AECOM

Appendix A

AHIMS Search Results

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Department of
Environment
and Climate Change (NSW)

Your reference	: Search 1
Our reference	: AHIMS #26303

AECOM - Pymble
PO Box 726
Pymble NSW 2073

02 JUL 2009

Monday, 29 June 2009

Attention: Geordie Oakes

Dear Sir or Madam:

Re: AHIMS Search for the following area at Search 1;E:301000-305000;N:6412500-6415500

I am writing in response to your recent inquiry in respect to Aboriginal objects and Aboriginal places registered with the NSW Department of Environment and Climate Change (DECC) at the above location.

A search of the DECC Aboriginal Heritage Information Management System (AHIMS) has shown that *33* Aboriginal objects and Aboriginal places are recorded in or near the above location. Please refer to the attached report for details.

The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.

The following qualifications apply to an AHIMS search:

- AHIMS only includes information on Aboriginal objects and Aboriginal places that have been provided to DECC;
- Large areas of New South Wales have not been the subject of systematic survey or recording of Aboriginal history. These areas may contain Aboriginal objects and other heritage values which are not recorded on AHIMS;
- Recordings are provided from a variety of sources and may be variable in their accuracy. When an AHIMS search identifies Aboriginal objects in or near the area it is recommended that the exact location of the Aboriginal object be determined by re-location on the ground; and
- The criteria used to search AHIMS are derived from the information provided by the client and DECC assumes that this information is accurate.

All Aboriginal places and Aboriginal objects are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to destroy, damage or deface them without the prior consent of the DECC Director-General. An Aboriginal object is considered to be known if:

- It is registered on AHIMS;
- It is known to the Aboriginal community; or

- It is located during an investigation of the area conducted for a development application.

If you considering undertaking a development activity in the area subject to the AHIMS search, DECC would recommend that an Aboriginal Heritage Assessment be undertaken. You should consult with the relevant consent authority to determine the necessary assessment to accompany your development application.

Yours Sincerely

Freeburn, Shannon
Administrator
Information Systems & Assessment Section
Culture & Heritage Division
Phone: 02 9585 6471
Fax: 02 9585 6094

List of Sites (List - Short)

Search 1

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 301000, Easting to = 305000, Northing From = 6412500, Northing to = 6415500, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-0034	Saltwater Creek;Saltwater Creek East Bank;	AGD	56	303501	6412509	Open Site	AFT : -	Open Camp Site	ASRSYS	310, 4525	NRS/17798/1/188
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0081	Saltwater Creek;	AGD	56	303653	6414158	Open Site	AFT : -	Open Camp Site	ASRSYS	313, 4525	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0088	Saltwater Creek;	AGD	56	302738	6414141	Open Site	AFT : -	Open Camp Site	ASRSYS	313, 4525	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0092	Saltwater Creek;	AGD	56	302738	6414141	Open Site	AFT : -	Open Camp Site	ASRSYS		NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0094	Saltwater Creek;	AGD	56	303670	6413244	Open Site	AFT : -	Open Camp Site	ASRSYS	4525	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0500	BMP 1;Jerrys Plain;	AGD	56	303550	6413620	Open Site	AFT : -	Open Camp Site	Koettig	1097, 1203, 4525	NRS/17798/1/195
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0818	P22;	AGD	56	304980	6412850	Open Site	AFT : -	Open Camp Site	Bell, McDonald		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0819	P23;	AGD	56	304740	6412800	Open Site	AFT : -	Open Camp Site	Bell, McDonald		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		

AMG 39

assume P21 37-2-817
P20 37-2-816
P19 37-2-815 (AMG 38)

List of Sites (List - Short)

Search 1

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 301000, Easting to = 305000, Northing From = 6412500, Northing to = 6415500, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-0820	P24;	AGD	56	304600	6412600	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0821	P25;	AGD	56	304500	6412580	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0822	P26;	AGD	56	304400	6412550	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0823	P27;	AGD	56	304370	6412650	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0824	P28;	AGD	56	304500	6412670	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0825	P29;	AGD	56	304400	6412700	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0826	P30;	AGD	56	304240	6412670	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0827	P31;	AGD	56	304050	6412650	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		

AHIMS Aboriginal Heritage Information Management System

Department of Environment & Climate Change NSW

List of Sites (List - Short)

Search 1

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 301000, Easting to = 305000, Northing From = 6412500, Northing to = 6415500, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-0828	P32;	AGD	56	304150	6412760	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0829	P33;	AGD	56	303910	6412780	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0830	P34;	AGD	56	303790	6412700	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0831	P35;	AGD	56	303730	6412720	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0832	P36;	AGD	56	303760	6412760	Open Site	AFT : -	Open Camp Site	**Bell, McDonald**		NRS/17798/1/198
		Status Valid									
		Primary Contact							Permit(s)		
37-2-1932	SC-OS-24	AGD	56	301320	6413190	Open Site	AFT : -	None	**Mills**		NRS/17798/1/209
		Status Valid									
		Primary Contact							Permit(s)		
37-2-1933	SC-OS-23	AGD	56	301780	6413700	Open Site	AFT : -	None	**Mills**		NRS/17798/1/209
		Status Valid									
		Primary Contact							Permit(s)		
37-2-1934	SC-OS-22	AGD	56	301780	6413890	Open Site	AFT : -	None	**Mills**		NRS/17798/1/209
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Search 1

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 301000, Easting to = 305000, Northing From = 6412500, Northing to = 6415500, Feature Search Type = AHIMS Features

3 sites with duplicate coords.

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-1956	SC-OS-28	AGD	56	301780	6413700	Open Site	AFT : -	None	Mills		NRS/17798/1/209
		Status Valid									
		Primary Contact							Permit(s)		
37-2-1957	SC-OS-26	AGD	56	301780	6413700	Open Site	AFT : -	None	Mills		NRS/17798/1/209
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2357	Delpah D17	GDA	56	304809	6415585	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2359	Delpah D19	GDA	56	304940	6415628	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2360	Delpah D20	GDA	56	305054	6415475	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2361	Delpah D21	GDA	56	304680	6415390	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2362	Delpah D22	GDA	56	304491	6415684	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2738	Liddell EW 2	GDA	56	304665	6415282	Open Site	AFT : 2	None	Insite Heritage	101420	
		Status Valid									
		Primary Contact							Permit(s)		

AHIMS Aboriginal Heritage Information Management System

Department of Environment & Climate Change NSW

List of Sites (List - Short)

Search 1

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 301000, Easting to = 305000, Northing From = 6412500, Northing to = 6415500, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-3-0021	Falbrook;Arizona;	AGD	56	301570	6412580	Open Site	GDG : -	Axe Grinding Groove	ASRSYS		NRS/17798/1/210
		Status Valid									
		Primary Contact							Permit(s)		

Department of
**Environment
and Climate Change (NSW)**

Your reference : Search 2
Our reference : AHIMS #26302

AECOM - Pymble
PO Box 726
Pymble NSW 2073

02 JUL 2009

Monday, 29 June 2009

Attention: Geordie Oakes

Dear Sir or Madam:

Re: AHIMS Search for the following area at Search 2;E:303000-308000;N:6414000-6417000

I am writing in response to your recent inquiry in respect to Aboriginal objects and Aboriginal places registered with the NSW Department of Environment and Climate Change (DECC) at the above location.

A search of the DECC Aboriginal Heritage Information Management System (AHIMS) has shown that *45* Aboriginal objects and Aboriginal places are recorded in or near the above location. Please refer to the attached report for details.

The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.

The following qualifications apply to an AHIMS search:

- AHIMS only includes information on Aboriginal objects and Aboriginal places that have been provided to DECC;
- Large areas of New South Wales have not been the subject of systematic survey or recording of Aboriginal history. These areas may contain Aboriginal objects and other heritage values which are not recorded on AHIMS;
- Recordings are provided from a variety of sources and may be variable in their accuracy. When an AHIMS search identifies Aboriginal objects in or near the area it is recommended that the exact location of the Aboriginal object be determined by re-location on the ground; and
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All Aboriginal places and Aboriginal objects are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to destroy, damage or deface them without the prior consent of the DECC Director-General. An Aboriginal object is considered to be known if:

- It is registered on AHIMS;
- It is known to the Aboriginal community; or

- It is located during an investigation of the area conducted for a development application.

If you considering undertaking a development activity in the area subject to the AHIMS search, DECC would recommend that an Aboriginal Heritage Assessment be undertaken. You should consult with the relevant consent authority to determine the necessary assessment to accompany your development application.

Yours Sincerely

Freeburn, Shannon
Administrator
Information Systems & Assessment Section
Culture & Heritage Division
Phone: 02 9585 6471
Fax: 02 9585 6094

List of Sites (List - Short)

Search 2

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 303000, Easting to = 308000, Northing From = 6414000, Northing to = 6417000, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-0062	Tinkers Creek;Liddell;	AGD	56	307210	6414682	Open Site	AFT : -	Open Camp Site	**ASRSYS**	4525	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0063	Liddell;Tinkers Creek;	AGD	56	307027	6414679	Open Site	AFT : -	Open Camp Site	**ASRSYS**	4525	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0064	Liddell;Tinkers Creek;	AGD	56	307553	6415877	Open Site	AFT : -	Open Camp Site	**ASRSYS**	4525, 98357, 98373	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-0081	Saltwater Creek;	AGD	56	303653	6414158	Open Site	AFT : -	Open Camp Site	**ASRSYS**	313, 4525	NRS/17798/1/189
		Status Valid									
		Primary Contact							Permit(s)		
37-2-1968	DR.1	AGD	56	303384	6416832	Open Site	AFT : -	None	**Russell, Hardy**	98357, 98373	NRS/17798/1/209
		Status Destroyed									
		Primary Contact							Permit(s) 1744		
37-2-1972	DR5	AGD	56	305215	6416973	Open Site	AFT : -	None	**Russell, Hardy**	98357, 98373	NRS/17798/1/209
		Status Destroyed									
		Primary Contact							Permit(s) 1744		
37-2-1977	DR10	AGD	56	304187	6416658	Open Site	AFT : -	None	**Russell, Hardy**	98357, 98373	NRS/17798/1/209
		Status Destroyed									
		Primary Contact							Permit(s) 1744		
37-2-1978	DR11	AGD	56	304117	6416624	Open Site	AFT : -	None	**Russell, Hardy**	98357, 98373	NRS/17798/1/209
		Status Destroyed									
		Primary Contact							Permit(s) 1744		

AHIMS
Aboriginal Heritage Information Management System

Department of Environment & Climate Change NSW

List of Sites (List - Short)

Search 2

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 303000, Easting to = 308000, Northing From = 6414000, Northing to = 6417000, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-1979	DR12	AGD	56	304523	6416628	Open Site	AFT : -	None	Russell, Hardy	98357, 98373	NRS/17798/1/209
		Status Destroyed									
		Primary Contact							Permit(s) 1744		
37-2-1980	DR13	AGD	56	304688	6416677	Open Site	AFT : -	None	Russell, Hardy	98357, 98373	NRS/17798/1/209
		Status Destroyed									
		Primary Contact							Permit(s) 1744		
37-2-1981	DR14	AGD	56	303332	6416603	Open Site	AFT : -	None	Russell, Hardy	98357, 98373	NRS/17798/1/210
		Status Destroyed									
		Primary Contact							Permit(s) 1744		
37-2-1989	DR1 (Drayton Coal)	AGD	56	303384	6416832	Open Site	AFT : -	None	Russell, Hardy		NRS/17798/1/210
		Status Valid									
		Primary Contact							Permit(s)		
37-2-1993	DR 5 - Drayton Coal(refer to 37-2-1972)	AGD	56	305215	6416973	Open Site	AFT : 10	None	Hardy		NRS/17798/1/210
		Status Deleted									
		Primary Contact							Permit(s)		
37-2-2064	ANT 12	AGD	56	307826	6416613	Open Site	AFT : 16	None	Stuart		
		Status Valid									
		Primary Contact	Northern HTO						Permit(s) 2425		
37-2-2065	ANT 13	AGD	56	307469	6415911	Open Site	AFT : 2	None	Stuart	99852, 99853	
		Status Valid									
		Primary Contact	Northern HTO						Permit(s) 2425		
37-2-2066	ANT 14	AGD	56	307298	6415651	Open Site	AFT : 5	None	Stuart	99852, 99853, 99854	
		Status Valid									
		Primary Contact	Northern HTO						Permit(s) 2425		

List of Sites (List - Short)

