pty Ltd
(Attention: Dr Bruce Blunden)
PO Box 514
UNANDERRA NSW 2526

Dear Sir

PROJECT APPLICATION NUMBER 08-0256
COMMENTS ON THE APPIN GAS DRAINAGE PROJECT

We refer to your request to the Department of Environment and Climate Change (DECC) to identify specific issues regarding the above proposal. DECC has reviewed the Preliminary Environmental Assessment (PEA) which was received on 11 February 2009, and provide the following comments on sections *2.4 Proposed Goaf Gas Management* and *2.5 Identification Of A Preferred Option* .

The Department recommends that these sections include an assessment of the proposed management options for greenhouse gas emissions against current best practice. In this instance DECC considers best practice to be electricity generation if technically feasible and reasonable. In this regards the options assessment would also need to consider the future liabilities for methane and carbon dioxide emissions under the Commonwealth Carbon Pollution Reduction Scheme and the likely increase in wholesale/retail electricity prices caused by the addition of a carbon price to the cost of generating electricity. We understand this pricing effect will make it even more commercially attractive to use the methane to generate electricity and avoid purchasing costs or take advantage of higher prices if the electricity is sold on the grid. However, if electricity generation is not the preferred option justification including technical/feasibility reasons would need to be documented to support any other option.

Please call Greg Newman on (02) 4224 4100 at the DECC Wollongong Office to discuss the above matter further.

Yours sincerely

9/3/09

PETER BLOEM
Acting Manager Illawarra
Environment Protection and Regulation

cc: Department of Planning
(Attention: Ms Alison Thomas)
GPO Box 39
SYDNEY NSW 2001

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PO Box 513 Wollongong NSW 2520
Level 3, 84 Crown Street Wollongong NSW
Tel: (02) 4224 4100 Fax: (02) 4224 4110
ABN 30 841 387 271
www.environment.nsw.gov.au

Department of **Environment and Climate Change** NSW

Alison Thomas - Re: Appin Goaf Gas Drainage Project

From: Alison Thomas
To: elise.newberry@dpi.nsw.gov.au
Date: 20/01/2009 15:09
Subject: Re: Appin Goaf Gas Drainage Project

Alison

These are fine although there could be a greater emphasis on the rehabilitation of disturbance. I'll be back in from Monday January 5 if you wish to discuss.

Elise Newberry
Director, Environmental Sustainability
Division of Mineral Resources
Department of Primary Industries
Phone: 02 4931 6601
Fax: 02 4931 6790
Mob: 0407 295 399
elise.newberry@dpi.nsw.gov.au

NSW Government
Department of Water & Energy

Ms Alison Thomas
NSW Department of Planning
GPO Box 39
Sydney
NSW 2001

Contact: Janne Grose
Phone: 9895 7651
Fax: 9895 7501
Email: janne.grose@dnr.nsw.gov.au

File:
Our Ref:

23 December 2008

Dear Alison

Subject: Major Project – Appin Area 7 - Goaf Gas Drainage – Wollondilly LGA – Director General Requirements

Thank you for your email of 22 December 2008 seeking comment from the Department of Water and Energy (DWE) on the suitability of using the DGR's that were issued for the West Cliff Surface Goaf Gas Drainage project as a template for the subject proposal.

The DWE has reviewed the DGRs that were issued for the West Cliff Surface Goaf Gas project and can not accept these DGRs in their current form as a template for the Appin Area 7 project or any other proposal.

DWE has concerns with the adequacy of the West Cliff DGRs. DWE found the EA that was submitted for the West Cliff proposal was lacking in details required by DWE to undertake assessment (please refer to attached submission on the EA for West Cliff, dated 7 July 2008).

The DGRs for West Cliff include no reference to water. The DGRs for Appin need to outline that the EA must provide details on:

- how water supply is sourced for the proposal
- any water licensing requirements under the *Water Act 1912* or *Water Management Act 2000*
- the protection of any watercourses, riparian corridors and wetlands on the site.

Please note.

1. All operations must be conducted in accordance with licence(s) in force under the *Water Act 1912* (WA) or Water Management Act 2000, whichever is applicable
2. Gas drainage bores which intersect groundwaters must be licensed under Part 5 of the WA
3. Mine workings which intercept groundwaters connected to the gas drainage bores must be licensed under Part 5 of the WA
4. No water supply to or water extraction from the workings may occur unless authorised under licences in force under Parts 2 or 5 of the WA
5. Bores constructed to extract coal bed gas must be fully cased or otherwise sealed to prevent drainage from or contamination of aquifers overlying the target coal seam(s)
6. Construction or upgrading of any surface activities must not damage or interfere in any way with:

- Native vegetation and habitat within the riparian zones.
- The stability of adjacent or nearby bed or banks of Waterfront Land.
- The stability of Waterfront Land and their associated environments
- The flow of watercourses within Waterfront Land.
- The quality of water within Waterfront Land
- Any pumps or structures in the vicinity (that are licensed under the Water Act 1912 or the Water Management Act 2000).