Search 2

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 303000, Easting to = 308000, Northing From = 6414000, Northing to = 6417000, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-2067	ANT 15	AGD	56	307371	6415680	Open Site	TRE : 1	None	Stuart	99852, 99853, 99854	
		Status Valid									
		Primary Contact	Northern HTO						Permit(s) 2425		
37-2-2321	Delpah D3	GDA	56	305279	6416047	Open Site	AFT : 1	None	Archaeological Risk Assessment Services		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2322	Delpah D4	GDA	56	305230	6415960	Open Site	AFT : 1	None	Archaeological Risk Assessment Services		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2325	Delpah D1	GDA	56	305074	6416069	Open Site	AFT : 1	None	Archaeological Risk Assessment Services		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2326	Delpah D5	GDA	56	305215	6415891	Open Site	AFT : 1, PAD : -	None	Archaeological Risk Assessment Services		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2327	Delpah D6	GDA	56	305583	6416460	Open Site	AFT : 1	None	Archaeological Risk Assessment Services		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2328	Delpah D7	GDA	56	304469	6416633	Open Site	AFT : 1	None	Archaeological Risk Assessment Services		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2348	Delpah D8	GDA	56	305350	6415942	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		

AHIMS Aboriginal Heritage Information Management System

Department of Environment & Climate Change NSW

List of Sites (List - Short)

Search 2

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 303000, Easting to = 308000, Northing From = 6414000, Northing to = 6417000, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-2349	Delpah D9	GDA	56	305504	6415960	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2350	Delpah D10	GDA	56	305660	6415981	Open Site	AFT : -, PAD : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2351	Delpah D11	GDA	56	305421	6416050	Open Site	AFT : -, PAD : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2352	Delpah D12	GDA	56	305283	6415888	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2353	Delpah D13	GDA	56	305337	6415875	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2354	Delpah D14	GDA	56	305781	6415786	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2355	Delpah D15	GDA	56	306003	6415415	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2356	Delpah D16	GDA	56	304942	6415925	Open Site	AFT : -	None	Hamm		
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Search 2

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 303000, Easting to = 308000, Northing From = 6414000, Northing to = 6417000, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-2357	Delpah D17	GDA	56	304809	6415585	Open Site	AFT : -	None	**Hamm**		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2358	Delpah D18	GDA	56	304847	6415798	Open Site	AFT : -	None	**Hamm**		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2359	Delpah D19	GDA	56	304940	6415628	Open Site	AFT : -	None	**Hamm**		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2360	Delpah D20	GDA	56	305054	6415475	Open Site	AFT : -	None	**Hamm**		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2361	Delpah D21	GDA	56	304680	6415390	Open Site	AFT : -	None	**Hamm**		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2362	Delpah D22	GDA	56	304491	6415684	Open Site	AFT : -	None	**Hamm**		
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2738	Liddell EW 2	GDA	56	304665	6415282	Open Site	AFT : 2	None	**Insite Heritage**	101420	
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2739	Liddell EW 3	GDA	56	305315	6415291	Open Site	AFT : 1	None	**Insite Heritage**	101420	
		Status Valid									
		Primary Contact							Permit(s)		

List of Sites (List - Short)

Search 2

Grid Reference Type = AGD (Australian Geodetic Datum), Zone = 56, Easting From = 303000, Easting to = 308000, Northing From = 6414000, Northing to = 6417000, Feature Search Type = AHIMS Features

Site ID	Site Name	Datum	Zone	Easting	Northing	Context	Site Features	Site Types (recorded prior to June 2001	Recording (Primary)	Reports (Catalogue Number)	State Arch. Box No (for office use only)
37-2-2740	Liddell EW 4	GDA	56	305491	6415308	Open Site	AFT : 1	None	Insite Heritage	101420	
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2741	Liddell EW 5	GDA	56	306483	6415297	Open Site	AFT : 2	None	Insite Heritage	101420	
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2742	Liddell EW 6	GDA	56	306707	6415201	Open Site	AFT : 2	None	Insite Heritage	101420	
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2743	Liddell EW 7	GDA	56	307986	6414767	Open Site	AFT : 1	None	Insite Heritage	101420	
		Status Valid									
		Primary Contact							Permit(s)		
37-2-2744	Liddell EW 8	GDA	56	308036	6414684	Open Site	AFT : 2	None	Insite Heritage	101420	
		Status Valid									
		Primary Contact							Permit(s)		

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AECOM

Appendix B

Historic Heritage Database Search Results

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Click on the BACK button of your browser to return to the search.

Statutory Listed Items

Information and items listed in the State Heritage Inventory come from a number of sources. This means that there may be several entries for the same heritage item in the database. For clarity, the search results have been divided into two sections.

- **Section 1**. contains items listed by the **Heritage Council** under the NSW Heritage Act. This includes listing on the State Heritage Register, an Interim Heritage Order or protected under section 136 of the NSW Heritage Act. This information is provided by the Heritage Branch.
- **Section 2**. contains items listed by **Local Councils & Shires and State Government Agencies**. This section may also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

Click on an item name to view the full details.
The search results can be re-sorted by clicking on the **(sort)** option at the top of each column.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Listed Under Heritage Act	
Eatons Hotel & St Vincent De Paul Group	178, 180-188 Bridge Street	Muswellbrook	Muswellbrook	Yes	MT
Edinglassie	Denman Road	Muswellbrook	Muswellbrook	Yes	MR
Loxton House	142-144 Bridge Street	Muswellbrook	Muswellbrook	Yes	MT
Merton	Jerrys Plains Road	Denman	Muswellbrook	Yes	DR
Muswellbrook District Hospital - Brentwood	Doyle Street	Muswellbrook	Muswellbrook	Yes	MT
Muswellbrook Railway Station and yard group	Main Northern railway	Muswellbrook	Muswellbrook	Yes	MT
Rous Lench	Denman Road	Edinglassie	Muswellbrook	Yes	DR
St Alban's Anglican Church	Hunter Terrace	Muswellbrook	Muswellbrook	Yes	MT
Weidmann Cottage	132 Bridge Street	Muswellbrook	Muswellbrook	Yes	MT

There were **9** records in this section matching your search criteria.

Section 2. Items listed by Local Government and State agencies.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Information Source (sort)		
Atherstone	5 Sowerby Street	Muswellbrook	Muswellbrook	GAZ	REP.	MT
Baerami Homestead	Berami Road via Sandy Hollow	Denman	Muswellbrook	GAZ	REP, RNE	DR

Balmoral	Denman Road	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MR
Barber Shop	5 Sydney Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Birralee	Brecht Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Brighton Villa	12 Hunter Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Campbell & Co Store, Former	54	Muswellbrook	Muswellbrook	GAZ	REP	MT
Courthouse & Police Station, Former	Palace Street	Denman	Muswellbrook	GAZ	REP	DT
Denman Conservation Area		Denman	Muswellbrook	GAZ	REP	DT
Eatons Group	164-166,172, 174, 178, 180 and 188 Bridge Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Hennor	Maitland Road	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Hospital, Former	37 Sowerby Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Item	27 Brovic Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Item	15 Hunter Terrace	Muswellbrook	Muswellbrook	GAZ	REP	MT
Keys Family Private Cemetery	Bengalla Road	Bengalla	Muswellbrook	GAZ	REP	MR
Koobahla Villa	Cook Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Martindale	Martindale Road	Denman	Muswellbrook	GAZ	REP	DT
Masonic Hall		Muswellbrook	Muswellbrook	GAZ	REP	MT
Merton Cemetery		Denman	Muswellbrook	GAZ	REP	DT
Muswellbrook (Bell Street) Footbridge	At Bell Street Overbridge South Of Station	Muswellbrook	Muswellbrook	SGOV	SRA	MT
Muswellbrook Ambulance	Market, William Streets	Muswellbrook	Muswellbrook	SGOV	DOH	MT
Muswellbrook Bridge	Kayuga Road	Muswellbrook	Muswellbrook	GAZ	REP	MT
Muswellbrook Conservation Area		Muswellbrook	Muswellbrook	GAZ	REP	M[illegible]
Muswellbrook Railway Station	Market Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Muswellbrook Station And Yard Group		Muswellbrook	Muswellbrook	SGOV	SRA	MT
Negoa Homestead	Kayuga Road	Muswellbrook	Muswellbrook	GAZ	REP	MR
Old Kayuga Cemetery	Kayuga Road	Kayuga	Muswellbrook	GAZ	REP	KR
Olinda		Denman	Muswellbrook	GAZ	REP	DT
Original buildings	Ogilvie,virginia Streets	Denman	Muswellbrook	SGOV	DOH	DT
Overdene	Bengalla Road	Muswellbrook	Muswellbrook	GAZ	REP	MR
Pickering	Mangoola Road	Denman	Muswellbrook	GAZ	REP	DR
Police Residence, Former	Palace Street	Denman	Muswellbrook	GAZ	REP	DT

Police Station	William Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Portable Timber Lockup	Palace Street	Denman	Muswellbrook	GAZ	REP	DT
Post Office		Muswellbrook	Muswellbrook	GAZ	REP	MT
Presbyterian Manse	106 Hill Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Railway Depot	Victoria Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Roman Catholic Church	Palace Street	Denman	Muswellbrook	GAZ	REP	DT
Royal Hotel	Palace Street	Denman	Muswellbrook	GAZ	REP	DT
Royal Hotel, Former	1 Sydney Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
Saltwater Creek Underbridge, Liddell	On The Liddell Power Station Loop	Liddell	Muswellbrook	SGOV	SRA	MR
School of Arts	Main Road	Baerami	Muswellbrook	GAZ	REP	MR
Shop façade	34 Bridge Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
Shop Front		Muswellbrook	Muswellbrook	LGOV	REP	MT
Slab Cottage	Main Road	Kerrabee	Muswellbrook	GAZ	REP	KR
St Alban's Precinct	Brook Street and Hunter Terrace	Muswellbrook	Muswellbrook	GAZ	REP	MT
St Alban's Precinct	Brovic Street	Muswellbrook	Muswellbrook	GAZ	REP	MT
St Alban's Precinct	Hunter Terrace	Muswellbrook	Muswellbrook	GAZ	REP	MT
St Heliers	McCulleys Gap Road	Muswellbrook	Muswellbrook	GAZ	REP	MR
St James Roman Catholic Church including surrounds	Brook Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
St John's Presbyterian Church Precinct	Hill Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
St Mary's School Skelletar	Tindale Street	Muswellbrook	Muswellbrook	GAZ	REP, RNE	MT
St Matthias Anglican Church	Palace Street	Denman	Muswellbrook	GAZ	REP, RNE	DT
Stone Bridge	Grass Tree Road	Muswellbrook	Muswellbrook	GAZ	REP	MR
Two Storey Shop	7-11 Sydney Street	Muswellbrook	Muswellbrook	GAZ	s 130	MT
Uniting Church		Muswellbrook	Muswellbrook	GAZ	REP	MT
Woodlands Stud	Woodlands Road	Denman	Muswellbrook	GAZ	REP	DR

There were **57** records in this section matching your search criteria.

MT = 33
MR = 8
DT = 11
DR = 3
KR 2
57

There was a total of **66** records matching your search criteria.

Key:
LGA = Local Government Area
GAZ= NSW Government Gazette (statutory listings prior to 1997), HGA = Heritage Grant Application, HS = Heritage Study, LGOV = Local Government, SGOV = State Government Agency.

Note: The Heritage Branch seeks to keep the State Heritage Inventory (SHI) up to date, however the latest listings in Local and Regional Environmental Plans (LEPs and REPs) may not yet be included. Always check with the relevant Local Council or Shire for the most recent listings.

Search Results

46 results found.

Baerami Homestead 300 Baerami Creek Rd	Baerami via Sandy Hollow, NSW, Australia	(Registered) Register of the National Estate
Balmoral 310 Denman Rd	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Barber Shop (former) 7 Sydney St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Birralee 33 Brentwood St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Brighton Villa 12 Hunters Tce	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Denman Courthouse (former) Palace St	Denman, NSW, Australia	(Registered) Register of the National Estate
Eatons Hotel 180-188 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Eatons Hotel Group 164-188 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Edinglassie 710 Denman Rd	Muswellbrook, NSW, Australia	(Indicative Place) Register of the National Estate
Goulburn River National Park Kerrabee Rd	Sandy Hollow, NSW, Australia	(Registered) Register of the National Estate
Hennor and Garden 3 Lorne St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
House 178 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
House - St Vincent De Paul Shop 174-176 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
House and Former Shop 164-166 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Hunter River Road Bridge Kayuga Rd	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Indigenous Place	Sandy Hollow,	(Removed from Register or

	NSW, Australia	(IL) Register of the National Estate
Loxton House 142-144 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Manobalai Nature Reserve (1978 boundary) Dry Creek Rd	Wybong, NSW, Australia	(Registered) Register of the National Estate
Masonic Hall 75 Bridge St	Muswellbrook, NSW, Australia	(Indicative Place) Register of the National Estate
Merton Cottage 4883 Jerrys Plains Rd	Denman, NSW, Australia	(Registered) Register of the National Estate
Overdene 79 Bengalla Rd	Bengalla via Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Pickering and Outbuildings 221 Mangoola Rd	Denman, NSW, Australia	(Registered) Register of the National Estate
Police Station William St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Presbyterian Church (original building) Hill St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Presbyterian Manse (former) 106 Hill St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Railway Cottage and Adjacent Fig Tree 27 Brook St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Railway Hotel 10-14 Market St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Railway Station Market St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Royal Hotel (former) 1 Sydney St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Shop (former) 172 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Skellatar Tindale St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Albans Anglican Church & Grounds Brook St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate

St Albans Precinct Brook St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Albans Rectory Brook St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Albans Sunday School 15 HuntersTce	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St James Catholic Church 4 Brook St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Johns Presbyterian Church Hill St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Johns Presbyterian Church Precinct Hill St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Matthias Anglican Church 23-25 Palace St	Denman, NSW, Australia	(Registered) Register of the National Estate
The Blue Mountains	Katoomba, NSW, Australia	(Indicative Place) Register of the National Estate
The Greater Blue Mountains Area Great Western Hwy	Katoomba, NSW, Australia	(Declared property) World Heritage List
The Greater Blue Mountains Area Greater Western Hwy	Katoomba, NSW, Australia	(Listed place) National Heritage List
The Greater Blue Mountains Area - Additional Values Great Western Hwy	Katoomba, NSW, Australia	(Nominated place) National Heritage List
Trinity Uniting Church 110 Bridge St	Muswellbrook, NSW, Australia	(Indicative Place) Register of the National Estate
Weidmann Cottage (former) 132-134 Bridge St	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Wollemi National Park (1980 boundary) The Putty Rd	Singleton, NSW, Australia	(Registered) Register of the National Estate

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Search Results

46 results found.

Baerami Homestead 300 Baerami Creek Rd SHR	Baerami via Sandy Hollow, NSW, Australia	(Registered) Register of the National Estate
Balmoral 310 Denman Rd MR	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Barber Shop (former) 7 Sydney St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Birralee 33 Brentwood St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Brighton Villa 12 Hunters Tce MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Denman Courthouse (former) Palace St DT	Denman, NSW, Australia	(Registered) Register of the National Estate
Eatons Hotel 180-188 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Eatons Hotel Group 164-188 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Edinglassie 710 Denman Rd MR	Muswellbrook, NSW, Australia	(Indicative Place) Register of the National Estate
Goulburn River National Park Kerrabee Rd SHR	Sandy Hollow, NSW, Australia	(Registered) Register of the National Estate
Hennor and Garden 3 Lorne St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
House 178 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
House - St Vincent De Paul Shop 174-176 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
House and Former Shop 164-166 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Hunter River Road Bridge Kayuga Rd MR	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Indigenous Place SHR	Sandy Hollow,	(Removed from Register or

	NSW, Australia	(IL) Register of the National Estate
Loxton House 142-144 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Manobalai Nature Reserve (1978 boundary) Dry Creek Rd W	Wybong, NSW, Australia	(Registered) Register of the National Estate
Masonic Hall 75 Bridge St MT	Muswellbrook, NSW, Australia	(Indicative Place) Register of the National Estate
Merton Cottage 4883 Jerrys Plains Rd DT	Denman, NSW, Australia	(Registered) Register of the National Estate
Overdene 79 Bengalla Rd MR	Bengalla via Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Pickering and Outbuildings 221 Mangoola Rd DR	Denman, NSW, Australia	(Registered) Register of the National Estate
Police Station William St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Presbyterian Church (original building) Hill St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Presbyterian Manse (former) 106 Hill St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Railway Cottage and Adjacent Fig Tree 27 Brook St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Railway Hotel 10-14 Market St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Railway Station Market St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Royal Hotel (former) 1 Sydney St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Shop (former) 172 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Skellatar Tindale St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Albans Anglican Church & Grounds Brook St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate

St Albans Precinct Brook St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Albans Rectory Brook St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Albans Sunday School 15 HuntersTce MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St James Catholic Church 4 Brook St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Johns Presbyterian Church Hill St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Johns Presbyterian Church Precinct Hill St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
St Matthias Anglican Church 23-25 Palace St DT	Denman, NSW, Australia	(Registered) Register of the National Estate
The Blue Mountains ??	Katoomba, NSW, Australia	(Indicative Place) Register of the National Estate
The Greater Blue Mountains Area Great Western Hwy ??	Katoomba, NSW, Australia	(Declared property) World Heritage List
The Greater Blue Mountains Area Greater Western Hwy ??	Katoomba, NSW, Australia	(Listed place) National Heritage List
The Greater Blue Mountains Area - Additional Values Great Western Hwy ??	Katoomba, NSW, Australia	(Nominated place) National Heritage List
Trinity Uniting Church 110 Bridge St MT	Muswellbrook, NSW, Australia	(Indicative Place) Register of the National Estate
Weidmann Cottage (former) 132-134 Bridge St MT	Muswellbrook, NSW, Australia	(Registered) Register of the National Estate
Wollemi National Park (1980 boundary) The Putty Rd SR.	Singleton, NSW, Australia	(Registered) Register of the National Estate

Report Produced: Mon Jul 20 12:09:18 2009

MR = 4
MT = 29
DT = 3
SMR = 3
SR = 1
?? = 4
DR = 1

W = 1
46

Search Results

No results found.

Enter at least one search criterion.

Search Hints

Search | Reset form

Place name

Street name

Town or suburb | State: New South Wales

Country

Advanced search options

List: All Lists

Different lists will provide different status and class options

Local Government Area: Muswellbrook | Place ID number

Legal status: --All-- | Class: --All--

Keyword Search

☑ Description ☑ Statement of Significance ☑ Place history

Latitude/Longitude

N

Latitude 1: 32.20.20 S

Longitude 1: W 150.51.06 E

Longitude 2: 150.57.30 E E

Latitude 2: 32.25.31 S

S

◉ Wholly within region

○ Wholly or partially within region

Longitude coordinates should be entered as ddd.mm.ss

Latitude coordinates should be entered as dd.mm.ss

Map Ref No

1:100,000 eg 2357

1:250,000 eg SF-50-01

Search Hints

- Not all fields need to be filled in. The fewer you fill in the more results you will get.
- If you cannot find a place, check spelling and try alternative names. Reduce the number of words that you include and use fewer fields.
- The Local Government field used on its own will provide a comprehensive list of places in an area.

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Click on the BACK button of your browser to return to the search.

Statutory Listed Items

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- **Section 1**. contains items listed by the **Heritage Council** under the NSW Heritage Act. This includes listing on the State Heritage Register, an Interim Heritage Order or protected under section 136 of the NSW Heritage Act. This information is provided by the Heritage Branch.
- **Section 2**. contains items listed by **Local Councils & Shires and State Government Agencies**. This section may also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

Click on an item name to view the full details.
The search results can be re-sorted by clicking on the **(sort)** option at the top of each column.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Listed Under Heritage Act
Beckers Bridge over Webbers Creek	Main Road 128	West Gresford	Singleton	Yes
Bulga Bridge over Wollombi Brook	Main Road 213	Bulga	Singleton	Yes
Dalwood House and surrounds of Wyndham Estate	Dalwood Road	Branxton	Singleton	Yes
Ewbank & Outbuildings	88 George Street	Singleton	Singleton	Yes
Inn & Outbuildings (former)	Old New England Highway	Chain of Ponds	Singleton	Yes
Middle Falbrook Bridge over Glennies Creek	Rixs Creek-Falbrook Road	Middle Falbrook	Singleton	Yes
Neotsfield	Neotsfield Lane	Whittingham	Singleton	Yes
Post Office (former)	25-27 George Street	Singleton	Singleton	Yes
Singleton District Hospital	25 Dangar Road	Singleton	Singleton	Yes
Singleton Railway Station group	Main Northern railway	Singleton	Singleton	Yes
St Patrick's Roman Catholic Church Cemetery	Queen Street	Singleton	Singleton	Yes
Wambo Homestead		Warkworth	Singleton	Yes

There were **12** records in this section matching your search criteria.

(12)

Section 2. Items listed by Local Government and State agencies.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Information Source (sort)
13th Jyotirlinga	Maison Dieu Road	Gowrie	Singleton	GAZ
2 George Street, Archaeological Site	Hambledon Hill Road	Singleton	Singleton	GAZ
Abbey Green & Outbuildings	Putty Road	Singleton	Singleton	GAZ
All Saints Anglican Church	High Street	Singleton	Singleton	GAZ
All Saints Parish Hall	Goulburn Street	Singleton	Singleton	GAZ
All Saints Rectory	High Street	Singleton	Singleton	GAZ
Anglican Church	Mirannie Road	Reedy Creek	Singleton	GAZ
Anglican Timber Church		Glendon	Singleton	GAZ
Archerfield outbuildings	Archerfield Road	Warkworth	Singleton	GAZ
Ardersier	Maitland Road	Singleton	Singleton	GAZ
Arrowfield	Piribil Street	Jerrys Plains	Singleton	GAZ
Bakery (former)	85 John Street	Singleton	Singleton	GAZ
Baroona & outbuildings		Whittingham	Singleton	GAZ
Bebeah	Waddell's Lane	Singleton	Singleton	GAZ
Belford Public School (former)	Bell Road	Belford	Singleton	GAZ
Ben Glen	4 Elizabeth Street	Singleton	Singleton	GAZ
Bendeich Cottage	Stanhope Road	Stanhope	Singleton	GAZ
Blaxland House	Fordwich Road	Broke	Singleton	GAZ
Boer War Memorial	75 George Street	Singleton	Singleton	GAZ
Bon Accord	7-9 George Street	Singleton	Singleton	GAZ
Bowman Street Trees	Bowman Street	Singleton	Singleton	GAZ
Brick Farm House	Jerry's Plain Road	Mount Thorley	Singleton	GAZ
Brick Shed	Soapsuds Lane	Singleton	Singleton	GAZ
Brougham Place	4 Goulburn Street	Singleton	Singleton	GAZ
Buen Vista	3 View Street	Singleton	Singleton	GAZ
Bundarra	37 Elizabeth Street	Singleton	Singleton	GAZ
Burdekin Medical Centre	90 George Street	Singleton	Singleton	GAZ
Burdekin Park	George Street	Singleton	Singleton	GAZ
Caledonian Hotel	38-40 George Street	Singleton	Singleton	GAZ
Catron	Dunolly Road	Singleton	Singleton	GAZ
Chain of Ponds Hotel (former)	Old Singleton Road	Liddell	Singleton	GAZ

Gould Brothers Timber Mill	1 Kelso Street	Singleton	Singleton	GAZ
Greater Newcastle Building Society	94 John Street	Singleton	Singleton	GAZ
Greenwood & outbuildings	Greenwood Lane	Singleton	Singleton	GAZ
Greylands & outbuildings	Goorangoola Road	Goorangoola	Singleton	GAZ
Hotel Ruins		Warkworth	Singleton	GAZ
House	26 Elizabeth Street	Singleton	Singleton	GAZ
House	26, 27, 37 Dangar Road	Singleton	Singleton	GAZ
House	5, 36 William Street	Singleton	Singleton	GAZ
House	12 View Street	Singleton	Singleton	GAZ
House Group	17-19 Campbell Street	Singleton	Singleton	GAZ
Hunter River, Singleton Underbridge	Main North 1.2Km Past Station	Singleton	Singleton	SGOV
Jack Daniels Tavern	142 John Street	Singleton	Singleton	GAZ
Jerry's Plais Roman Catholic Church	Pagan Street	Jerrys Plains	Singleton	GAZ
Johnsons Cottage	Stanhope Road	Stanhope	Singleton	GAZ
Kath's Cottage	228 John Street	Singleton	Singleton	GAZ
Kirkton Winery & Vineyard site	Standen Drive	Belford	Singleton	GAZ
Lairmont Hotel (former)	Maitland Road	Singleton	Singleton	GAZ
Leconfield	Dalwood Road	Branxton	Singleton	GAZ
Lonsdale	10-12 Dangar Road	Singleton	Singleton	GAZ
Lych Gate, All Saints Anglican Church	High Street	Singleton	Singleton	GAZ
Manresa	Singleton-Gresford	Glendon Brook	Singleton	GAZ
Maria Immaculate Roman Catholic Church		Broke	Singleton	GAZ
Masonic Hall	219 John Street	Singleton	Singleton	GAZ
Merah	259 John Street	Singleton	Singleton	GAZ
Methodist Sunday School Hall	2 Elizabeth Street	Singleton	Singleton	GAZ
Milbrodale Estate	Putty Road	Milbrodale	Singleton	GAZ
Minimbah House and Outbuildings		Whittingham	Singleton	GAZ
Mount Leonard	Putty Road	Bulga	Singleton	GAZ
Mount Leonards Public School now Scout Hall	Putty Road	Bulga	Singleton	GAZ
Museum, Sisters of Mercy Convent	Queen Street	Singleton	Singleton	GAZ