7. The proponent must ensure that all works and disturbance areas associated with the proposal (with the exception of crossings) are located outside riparian zones and do not compromise the integrity of riparian zones

Water Management

The EA must provide adequate details for DWE to assess the impact of the proposal on surface water and groundwater resources. Details required by DWE include:

- any water supply sourced within current licence arrangements – water supply source(s) for the proposal must be fully explained
- volumes of water to be used for this aspect of the mine project must be explained,
- any proposed additional surface water extraction for the proposal must be explained, including purpose, location of existing and proposed pumps, dams,
- any proposed groundwater extraction related to the project, including extraction from the operating coal mine, must be explained
- the function and location of all existing and proposed storages/ponds on the site must be explained,
- the design, layout, pumping and storage capacities, all associated earthworks and infrastructure works must be clearly shown and explained
- whether any extraction of incidental groundwater by means of the works are proposed, and how this will be authorised under licence

Groundwater

The EA must take into account the potential impacts of the proposal on the surrounding groundwater resources and other users of groundwater in the vicinity of the development (including the environment).

Appin Colliery does not possess a licence under Part 5 of the Water Act 1912 authorising interception, extraction and use of groundwater. If the gas drainage bores are to be constructed to the producing seam for the underground mine, the mining operation must be licensed prior to any gas drainage works being installed, should incidental groundwater extraction be required.

DWE will require evidence that the gas extraction bore holes have been successfully isolated from the producing aquifers. The proposal may require a Part 5 licence from DWE under the Water Act 1912, so in this regard it is considered necessary for the results of full casing or cement bond logging of the bore holes to be provided. If it can be demonstrated that the bores holes have been successfully isolated from the producing aquifers a licence under the Water Act 1912 will not be required.

Appropriate measures must be adopted to avoid impacts, should risks to groundwater be identified. The project must protect the groundwater resource, enhance groundwater quality and protect groundwater-dependent ecosystems. Consideration must be given to the vulnerability of groundwater locally and prevention of any potential mixing of lower with higher quality groundwater source by explaining the risks associated with drilling through any higher aquifer and means to protect these aquifers from drainage or contamination. The vulnerability of groundwaters and the aquifers in which those groundwaters are associated must be examined; any disturbance to groundwater sources through which drilling is proposed, and any protective measures for these groundwater sources must be explained.

Protection of Watercourses and Riparian Lands

The EA should explain any potential impacts on watercourses, wetlands and riparian corridors including the location of any surface activities associated with the proposal in relation to the location of watercourses/wetlands/riparian corridors such as any additional stream crossings or upgrade to existing stream crossings. Any crossing construction should comply with Departmental standards for crossing construction.

Should you have any queries in respect to this matter, please contact Fergus Hancock on (02) 4904 2532 at the Newcastle office or Janne Grose on (02) 9895 7651 at the Parramatta office.

Yours sincerely

pp

Mark Mignanelli
Manager,
Major Projects, Mines Assessments and Planning

RTA

Our Ref: 09/546
Contact: Chris Millet (42212570)
Your Ref:

Mr Hank Pinkster
Manager, Rehabilitation and Infrastructure
BHP Biliton
PO Box 514
UNANDERRA NSW 2526

06 MAY 2009

WOLLONDILLY SHIRE COUNCIL – PROPOSED PART 3A MAJOR PROJECT – HW2, HUME HIGHWAY, GOAF – IC GAS DRAINAGE PROJECT ADJACENT TO HUME HIGHWAY, DOUGLAS PARK

Dear Sir

Reference is made to your email to Mal Blianiwskyj, Southern Regional Manager Roads and Traffic Authority (RTA), dated 16 April 2009 regarding the subject proposal forwarded to the RTA for consideration.

The RTA has reviewed the information submitted and provides the following comments for your consideration:

- The environmental assessment (EA) should outline any impacts to the Hume Highway during construction and operation. This should include construction of the pipe, access for construction and potential lane closures.
- Section 138 consent will be required from the RTA under the Roads Act, 1993 for the structures within the road reserve. In this regard, the RTA will require a Deed of Agreement to be executed between the RTA and the Proponent. The RTA's preference is to modify the existing Appin Area 7 Deed of Agreement to cover this pipeline. All costs associated with this agreement will be borne by the Proponent.
- The Proponent would be responsible for all OHS issues, traffic management (if required), and public liability issues associated with the work.
- The top of the pipe would need to be at least 5 m below the surface of the Hume Highway.
- The pipe would need to be installed by under boring from outside the Hume Highway road reserve.
- When the pipeline is decommissioned, the Proponent would be responsible for any works required to rehabilitate the area, including filling and blocking of the pipe..

Should you require any clarification on this matter please call Chris Millet on 4221 2570

Yours faithfully

Trish McClure
Manager, Road Safety and Traffic Management
Southern Operations & Engineering Services

CC:

Major Development Assessment
Department of Planning
GPO Box 39
SYDNEY NSW 2001