31

18

Charlton	Cobcroft Road	Bulga	Singleton	GAZ
Church of the Good Shepherd	Bell Road	Belford	Singleton	GAZ
Clifford & Staford Homesteads ruins only	Long Point Road	Warkworth	Singleton	GAZ
Club House Hotel Group	148 John Street	Singleton	Singleton	GAZ
Commercial Premises	58 George Street	Singleton	Singleton	GAZ
Commercial Premises & Residence	49 George Street	Singleton	Singleton	GAZ
Commercial Premises & Residence	42-44 George Street	Singleton	Singleton	GAZ
Community Arts & Crafts Learning Centre	74 George Street	Singleton	Singleton	GAZ
Community Hall CI		Camberwell	Singleton	GAZ
Corinda House Farm	Corinda Street	Belford	Singleton	GAZ
Cottage	16 View Street	Singleton	Singleton	GAZ
Courthouse & Associated Buildings	39 Elizabeth Street	Singleton	Singleton	GAZ
Crail House	Howe Street	Singleton	Singleton	GAZ
Cranston House	28 Dangar Road	Singleton	Singleton	GAZ
Cyril Moxhams House	1910 Hambledon Hill Road	Wylies Flat	Singleton	GAZ
Dangar Mausoleum	High Street	Singleton	Singleton	GAZ
Dulwich	Middle Falbrook Road	Nundah	Singleton	GAZ
Dunolly Ford Bridge	New England Highway	Singleton	Singleton	GAZ
Elderslie Bridge over Hunter River	Branxton Road (MR 220)	Elderslie	Singleton	GAZ
Fairholme	16 Broughton Street	Singleton	Singleton	GAZ
Federation Bungalow	14 View Street	Singleton	Singleton	GAZ
Flowerbank	8 Flowerbank Close	Singleton	Singleton	GAZ
Frome	Frome Close	Singleton	Singleton	GAZ
Gas Works	Gas Street	Singleton	Singleton	GAZ
Gates & Gate Lodge (former)	New England Highway	Whittingham	Singleton	GAZ
General Cemetery		Broke	Singleton	GAZ
Geraldine & Medical Centre	68 High Street	Singleton	Singleton	GAZ
Glen Nevis	Westbrook Road	Westbrook	Singleton	GAZ
Glenayr	1 Kent Street	Singleton	Singleton	GAZ
Glendon & outbuildings		Glendon	Singleton	GAZ
Glenridding Presbyterian Church & Cemetery	Putty Road	Singleton	Singleton	GAZ

31 19

New Freugh Ruin	Bell Road	Belford	Singleton	GAZ
Office & Residence	25-27 George Street	Singleton	Singleton	GAZ
Old Anglican Cemetery	Piribil Street	Jerrys Plains	Singleton	GAZ
Pelerin	30 Edinburgh Avenue	Singleton	Singleton	GAZ
Pelham Residence	30 Bishpgate Street	Singleton	Singleton	GAZ
Percy Hotel	65-67 George Street	Singleton	Singleton	GAZ
Pines Cafe	26 George Street	Singleton	Singleton	GAZ
Pizza Hut & Offices	57 George Street	Singleton	Singleton	GAZ
Police Station	Doyle Street	Jerrys Plains	Singleton	GAZ
Police Station	22 Hunter Street	Singleton	Singleton	GAZ
Police Station (former)	79 York Street	Singleton	Singleton	GAZ
Post Office & Store	Pagan Street	Jerrys Plains	Singleton	GAZ
Presbyterian Church Property Trust	Elizabeth Street	Singleton	Singleton	GAZ
Public School	New England Highway	Ravensworth	Singleton	GAZ
Public School	Doyle Street	Jerrys Plains	Singleton	GAZ
Public School Group	31 Elizabeth Street	Singleton	Singleton	GAZ
Pumping Station (former)	Waterworks Lane	Singleton	Singleton	GAZ
Queen Street Cemetery	Queen Street	Singleton	Singleton	GAZ
Queen Victoria Inn Ruins (former)	Jerry's Plains Road	Warkworth	Singleton	GAZ
Ravensworth Homestead	(not given)	Ravensworth	Singleton	GAZ
Redbournberry Bridge	Redbournberry Road	Redbournberry	Singleton	GAZ
Residence	17 Bathurst Street	Singleton	Singleton	GAZ
Residence	4, 8 Cambridge Street	Singleton	Singleton	GAZ
Residence	55 Pitt Street	Singleton	Singleton	GAZ
Residence	65 High Street	Singleton	Singleton	GAZ
Residence	66 York Street	Singleton	Singleton	GAZ
Residence	96 George Street	Singleton	Singleton	GAZ
Residence	8, 24-26 Hunter Street	Singleton	Singleton	GAZ
Residence	257 John Street	Singleton	Singleton	GAZ
Residences	3-5 Macquarie Street	Singleton	Singleton	GAZ
Residential Cottage	11 Campbell Street	Singleton	Singleton	GAZ
Richards Family Cemetery		Dawsons Hill	Singleton	GAZ
Rixs Creek Coke Ovens & Associated Works	New England Highway	Rixs Creek	Singleton	GAZ
Roman Catholic Presbytery	6 Patrick Street	Singleton	Singleton	GAZ

34 23

Roselands Uniting Church	Goorangoola Road	Goorangoola	Singleton	GAZ
Royal Hotel	86 George Street	Singleton	Singleton	GAZ
Shop	76-78 George Street	Singleton	Singleton	GAZ
Showground group	Church Street	Singleton	Singleton	GAZ
Singleton District Hospital	HOWE STreet	Singleton	Singleton	SGOV
Singleton Fire Station	Pitt Street	Singleton	Singleton	SGOV
Singleton High School	York Street	Singleton	Singleton	GAZ
Singleton Historical Society Museum	George Street	Singleton	Singleton	GAZ
Singleton Inn	John Street	Singleton	Singleton	GAZ
Singleton Mowers Commercial Shop	32 George Street	Singleton	Singleton	GAZ
Singleton Presbyterian Church Hall	7 Elizabeth Street	Singleton	Singleton	GAZ
Singleton Railway Station	Munro Street	Singleton	Singleton	GAZ
Singleton Station Group		Singleton	Singleton	SGOV
Sisters of Mercy Convent Building and Chapel School	Queen Street	Singleton	Singleton	GAZ
Spottiswood	Mirannie Road	Westbrook	Singleton	GAZ
St Andrews Uniting Church	Church Street	Singleton	Singleton	GAZ
St Clement's Anglican Church		Camberwell	Singleton	GAZ
St Elmo	Castlereagh Street	Singleton	Singleton	GAZ
St James Anglican Church	Pagan Street	Jerrys Plains	Singleton	GAZ
St Patrick's Roman Catholic Church	Queen Street	Singleton	Singleton	GAZ
St Philip's Church		Warkworth	Singleton	GAZ
St Vincent De Paul Society Shop	13-15 Campbell Street	Singleton	Singleton	GAZ
Strowan	Piribil Street	Jerrys Plains	Singleton	GAZ
Tennis Club	Edinburgh Avenue	Singleton	Singleton	GAZ
Terraces	37-39 Macquarie Street	Singleton	Singleton	GAZ
The Singleton Arcade	71-75 John Street	Singleton	Singleton	GAZ
The Woolpack Inn	Maitland Road / New England Highway	Singleton	Singleton	GAZ
Timber House	89 Castlereagh Street	Singleton	Singleton	GAZ
Townhead Estate	5 Townhead Crescent	Singleton	Singleton	GAZ
Uniting Church of Australia	Church Street	Singleton	Singleton	GAZ
Wade Cottage	25-27 Bishopgate Street	Singleton	Singleton	GAZ

War Memorial		Broke	Singleton	GAZ
War Memorial	75 George Street	Singleton	Singleton	GAZ
War Memorial Gates	Inlet Road	Bulga	Singleton	GAZ
Warromean	Glendon Road	Scotts Flat	Singleton	GAZ
Water Tower	12 View Street	Singleton	Singleton	GAZ
Westpac Bank & Shop	110-112 John Street	Singleton	Singleton	GAZ
White Heather	11 Macquarie Street	Singleton	Singleton	GAZ
Wittingham Anglican Cemetery	Haggerteys Lane	Singleton	Singleton	GAZ
Woodboune	20 Elizabeth Street	Singleton	Singleton	GAZ

There were **166** records in this section matching your search criteria.

There was a total of **178** records matching your search criteria.

Key:
LGA = Local Government Area
GAZ= NSW Government Gazette (statutory listings prior to 1997), HGA = Heritage Grant Application, HS = Heritage Study, LGOV = Local Government, SGOV = State Government Agency.

Note: The Heritage Branch seeks to keep the State Heritage Inventory (SHI) up to date, however the latest listings in Local and Regional Environmental Plans (LEPs and REPs) may not yet be included. Always check with the relevant Local Council or Shire for the most recent listings.

9

AUSTRALIAN HERITAGE PLACES INVENTORY

[New Search]

1.	**Dwelling ('Singleton')** 23 North Terrace HACKNEY, SA	**LGA:** Norwood, Payneham and St Peters **Source:** SA Local Heritage Registe
2.	**Post Office (former)** 25-27 George Street, Singleton, NSW	**LGA:** Singleton **Source:** NSW Heritage Register
3.	**Singleton Conservation Area** Singleton, NSW	**LGA:** Singleton Shire **Source:** Register of the National Estate
4.	**Singleton Courthouse** 39 Elizabeth St, Singleton, NSW	**LGA:** Singleton Shire **Source:** Register of the National Estate
5.	**Singleton District Hospital** 25 Dangar Road, Singleton, NSW	**LGA:** Singleton **Source:** NSW Heritage Register
6.	**SINGLETON MEDICAL CENTRE** 162 WELLINGTON STREET COLLINGWOOD, VIC	**LGA:** Yarra City **Source:** Victorian Heritage Registe
7.	**Singleton Medical Welfare Centre** 162 Wellington St, Collingwood, VIC	**LGA:** Yarra City **Source:** Register of the National Estate
8.	**Singleton Post Office and Stables (former)** 25A-27 George St, Singleton, NSW	**LGA:** Singleton Shire **Source:** Register of the National Estate
9.	**Singleton Railway Station group** Main Northern railway, Singleton, NSW	**LGA:** Singleton **Source:** NSW Heritage Register

Query matched 9 records.

Report produced : 28/8/2009
AHPI URL : http://www.environment.gov.au/heritage/ahpi/index.html

Appendix C

Aboriginal Sites within the Study Area

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Table T1: Fields Used in Following List of Aboriginal Sites within the Study Area

Field	Definition
Site Name	Site name numbered sequentially and prefixed with MGA (Macquarie Generation – Aboriginal [site])
Site Type	Identifies the type of Aboriginal site (e.g. artefact scatter, isolated find, etc.).
Point	The location of the MGA co-ordinates within the Aboriginal site.
MGA Easting and Northing	Grid references for site location and/or individual artefact locations, taken from DGPS. Grid coordinates are taken using MGA datum (GDA 94).
Location	A description (in physical terms) of where the site is within the study area.
Landform/s	Specific type of topographical feature(s), following definitions of morphological elements in McDonald et al (1984: 13-19).
Aspect	The general direction the site is facing if sloping. “N/A” denotes that the site is on level ground.
Slope	Slope is defined by the following three criteria: 1 – Level/very gentle 2 – Gentle 3 – Moderate/Steep As defined in McDonald et.al. 1998
Description	Description of the site
Exposure Area	Area of bare ground
Site Area	Area over which artefacts are distributed
Visibility	The percentage of ground surface visible within an exposure allowing for minor intrusions of vegetation cover. This affects the “detectability” of archaeological material.
Erosion State	1 – Low state of erosion 2 – Moderate state of erosion 3 – High state of erosion
Exposure Form	1 – Sheet erosion 2 – Rill erosion 3 – Gully erosion 4 – Stream bank erosion 5 – Aggrading 6 – Modified 7 – Densely vegetated 8 – Ant nest 9 – Animal track
Number of Artefacts	The number refers to the total number of artefacts recorded within a site. Count may also be an estimate where high numbers were encountered.

Field	Definition
Artefact Density	Calculated by dividing the number of artefacts by the area of exposure
Dominant Raw Material	The most common raw material/s identified for stone artefacts (e.g. indurated mudstone, silcrete, etc).
Other Raw Materials	Other raw materials occurring at the site in lower numbers than the dominant raw material/s.
Area	Exposure Area for Artefact Density calculation

Aboriginal Sites within the Study Area

Site Name	**37-2-500**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303655
MGA Northing	6413809
Location	east of Saltwater Creek
Landform	hillslope
Stream Order	3
Aspect	SW
Slope	2
Description	10 artefacts on a heavilly eroded scald
Exposure Area	10 x 10 m
Site Area	100 m
Visibility	1
Erosion State	3
Erosion Form	1
No of Artefacts	10
Artefact Density	0.10
Area	100

Aboriginal Sites within the Study Area

Site Name	**37-2-815 (P19)**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	305313
MGA Northing	6413121
Location	On the western edge of a large gullied creek.
Landform	Creek bank
Stream Order	2
Aspect	E
Slope	1
Description	This site consists of three stone artefacts located along the edge of a creek. The creek gully is deflated on its sides and the bank tops heavily grassed. Recorded in field notes as MGA38
Exposure Area	10 x 1 m
Site Area	10 x 1 m = $10m^2$
Visibility	0.2
Erosion State	1
Erosion Form	4
No of Artefacts	3
Artefact Density	0.30
Area	10

Aboriginal Sites within the Study Area

Site Name	**37-2-818 (P22)**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	305141
MGA Northing	6412986
Location	On the eastern side of a small hill.
Landform	Mid slope
Stream Order	2
Aspect	E
Slope	2
Description	This site consists of 30 artefacts located on a large erosion scour on the side of a small hill. Recorded in field notes as MGA39
Exposure Area	90 x 10 m
Site Area	70 x 5 m = 350m ^{2}
Visibility	0.6
Erosion State	1
Erosion Form	1
No of Artefacts	30
Artefact Density	0.03
Area	900

Aboriginal Sites within the Study Area

Site Name	**37-2-820 (P24)**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	304761
MGA Northing	6412794
Location	Scattered over a small 'island' between two creek lines.
Landform	Creek flats
Stream Order	3
Aspect	N/A
Slope	1
Description	This site consists of over 100 artefacts of mudstone and silcrete. Artefact types include flakes, backed artefacts, grindstone, elouera and knapping floors. Recorded in field notes as MGA40
Exposure Area	N/A
Site Area	110 x 40 m = 4400m ²
Visibility	0.6
Erosion State	1
Erosion Form	4
No of Artefacts	
Artefact Density	
Area	

Aboriginal Sites within the Study Area

Site Name	**MGA1**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303273
MGA Northing	6413232
Location	On western side of large tributary of Saltwater Creek, north of the confluence.
Landform	Creek flat, gully side
Stream Order	2
Aspect	N/A
Slope	1
Description	This site consists of six stone artefacts scattered over 50 m of the upper rim of the creek gully on a series of cattle tracks, 3 m from the gully edge. Artefacts consist of two mudstone proximal flakes (12x17x4 and 22x27x11mm), three mudstone flaked pieces (16x14x4, 17x14x3 and 9x5x2 mm) and one silcrete flaked core (28x14x11 mm).
Exposure Area	40 x 8 m = 400 m2
Site Area	50 x 5 m = 250 m2
Visibility	0.6
Erosion State	1
Erosion Form	9
No of Artefacts	6
Artefact Density	0.02
Area	400

Aboriginal Sites within the Study Area

Site Name	**MGA10**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	302505
MGA Northing	6412632
Location	On the eastern side of western tributary creek, approximately 25 m west of MGA9
Landform	Creek bank, creek flats, minor creek terrace
Stream Order	3
Aspect	S
Slope	1
Description	This site consists of 200+ stone artefacts, in several discrete clusters, eroding from the creek bank. The density of artefacts diminishes sharply in the western-most 100 m. Artefacts consist of flakes, broken flakes, flaked pieces, retouched flakes and cores, and are predominantly mudstone, with silcrete and quartz also present.
Exposure Area	340 x 10 m = 3,400 m2
Site Area	296 x 5 m = 1,480 m2
Visibility	0.8
Erosion State	3
Erosion Form	1, 4, 9
No of Artefacts	
Artefact Density	0.06
Area	3400

Aboriginal Sites within the Study Area

Site Name	**MGA11**
Site Type	Isolated Find
Point	Object
MGA Easting	302267
MGA Northing	6412799
Location	On eastern side of western tributary creek, approximately 181 m west of MGA10
Landform	Creek bank, creek flat
Stream Order	3
Aspect	SW
Slope	1
Description	This site consists of a single mudstone flaked piece, measuring 21 x 16 x 9 mm.
Exposure Area	10 x 3 m = 30 m2
Site Area	1 m2
Visibility	0.7
Erosion State	3
Erosion Form	1,4
No of Artefacts	1
Artefact Density	0.03
Area	30

Aboriginal Sites within the Study Area

Site Name	**MGA12**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	302358
MGA Northing	6412725
Location	On eastern side of western tributary creek, approximately 75 m west of MGA10
Landform	Creek bank, creek terrace, 1st order drainage
Stream Order	3
Aspect	SW
Slope	1
Description	This site consists of three stone artefacts including a medial flake, a proximal flake and a flaked piece, all of indurated mudstone.
Exposure Area	5 x 3 m = 15 m2
Site Area	1 m2
Visibility	0.8
Erosion State	2
Erosion Form	1, 4
No of Artefacts	3
Artefact Density	0.20
Area	15

Aboriginal Sites within the Study Area

Site Name	**MGA13**
Site Type	Isolated Find
Point	Object
MGA Easting	302139
MGA Northing	6412915
Location	On western tributary creek on the northern end of a dam wall that is damming the creek.
Landform	Modified terrain - dam wall
Stream Order	3
Aspect	N/A
Slope	
Description	This site consists of a single white silcrete flake measuring 32 x 39 x 10 mm. The flake has a bulb; 2 ridges and a platform.
Exposure Area	20 x 8 m = 160 m2
Site Area	1 m2
Visibility	1
Erosion State	1
Erosion Form	6
No of Artefacts	1
Artefact Density	0.01
Area	160

Aboriginal Sites within the Study Area

Site Name	**MGA14**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	301858
MGA Northing	6413422
Location	On the western side of western tributary creek, on a spur crest in the confluence of a 1st order drainage line
Landform	Spur crest, creek bank
Stream Order	3
Aspect	E
Slope	2
Description	This site consists of two indurated mudstone artefacts, a flake and a flaked piece, located about 5 m apart.
Exposure Area	30 x 10 m = 300 m2
Site Area	5 x 1 m = 5 m2
Visibility	0.8
Erosion State	2
Erosion Form	1, 4
No of Artefacts	2
Artefact Density	0.01
Area	300

Aboriginal Sites within the Study Area

Site Name	**MGA15**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	301871
MGA Northing	6413466
Location	On the western side of western tributary creek, on an eroding bank
Landform	Lower slope
Stream Order	2
Aspect	W
Slope	2
Description	This site consists of three mudstone flaked pieces; two are located together whist the third is located 5 m to the north.
Exposure Area	5 x 3 m = 15 m2
Site Area	5 x 1 m = 5 m2
Visibility	0.7
Erosion State	2
Erosion Form	1, 4, 9
No of Artefacts	3
Artefact Density	0.20
Area	15

Aboriginal Sites within the Study Area

Site Name	**MGA16**
Site Type	Isolated Find
Point	Object
MGA Easting	301843
MGA Northing	6413483
Location	On the western side of western tributary creek, on an eroding bank, approx. 63 m north of MGA14
Landform	Lower slope
Stream Order	2
Aspect	E
Slope	2
Description	This site consists of a single silcrete core, single platform.
Exposure Area	20 x 20 m = 400 m2
Site Area	1 m2
Visibility	0.7
Erosion State	2
Erosion Form	1
No of Artefacts	1
Artefact Density	0.00
Area	400

Aboriginal Sites within the Study Area

Site Name	**MGA17**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	301864
MGA Northing	6413577
Location	On the western side of western tributary creek, on both the creek bank and on the adjacent lower slope, approx. 97 m north of MGA16.
Landform	Lower slope, creek bank
Stream Order	2
Aspect	E
Slope	2
Description	The site consists of three mudstone flakes and one silcrete flake, all within a 10 m radius. The site is located on the southern side of a confluence with a first-order drainage line. The exposure is littered with a high density of gravel.
Exposure Area	20 x 20 m = 400 m2
Site Area	8 x 4 m = 32 m2
Visibility	0.8
Erosion State	2
Erosion Form	1, 4
No of Artefacts	4
Artefact Density	0.01
Area	400

Aboriginal Sites within the Study Area

Site Name	**MGA18**
Site Type	Isolated Find
Point	Object
MGA Easting	301888
MGA Northing	6413612
Location	On the eastern side of western tributary creek, on an eroding creek bank
Landform	Creek bank
Stream Order	1
Aspect	ESE
Slope	2
Description	The site consists of a single quartz flake, measuring 25 x 12 x 4 mm.
Exposure Area	15 x 3 m = 45 m2
Site Area	1 m2
Visibility	0.7
Erosion State	2
Erosion Form	1, 4, 9
No of Artefacts	1
Artefact Density	0.02
Area	45

Aboriginal Sites within the Study Area

Site Name	**MGA19**
Site Type	Isolated Find
Point	Object
MGA Easting	303206
MGA Northing	6413407
Location	On the creek flats on the western side of Saltwater Creek.
Landform	Creek flat
Stream Order	2
Aspect	N/A
Slope	1
Description	The site consists of a single silcrete distal flake, measuring 19 x 12 x 3 mm. The site is located on a cattle track beside the creek gully.
Exposure Area	100 x 0.2 m = 20 m2
Site Area	1 m2
Visibility	0.6
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.05
Area	20

Aboriginal Sites within the Study Area

Site Name	**MGA2**
Site Type	Isolated Find
Point	Object
MGA Easting	303357
MGA Northing	6413051
Location	On western side of Saltwater Creek, 200 m south of MGA1.
Landform	Creek flat, gully side
Stream Order	3
Aspect	N/A
Slope	1
Description	This site consists of a single silcrete flake measuring 36x26x8 mm. The flake has a bulb; 2 ridges and a platform.
Exposure Area	50 x 10 m = 500 m2
Site Area	1 m2
Visibility	0.2
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.00
Area	500

Aboriginal Sites within the Study Area

Site Name	**MGA20**
Site Type	Isolated Find
Point	Object
MGA Easting	303180
MGA Northing	6413309
Location	On the main vehicle track on the creek flats on the western side of a tributary of Saltwater Creek
Landform	Creek flat
Stream Order	2
Aspect	E
Slope	1
Description	The site consists of a single mudstone flake, measuring 19 x 14 x 4 mm. The site is 20 m west of the creek gully.
Exposure Area	100 x 2 m = 200 m2 (approx.)
Site Area	1 m2
Visibility	0.7
Erosion State	1
Erosion Form	6
No of Artefacts	1
Artefact Density	0.01
Area	200

Aboriginal Sites within the Study Area

Site Name	**MGA21**
Site Type	Isolated Find
Point	Object
MGA Easting	303240
MGA Northing	6413337
Location	On the eastern side of a tributary of Saltwater Creek, approx 80 m south of MGA19, and 90 m north of the confluence with Saltwater Creek.
Landform	Creek flat
Stream Order	2
Aspect	N/A
Slope	1
Description	This site consists of a single mudstone flaked piece, measuring 34 x 32 x 15 mm.
Exposure Area	20 x 5 m = 100 m2
Site Area	1 m2
Visibility	0.2
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.01
Area	100

Aboriginal Sites within the Study Area

Site Name	**MGA22**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303328
MGA Northing	6413420
Location	On the western side of Saltwater Creek, approx 145 m north of the confluence (MG-PAD1)
Landform	Creek flat, creek gully
Stream Order	3
Aspect	N/A
Slope	2
Description	This site consists of a mudstone flake core (unidirectional), measuring 55 x 57 x 21 mm, and a mudstone flaked piece, measuring 24 x 16 x 6 mm. The artefacts are 20 m apart
Exposure Area	30 x 1.5 = 45 m2
Site Area	20 x 1 m - 20 m2
Visibility	0.3
Erosion State	1
Erosion Form	9
No of Artefacts	2
Artefact Density	0.04
Area	45

Aboriginal Sites within the Study Area

Site Name	**MGA23**
Site Type	Isolated Find
Point	Object
MGA Easting	303378
MGA Northing	6413613
Location	On the western side of Saltwater Creek, approx 210 m north of MGA22.
Landform	Gully edge
Stream Order	3
Aspect	E
Slope	1
Description	This site consists of a single mudstone medial flake on the edge of a gully overlooking an area of sandstone bedrock in the gully floor. The site lies on an exposure formed by cattle.
Exposure Area	5 x 5 m = 25 m2
Site Area	1 m2
Visibility	0.2
Erosion State	2
Erosion Form	9
No of Artefacts	1
Artefact Density	0.04
Area	25

Aboriginal Sites within the Study Area

Site Name	**MGA24**
Site Type	Isolated Find
Point	Object
MGA Easting	303372
MGA Northing	6413685
Location	On the western side of Saltwater Creek, approx 72 m north of MGA23
Landform	Creek bank
Stream Order	3
Aspect	E
Slope	3
Description	This site consists of a single mudstone flaked piece on an old vehicle track leading down from the main access track to the creek bed. The artefact is just below the lip of the gully edge, in an area overlooking sandstone bedrock in the creek bed.
Exposure Area	40 x 2 m = 80 m2
Site Area	1 m2
Visibility	0.1
Erosion State	3
Erosion Form	6, 9
No of Artefacts	1
Artefact Density	0.01
Area	80

Aboriginal Sites within the Study Area

Site Name	**MGA25**
Site Type	Isolated Find
Point	Object
MGA Easting	303324
MGA Northing	6413767
Location	On the western side of a small first-order tributary to the west of Saltwater Creek
Landform	Creek flat
Stream Order	1
Aspect	N/A
Slope	1
Description	This site consists of a single mudstone flaked piece, measuring 35 x 21 x 11 mm.
Exposure Area	4 x 2 = 8 m2
Site Area	1 m2
Visibility	0.3
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.13
Area	8

Aboriginal Sites within the Study Area

Site Name	**MGA26**
Site Type	Isolated Find
Point	Object
MGA Easting	303463
MGA Northing	6413904
Location	On the western side of Saltwater Creek, approx 195 m NE of MGA25
Landform	Gentle lower slope
Stream Order	3
Aspect	ESE
Slope	2
Description	This site consists of a single mudstone flake, measuring 35 x 25 x 14 mm. It is located on a large eroded cattle track, with side-slump, leading down to the creek bed above a culvert. The creek formation is different in this area, with no creek flats (except in valley floor) with slopes leading directly to adjacent hills.
Exposure Area	40 x 4 = 160 m2
Site Area	1 m2
Visibility	0.8
Erosion State	2
Erosion Form	9
No of Artefacts	1
Artefact Density	0.01
Area	160

Aboriginal Sites within the Study Area

Site Name	**MGA27**
Site Type	Isolated Find
Point	Object
MGA Easting	303568
MGA Northing	6414179
Location	On the western side of Saltwater Creek, approx 300 m north of MGA26
Landform	Gentle lower slope
Stream Order	3
Aspect	E
Slope	1
Description	This site consists of a single mudstone flake, measuring 48 x 28 x 20 mm. It is located in a small cattle pad formed at the base of two grey box trees. The artefacts are about a metre apart.
Exposure Area	2 x 2 m = 4 m2
Site Area	1 m2
Visibility	0.8
Erosion State	1
Erosion Form	9
No of Artefacts	2
Artefact Density	0.50
Area	4

Aboriginal Sites within the Study Area

Site Name	**MGA28**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303527
MGA Northing	6414263
Location	On the main access track, west of Saltwater Creek, approx 230 m WSW of the stockyards.
Landform	Very gentle mid slope
Stream Order	3
Aspect	E
Slope	2
Description	This site consists of nine artefacts spread over a distance of 52 m along the track. The site consists of 2 x mudstone flakes, 1 x silcrete distal flake, 1 x silcrete medial flake, 3 x mudstone flaked pieces, 1 x silcrete flaked piece and 1 x mudstone core. The site consists of two clusters at either end with two artefacts approximately mid-way between. This site is located approximately 100 m west of the Saltwater Creek gully.
Exposure Area	52 x 2 m = 104 m2
Site Area	52 x 2 m = 104 m2
Visibility	0.2
Erosion State	1
Erosion Form	6
No of Artefacts	9
Artefact Density	0.09
Area	104

Aboriginal Sites within the Study Area

Site Name	**MGA29**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	302672
MGA Northing	6412895
Location	On a large scour erosion patch in the centre of the southern "meadow", approx 320 m due north of the end of the contour bank within MGA9
Landform	Gentle mid slope
Stream Order	
Aspect	S
Slope	2
Description	This site consists of three stone artefacts including 2 x mudstone flakes and a mudstone flaked piece. The site is within a large sheetwash scour, which has eroded to the B horizon.
Exposure Area	30 x 8 m = 240 m2
Site Area	8 x 8 m - 64 m2
Visibility	0.9
Erosion State	3
Erosion Form	1
No of Artefacts	3
Artefact Density	0.01
Area	240

Aboriginal Sites within the Study Area

Site Name	**MGA3**
Site Type	Artefact Scatter
Point	Object
MGA Easting	303417
MGA Northing	6412766
Location	On western side of Saltwater Creek, 290 m south of MGA2.
Landform	Creek flat, gully side
Stream Order	3
Aspect	N/A
Slope	1
Description	This site consists of 11 stone artefacts, consisting of proximal flakes, flakes, flaked pieces and cores. Raw material is predominantly indurated mudstone, but with single occurrences of quartzite and silcrete. The site occurs on a large area of cattle track and natural exposure on the edge of the creek gully.
Exposure Area	50 x 6 m = 300 m2
Site Area	40 x 3 m = 120 m2
Visibility	0.1
Erosion State	1
Erosion Form	9
No of Artefacts	11
Artefact Density	0.09
Area	120

Aboriginal Sites within the Study Area

Site Name	**MGA30**
Site Type	Isolated Find
Point	Object
MGA Easting	303796
MGA Northing	6413236
Location	On erosion scour on crest
Landform	Spur Crest
Stream Order	1
Aspect	S
Slope	1
Description	This site consists of a single silcrete flake found on a large exposure on top of a medium sized hill
Exposure Area	163 x 53 m
Site Area	1 m^2
Visibility	0.5
Erosion State	1
Erosion Form	1
No of Artefacts	1
Artefact Density	0.02
Area	53

Aboriginal Sites within the Study Area

Site Name	**MGA31**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303441
MGA Northing	6413517
Location	High east side of Saltwater Creek
Landform	Creek bank
Stream Order	3
Aspect	N/A
Slope	1
Description	'The site consists of 1 artefact located on an a cattle track exposure on the eastern side of Saltwater Creek. The site is approximately 5 m of the creek.
Exposure Area	35 x 2 m
Site Area	35 x 2 m = 70m²
Visibility	0.3
Erosion State	1
Erosion Form	9
No of Artefacts	6
Artefact Density	0.09
Area	70

Aboriginal Sites within the Study Area

Site Name	**MGA32**
Site Type	Isolated Find
Point	Object
MGA Easting	303419
MGA Northing	6413201
Location	High east side of Saltwater Creek
Landform	Creek bank
Stream Order	3
Aspect	N/A
Slope	1
Description	The site consists of 1 artefact located on an a cattle track exposure on the eastern side of Saltwater Creek. The site is approximately 5 m of the creek.
Exposure Area	35 x 2 m
Site Area	1 m²
Visibility	0.3
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.01
Area	70

Aboriginal Sites within the Study Area

Site Name	**MGA33**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303450
MGA Northing	6412861
Location	High east side of Saltwater Creek
Landform	Creek bank
Stream Order	3
Aspect	N/A
Slope	1
Description	The site consists of 20 artefacts located on an a cattle track exposure on the eastern side of Saltwater Creek. The site is approximately 5 m of the creek.
Exposure Area	36 x 2 m
Site Area	36 x 2 m = 72m²
Visibility	0.3
Erosion State	1
Erosion Form	9
No of Artefacts	20
Artefact Density	0.28
Area	72

Aboriginal Sites within the Study Area

Site Name	**MGA34**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303450
MGA Northing	6412918
Location	On the western edge of a drainage trench east of Saltwater Creek
Landform	Drainage bank
Stream Order	1
Aspect	E
Slope	1
Description	This site consists of 52 stone artefacts including one grindstone. The site runs along the edge of a drainage depression subject to significant erosion.
Exposure Area	50 x 5
Site Area	50 x 5 m = 100m ^{2}
Visibility	0.8
Erosion State	2
Erosion Form	4
No of Artefacts	52
Artefact Density	0.21
Area	250

Aboriginal Sites within the Study Area

Site Name	**MGA35**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303654
MGA Northing	6412918
Location	On the western edge of a drainage trench east of Saltwater Creek
Landform	Drainage bank
Stream Order	1
Aspect	E
Slope	1
Description	This site consists of 2 stone artefacts consisting of mudstone flakes. The site runs along the edge of a drainage depression subject to significant erosion.
Exposure Area	10 x 10 m
Site Area	1 m^2
Visibility	0.8
Erosion State	2
Erosion Form	4
No of Artefacts	2
Artefact Density	0.02
Area	100

Aboriginal Sites within the Study Area

Site Name	**MGA36**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303656
MGA Northing	6413000
Location	On the western edge of a drainage trench east of Saltwater Creek.
Landform	Drainage bank
Stream Order	1
Aspect	E
Slope	1
Description	This site consists of 10 stone artefacts of mudstone, chert and quartzite. The site runs along the edge of a drainage depression subject to significant erosion.
Exposure Area	40 x 10 m
Site Area	30 x 5 m = 150m ^{2}
Visibility	0.8
Erosion State	2
Erosion Form	4
No of Artefacts	10
Artefact Density	0.03
Area	400

Aboriginal Sites within the Study Area

Site Name	**MGA37**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303694
MGA Northing	6412985
Location	On the eastern edge of a drainage trench east of Saltwater Creek
Landform	Drainage bank
Stream Order	1
Aspect	E
Slope	1
Description	This site consists of 12 stone artefacts of silcrete, mudstone and quartzite. The site runs along the edge of a drainage depression subject to significant erosion.
Exposure Area	56 x 13 m
Site Area	20 x 5 m = 100m ^{2}
Visibility	0.8
Erosion State	2
Erosion Form	4
No of Artefacts	12
Artefact Density	0.02
Area	728

AECOM

Aboriginal Sites within the Study Area

Site Name	**MGA4**
Site Type	Isolated Find
Point	Object
MGA Easting	303445
MGA Northing	6412660
Location	On western side of Saltwater Creek, 170 m south of MGA3.
Landform	Creek flat, gully side
Stream Order	3
Aspect	N/A
Slope	1
Description	This site consists of a single mudstone flake, measuring 35 x 17 x 8 mm. The site is located just north of another confluence, with an old ruined farmland bridge..
Exposure Area	5 x 3 m = 15 m2
Site Area	1 m2
Visibility	0.3
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.07
Area	15

Aboriginal Sites within the Study Area

Site Name	**MGA41**
Site Type	Isolated Find
Point	Object
MGA Easting	304649
MGA Northing	6412669
Location	On the NE side of a small hill.
Landform	Mid slope
Stream Order	3
Aspect	N
Slope	2
Description	The site consists of one indurated mudstone broken flake.
Exposure Area	25 x 10 m
Site Area	1m²
Visibility	0.7
Erosion State	1
Erosion Form	1
No of Artefacts	1
Artefact Density	0.00
Area	250

Aboriginal Sites within the Study Area

Site Name	**MGA42**
Site Type	Isolated Find
Point	Object
MGA Easting	304540
MGA Northing	6412563
Location	On the side of a 1st order creek.
Landform	Creek bank
Stream Order	1
Aspect	N
Slope	1
Description	This site consists of one silcrete core located on the side of a 1st order creek.
Exposure Area	25 x 10 m
Site Area	1m²
Visibility	0.6
Erosion State	1
Erosion Form	4
No of Artefacts	1
Artefact Density	0.00
Area	250

Aboriginal Sites within the Study Area

Site Name	**MGA43**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	304043
MGA Northing	6412556
Location	On the eastern aspect of a small hill.
Landform	Mid slope
Stream Order	1
Aspect	E
Slope	2
Description	This site consists of 4 mudstone and silcrete artefacts.
Exposure Area	30 x 25 m
Site Area	10 x 2 m = 20m²
Visibility	0.8
Erosion State	1
Erosion Form	1
No of Artefacts	4
Artefact Density	0.01
Area	750

Aboriginal Sites within the Study Area

Site Name	**MGA44**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	305753
MGA Northing	6414973
Location	On the side of a small dam wall
Landform	Lower slope
Stream Order	1
Aspect	E
Slope	1
Description	This site consists of 3 artefacts consisting of silcrete, quartz and mudstone. The site sits adjacent to a small dam which itself is located about 50 metres from a larger dam.
Exposure Area	40 x 8 m
Site Area	40 x 8 m = 320m ^{2}
Visibility	0.4
Erosion State	1
Erosion Form	1
No of Artefacts	3
Artefact Density	0.01
Area	320

Aboriginal Sites within the Study Area

Site Name	**MGA45**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303834
MGA Northing	6413699
Location	On a large exposure at the headwaters of a 1st order drainage depression
Landform	Drainage bank
Stream Order	1
Aspect	S
Slope	1
Description	This site consists of 15 artefacts of primarily mudstone, and silcrete on a large exposure. The exposure lies on the western side of a first order drainage depression.
Exposure Area	80 x 20 m
Site Area	65 x 10 m = 650m ²
Visibility	0.6
Erosion State	1
Erosion Form	4
No of Artefacts	15
Artefact Density	0.09
Area	160

Aboriginal Sites within the Study Area

Site Name	**MGA46**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303426
MGA Northing	6413773
Location	On the eastern bank of Saltwater Creek
Landform	Creek bank
Stream Order	3
Aspect	N/A
Slope	1
Description	This site consists of 2 stone artefacts located on the eastern side of Saltwater Creek, The artefacts consists of mudstone flakes exposed on a cattle track next to the creek.
Exposure Area	5 x 1 m
Site Area	1m²
Visibility	0.5
Erosion State	1
Erosion Form	9
No of Artefacts	2
Artefact Density	0.40
Area	5

Aboriginal Sites within the Study Area

Site Name	**MGA5**
Site Type	Isolated Find
Point	Object
MGA Easting	303584
MGA Northing	6412575
Location	On western side of Saltwater Creek, 91 m south of MGA4.
Landform	Creek flat, gully side
Stream Order	4
Aspect	N/A
Slope	1
Description	This site consists of a single silcrete proximal flake, measuring 16 x 20 x 5 mm. It is located on the gully rim, above a creek confluence, next to a rabbit warren that appears to have been ripped in the past.
Exposure Area	10 x 5 m = 50 m2
Site Area	1 m2
Visibility	0.6
Erosion State	1
Erosion Form	9
No of Artefacts	1
Artefact Density	0.02
Area	50

Aboriginal Sites within the Study Area

Site Name	**MGA6**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	303396
MGA Northing	6412413
Location	On western side of Saltwater Creek, ? m south of MGA4.
Landform	Creek flat, gully side
Stream Order	4
Aspect	N/A
Slope	1
Description	This site consists of a scatter of 33 stone artefacts including flakes, flaked pieces broken flakes (inc. medial and proximal flakes), retouched flakes (including a scraper) and cores. Raw material is predominantly mudstone, with much lesser quantities of silcrete, quartz and fine-grained siliceous material. The site is located on a gully edge along a cattle track and consists of two larger clusters at either end with individual artefacts in between.
Exposure Area	100 x 5 m = 500 m2
Site Area	81 x 4 m =324 m2
Visibility	0.8
Erosion State	1
Erosion Form	9
No of Artefacts	33
Artefact Density	0.07
Area	500

Aboriginal Sites within the Study Area

Site Name	**MGA7**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	302856
MGA Northing	6412107
Location	On eastern side of western tributary creek, on the section that heads south towards Plashett Dam.
Landform	Creek bank
Stream Order	3
Aspect	S
Slope	1
Description	This site consists of three stone artefacts including an indurated mudstone flaked piece, a silcrete medial flake and a silcrete flaked piece. Very few other lithics are associated with this site. The two silcrete flakes are located together while the mudstone artefact is 5 m away.
Exposure Area	20 x 5 m = 100 m2
Site Area	5 x 1 m = 5 m2
Visibility	0.95
Erosion State	2
Erosion Form	4, 9
No of Artefacts	3
Artefact Density	0.03
Area	100

Aboriginal Sites within the Study Area

Site Name	**MGA8**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	302752
MGA Northing	6412402
Location	On eastern side of western tributary creek, starting on the confluence with a 1st order stream and extending north west as far as a former dam
Landform	Creek bank, creek flats
Stream Order	3
Aspect	S
Slope	1
Description	
Exposure Area	
Site Area	
Visibility	
Erosion State	
Erosion Form	
No of Artefacts	
Artefact Density	
Area	

Aboriginal Sites within the Study Area

Site Name	**MGA9**
Site Type	Artefact Scatter
Point	Centroid
MGA Easting	302590
MGA Northing	6412532
Location	On the eastern side of western tributary creek, approximately 52 m west of MGA8
Landform	Modified terrain - dam wall, contour bank on creek
Stream Order	3
Aspect	S
Slope	1
Description	This site consists of 74 stone artefacts on a (breached) dam wall (eastern side), a contour bank and extending northwards along a cattle track. Artefacts include flakes, broken flakes, retouched flakes (scrapers), flaked pieces and cores. Raw material is mudstone, silcrete and quartz.
Exposure Area	20 x 4; 90 x 5; 43 x 0.2 = 540 m2
Site Area	110 x 4 m; 43 x 0.2 = 449 m2
Visibility	1
Erosion State	1
Erosion Form	6
No of Artefacts	74
Artefact Density	0.14
Area	540

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Appendix D

Survey Results Transects

Table T 2: Survey results transects

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T1	N Extent S Extent	303076 302987	6413101 6411796	4th order stream bank, Creek flats	Commences near the main access track near the eastern side of the southern hill feature. Traverses the western banks of a large tributary, then continues down the western bank of Saltwater Creek to the southern extent of the study area before meeting Plashett Dam. Both the tributary and Saltwater Creek itself consists of wide (10-50 m wide), deep (approx. 20 m) gullies with permanent water, although forming only pools in places. There is a very sharp delineation between the gully sides and the adjacent creek flats, which are expansive on both sides of the creek. The flats are cleared of most trees, and covered in tall, thick pasture. Taller stratum (grey box) are restricted to the gully sides. Ground visibility throughout the transect is 0%, except in minor exposures formed from cattle tracks/pads and stream bank erosion. Exposures are limited to the gully sides, particularly where cattle have formed tracks down to the stream bed and on cattle pads along the rim of the gully on the creek flats. Several Aboriginal sites (MGA1 to MGA6) were identified along the creek flats and are considered to be surface expressions of a continuous archaeological deposit, although the extent of the deposit away from the creek bank is not known.	1280	2	2.56	7.81%	0.2000	50	0.1000	3.91

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T2	N Extent S Extent	302130 302721	6412664 6411758	2nd order stream bank, minor creek terrace, creek flats	Commences at the southern extent of the study area above Plashett Dam and continues along the eastern bank of western tributary creek and terminates at the north-south fenceline that traverses the western side of the hills. The creek in this location consists of a shallow (1-2 m deep) channel, approximately 10 m wide skirting around some low hills to the south west. Vegetation is almost wholly thick, low pasture (visibility <10%) with occasional eucalypt trees. Exposures consist of extensive stream bank flood-scours along almost the entire length of this section of the creek, to a width of up to 20 m. Six Aboriginal sites (MGA7 to MGA12) were identified in this transect, three of which were extensive. The extent of the surface archaeological material in this area suggests that there is a continuous archaeological deposit from the western extent of the transect to the point where the creek turns sharply south. It is considered to extend up to 150 m away from the creek edge as demonstrated by the extent of site MGA9. Surface materials diminish rapidly outside of these areas.	1780	2	3.56	21.07%	0.7500	85	0.6375	17.91

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T3	N Extent S Extent	302159 302080	6413578 6412686	2nd order stream bank, minor creek terrace, gentle slopes	Commences on western side of fence, near the end of T2 and continues northwards along both sides of western tributary creek, to near its headwaters, then climbs the slopes to the east and terminates near the saddle north of the southern hill. Vegetation consists of low, thick pasture throughout the eastern side of the creek, but has *Allocasuarina* low open woodland on the lower slopes to the south and west. Exposures on the eastern side are limited to small 10 m^2 stream bank erosion. Exposures are much larger on the western side (within the woodland) and near the headwaters where large areas of ironstone occur. The slopes to the east are littered with sandstone cobbles. A total of six Aboriginal sites were identified in this transect. Surface indications of archaeological material suggest that there is archaeological deposit associate with the creek, but in far lower densities than exhibited further downstream. Archaeological potential on the slopes to the east is considered to be low to moderate.	1300	2	2.6	46.15%	1.2000	80	0.9600	36.92

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T4	W Extent E Extent	302265 303111	6413672 6413138	Gentle simple slopes, very gentle drainage depression (1st order), creek flats	Commences at the head of the first-order drainage depression, north of the southern hill and continues along the depression eastwards. Near the main access track, the depression opens up into a deep gully (up to 15 m deep) where it finishes near the start of T1 near Saltwater Creek. Vegetation is almost completely open pasture with thick cover (0% visibility), except in the gully at the eastern end where taller vegetation (eucalypts) occur in the gully sides. Exposures are limited to a narrow cattle track along the length of the drainage depression and 2-3 small cattle pads. Surface lithics in this area were negligible. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	1450	2	2.9	24.14%	0.7000	90	0.6300	21.72
T5	E Extent W Extent	303011 302110	6413138 6412919	Creek flat, gentle lower slopes	Commences at the termination of T4 near Saltwater Creek and traverses the basal slopes on the south side of the southern hill to meet the north-south fenceline on the western side of the hill, then continues southwards along the fence to meet the end of T2. Vegetation in this area is wholly open pasture with visibility <5%. Exposures are limited to isolated occurrences of cattle track or ant nests, and the main access track. Archaeological potential is considered to be low, except at the eastern and western extremities within 100 m of the creeks.	1480	2	2.96	0.34%	0.0100	80	0.0080	0.27

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T6	W Extent E Extent			Creek flat, gentle lower slopes	Vehicle transect. Commences along the north-south fenceline, approximately 50 m south of the end of T5 and follows parallel to T5 until it meets Saltwater Creek. Vegetation and visibility as for T5. Low archaeological potential.	1150	2	2.3	0.59%	0.0135	50	0.0068	0.29
T7	E Extent W Extent			Creek flat, gentle lower slopes	Vehicle transect. Commences at Saltwater Creek, approximately 50 m south of the end of T6 and follows parallel to T6 until it meets the north-south fenceline. Vegetation and visibility as for T5 and T6. Low archaeological potential.	1200	2	2.4	3.85%	0.0925	30	0.0278	1.16
T8	W Extent E Extent			Creek flat, gentle lower slopes	Vehicle transect. Commences along the north-south fenceline, approximately 50 m south of the end of T7 and follows parallel to T7 until it meets Saltwater Creek. Vegetation and visibility as for T7, except with the addition of a large (72 m^2) scour erosion on the north side of a small hillock. Low archaeological potential.	1175	2	2.35	0.99%	0.0232	30	0.0070	0.30

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T9	Start/Finish	303203	6413662	Creek flat, gentle lower slopes	Pedestrian transect. Commences on the main access track, and continues down the east bank of a large tributary of Saltwater Creek to the confluence, then north along the west bank of Saltwater Creek, along the south bank of another tributary, thence south along the main track back to the start point. Vegetation consists of cleared pasture with upper stratum occurring only on the gully sides. Visibility is 0%, except in minor exposures formed by cattle tracks. Five Aboriginal sites and a PAD were located in this transect. The banks of Saltwater Creek in this area are considered to contain a continuum of archaeological deposit.	1500	2	3	5.00%	0.1500	70	0.1050	3.50
T10	Start/Finish	303276	6413885	Creek flat, gentle lower slopes	Pedestrian transect. Commences on the main access track, and continues down the north bank of a tributary of Saltwater Creek to the confluence, then north along the west bank of Saltwater Creek, along the south bank of another tributary just south of the stockyards, thence south along the main track to the start point. Vegetation and visibility as for T9. Three Aboriginal sites were identified on this transect, the largest occurring on the access track, on a slope approx 100 m west of the Saltwater Creek gully.	1600	2	3.2	4.06%	0.1300	60	0.0780	2.44

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T11	Start/Finish	303490	6414390	Creek flat, gentle slopes, spur crest	Pedestrian transect. Commences on the main access track and takes in a large loop incorporating the headwaters of Saltwater Creek as far north as the Mt Arthur Coal conveyor. The majority of the transect is through thick pasture to 0.5 m high with 0% visibility except in exposures formed by cattle tracks/pads, stream bank erosion and sheetwash erosion on some hill slopes. No Aboriginal sites were identified in this transect and archaeological potential is considered to be low to moderate.	3350	2	6.7	17.91%	1.2000	50	0.6000	8.96
T12	E Extent W Extent			Creek flats, very gentle lower slope, hillock	Vehicle transect. Commences at Saltwater Creek, approximately 50 m south of the end of T8 and follows parallel to T8 until it meets the north-south fenceline. Vegetation and visibility as for previous vehicle transects, except for a much larger eroded scour approximately mid-way. One Aboriginal site was located on this transect (MGA29), but potential for archaeological deposit is considered to be low.	1200	2	2.4	1.04%	0.0250	90	0.0225	0.94
T13	W Extent E Extent			Creek flats, very gentle lower slope	Vehicle transect. Commences at the edge of western tributary creek, and follows parallel to, and approximately 50 m south of, T12 until it meets Saltwater Creek. Vegetation and visibility as for previous vehicle transects. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	1200	2	2.4	0.09%	0.0145	20	0.0029	0.02

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T14	E Extent W Extent			Creek flats, very gentle lower slope	Vehicle transect. Commences at Saltwater Creek, approximately 50 m south of the end of T13 and follows parallel to T13 until it meets western tributary creek. Vegetation and visibility as for previous vehicle transects, except for a much larger eroded scour approximately mid-way. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	1050	2	2.1	1.00%	0.0210	20	0.0042	0.20
T15	W Extent E Extent			Creek flats, very gentle lower slope	Vehicle transect. Commences at the edge of western tributary creek, and follows parallel to, and approximately 50 m south of, T14 until it meets Saltwater Creek. Vegetation and visibility as for previous vehicle transects. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	1070	2	2.14	0.012	0.0810	10	0.0081	0.38
T16	E Extent W Extent			Creek flats, very gentle lower slope, 1st order drainage depression	Vehicle transect. Commences at Saltwater Creek, approximately 50 m south of the end of T15 and follows parallel to T15 until it meets western tributary creek. Vegetation and visibility as for previous vehicle transects, except for the headwaters of a first-order drainage depression with large areas of erosion. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	750	2	1.5	28.20%	0.4230	10	0.0423	2.82

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T17	W Extent E Extent			Creek flats, very gentle lower slope, 1st order drainage depression	Vehicle transect. Commences at the edge of western tributary creek, and follows parallel to, and approximately 50 m south of, T16 until it meets Saltwater Creek. Vegetation and visibility as for previous vehicle transects, except for the first-order drainage depression with large areas of erosion, principally formed by an old dam that has been breached. A second first-order drainage depression is located near, and roughly parallel to, Saltwater Creek. The transect also takes in a loop to the south between Saltwater Creek and the second tributary. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	780	2	1.56	1.28%	0.0200	90	0.0180	1.15
T18	E Extent W Extent			Creek flats, 1st order drainage depression	Vehicle transect. Commences at the tributary of Saltwater Creek, and follows parallel to, and approximately 50 m south of, T17 until it meets western tributary creek. Vegetation and visibility as for previous vehicle transects, except for the headwaters of a first-order drainage depression with large areas of erosion. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	380	2	0.76	1.32%	0.0100	10	0.0010	0.13

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T19	W Extent E Extent			Creek flats, 1st order drainage depression	Vehicle transect. Commences at the edge of western tributary creek, and follows parallel to, and approximately 50 m south of, T18 until it meets the tributary of Saltwater Creek. Vegetation and visibility as for previous vehicle transects. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	270	2	0.54	1.85%	0.0100	10	0.0010	0.19
T20	E Extent W Extent			Creek flats, 1st order drainage depression	Vehicle transect. Commences at the tributary of Saltwater Creek, and follows parallel to, and approximately 50 m south of, T19 until it meets western tributary creek. Vegetation and visibility as for previous vehicle transects, except for the headwaters of a first-order drainage depression with large areas of erosion. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	250	2	0.5	2.00%	0.0100	10	0.0010	0.20
T21	W Extent E Extent			Creek flats, 1st order drainage depression	Vehicle transect. Commences at the edge of western tributary creek, and follows parallel to, and approximately 50 m south of, T20 until it meets the tributary of Saltwater Creek. Vegetation and visibility as for previous vehicle transects. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	250	2	0.5	2.72%	0.0136	10	0.0014	0.27

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T22	S Extent N Extent	302901 6411982	303948 6415268	Dirt Road	Vehicle and pedestrian transect. Commences at southern extent of vehicle track to the northern conveyor, approximately 4.5km in distance. Visibility along road is good. Vegetation is limited to short grasses. No Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	4500	2	9.0	80%	7.2	70	5.04	.56
T23	S Extent N Extent	303385 6413358	303481 6413889	Creek flats Gentle slope	Pedestrian transect. Commences in northern section of Saltwater Creek and extents south along its edge. Visibility is good along the bank where cattle have created exposure. Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low to moderate.	1200	2	2.4	50%	1.2	60	.72	.30
T24	S Extent N Extent	303718 6412733	303894 6413838	Drainage depression Gentle slope	Pedestrian transect. Commences at the southern extent where the tributary meets Saltwater Creek. Visibility is good along eroded banks and erosion scars adjacent to water course. The tributary rises between two low hills. Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low to moderate.	1200	2	2.4	70%	1.68	50	.84	.35
T25	E Extent W Extent	305194 6413223	303766 6412680	Creek bank, upper slope, mid slope, lower slope, crest	Pedestrian transect. Commences at the dirt road east of the main study area and travels west to meet Saltwater Creek. Visibility varies from good at exposures to poor where waist high grasses limit ground visibility. Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low in places to moderate at others.	2000	2	4	5%	.2	20	.04	.01

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T26	E Extent W Extent	306040 6413708	305330 6413321	Drainage depression, gentle slope, crest	Pedestrian transect. Commences at the dirt road east of the main study area and travels east to meet the current power station. Visibility varies from good at exposures to poor where waist high grasses limit ground visibility. This transect has been subject to considerable landscape disturbance from activities related to the power station. Aboriginal sites were not located on this transect, and the potential for archaeological deposit is considered to be low.	750	2	1.5	5%	.075	20	.015	.01
T27	S Extent N Extent	305021 6414501	305672 6415075	Upper, mid, lower slope, spur, crest	Pedestrian transect. Commences at the dirt road east of the main study area and travels east to meet the northern extent of Freshwater Dam. Visibility varies from good at exposures to poor where waist high grasses limit ground visibility. Aboriginal sites were located on this transect, and the potential for archaeological deposit is considered to be low.	880	2	1.76	7%	.1232	20	.02464	.014
T28	S Extent N Extent	305040 6414443	303899 6413741	Upper, mid, lower slope, spur, crest, drainage depression	Pedestrian transect. Commences at the dirt road east of the main study area and travels west to meet T24. Visibility varies from good at exposures to poor where waist high grasses limit ground visibility. Aboriginal sites were not located on this transect, and the potential for archaeological deposit is considered to be low.	1300	2	2.6	5%	.13	10	.013	.05

Transect No.	Point	MGA Easting	MGA Northing	Landform/s	Description of Transect	Length (m)	No. of Persons	Transect Area (km²)	Exposure (%)	Exposure Area (m)	Visibility (%)	Detection Area (m)	Effective Coverage (%)
T29	E Extent W extent	303155 6413486	302477 6413531	Upper, mid, lower slope, spur, crest,	Vehicle transect. Commences at Saltwater Creek and travels west to the crest of a medium size hill in the middle of the study area. Visibility is poor due to knee high grasses. Aboriginal sites were not located on this transect, and the potential for archaeological deposit is considered to be low.	700	2	1.4	3	.042	5	.0021	.15

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Appendix E

Aboriginal Stakeholder Consultation Log

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Aboriginal Consultation Log

Project: S7008808 Bayswater B Power Station

Stage 1 - Advisory Requests Sent 13-Jul-09

	Contact	Date Sent	Comment
Local Newsapaper Ad		13-Jul-09	Ad placed in the Hunter Valley News
DECC		13-Jul-09	Letter sent to enquiring of Aboriginal Stakeholders
LALC		13-Jul-09	Letter sent to enquiring of Aboriginal Stakeholders
Registrar Aboriginal Owners		13-Jul-09	Letter sent to enquiring of Aboriginal Stakeholders
Native Title Services		13-Jul-09	Letter sent to enquiring of Aboriginal Stakeholders
Native Title Tribunal		13-Jul-09	Letter sent to enquiring of Aboriginal Stakeholders
Local Council		13-Jul-09	Letter sent to enquiring of Aboriginal Stakeholders

Aboriginal Group Notifications Sent 16 July 09 - see "addresses" sheet

Aboriginal Group Registrations & Communications

Organisation	Contact person(s)	Date	Comments
Wanaruah LALC	Noel Downs/Suzie Worth	15-Jul-09	Registered Interest in the project.
Aboriginal Native Title Consultants	John & Margaret Mathews	16-Jul-09	Registered Interest in the project.
Hunter Valley Culture Consultants	Christine Archibold	16-Jul-09	Registered Interest in the project. No phone number provided.
Upper Hunter Heritage Consultants	Darrel Mathews	16-Jul-09	Registered Interest in the project.
Yinarr Cultural Services	Kathleen Steward - Kinchela	16-Jul-09	Registered Interest in the project.
Wanaruah Local Aboriginal Land Council	Noel Downs	17-Jul-09	fax sent with briefing notes about project
Wanaruah Custodians Aboriginal Corporation	Reginald Eveleigh	20-Jul-09	Registered Interest in the project. No phone number provided.
Ungaroo Aboriginal Corporation	Tasha Layer	20-Jul-09	Registered Interest in the project.
Giwiir	Rodney Mathews	03-Aug-09	Registered Interest in the project.
Culturally Aware	Tracey Skene	03-Aug-09	Registered Interest in the project.
Wattaka Wonnarua	Des Hickey	04-Aug-09	Registered Interest in the project.
Ungaroo Cultural & Community Service	Rhonda Ward	06-Aug-09	Registered Interest in the project. Phone number has engaged sound.
Wanaruah Local Aboriginal Land Council	Suzie Worth	07-Aug-09	telephone conversation NB & SW re 17 July 09 fax and background to project and potential to have meeting with WLALC board. NB mentioned sending pdf map of results to SW Monday 10 Aug
Wanaruah Local Aboriginal Land Council	Suzie Worth	11-Aug-09	Sent email to WLALC via Suzie Worth with map of Aboriginal sites and PAD attached seeking feedback on Aboriginal heritage values for area

Aboriginal Consultation Log

Project: S7008808 Bayswater B Power Station

Stage 2 - Briefing & Methodology Advice Sent 27 July 09

Organisation	Contact person	Date Sent	Comments
Wanarrua LALC	Noel Downs	27-Jul-09	Sent Methodology.
Aboriginal Native Title Consultants	John & Margaret Mathews	27-Jul-09	Sent Methodology.
Hunter Valley Cultural Consultants	Christine Archibold	27-Jul-09	Sent Methodology.
Upper Hunter Heritage Consultants	Darrel Mathews	27-Jul-09	Sent Methodology.
Yinarr Cultural Services	Kathleen Steward - Kinchela	27-Jul-09	Sent Methodology.
Wanaruah Custodians Aboriginal Corporation	Reginald Eveleigh	27-Jul-09	Sent Methodology.
Ungaroo Aboriginal Corporation	Tasha Layer	27-Jul-09	Sent Methodology.

Letter Seeking Registration of Interest and Methodology (sent to groups identified through agencies)

Organisation	Contact person	Date	Comments
Hunter Valley Aboriginal Consultants	Julie Griffiths	27-Jul-09	Letter sent requesting registration of interest + Methodology
Giwirr Consultants	Rodney Mathews	27-Jul-09	Letter sent requesting registration of interest + Methodology
Lower Wonnarua Tribal Consultancy Pty Ltd	Barry Anderson	27-Jul-09	Letter sent requesting registration of interest + Methodology
Upper Hunter Wonnarua Council Inc	Victor Perry	27-Jul-09	Letter sent requesting registration of interest + Methodology. (Letter Returned to Sender).
Valley Culture	Larry Van Vliet	27-Jul-09	Letter sent requesting registration of interest + Methodology
Wanaruah Custodians	Barbara Foot	27-Jul-09	Letter sent requesting registration of interest + Methodology
Wattaka Wonnarua CC Service	Des Hickey	27-Jul-09	Letter sent requesting registration of interest + Methodology
Wonnarua Nation Aboriginal Corporation	Glen Walker	27-Jul-09	Letter sent requesting registration of interest + Methodology
Wonn1 Contracting	Arthur Fletcher	27-Jul-09	Letter sent requesting registration of interest + Methodology
Wonnarua Elders Council	Rhoda Perry	27-Jul-09	Letter sent requesting registration of interest + Methodology
Yarrawalk	Barry Mctaggart	27-Jul-09	Letter sent requesting registration of interest + Methodology
Wonnarua Culture Heritage	Joe Hampton	27-Jul-09	Letter sent requesting registration of interest + Methodology
Muswellbrook Cultural Consultants	Brian Horton	27-Jul-09	Letter sent requesting registration of interest + Methodology
Mingga Consultants	Clifford Mathews	27-Jul-09	Letter sent requesting registration of interest + Methodology
Hunter Valley Cultural Surveying	Luke Hickey	27-Jul-09	Letter sent requesting registration of interest + Methodology. (Letter Returned to Sender).
Culturally Aware	Tracey Skene	27-Jul-09	Letter sent requesting registration of interest + Methodology
Ungaroo Cultural & Community Services Inc	Rhonda Ward	27-Jul-09	Letter sent requesting registration of interest + Methodology

Aboriginal Consultation Log

Project: S7008808 Bayswater B Power Station

Letter Sent Requesting Site Meeting to discuss project, visit study area and discuss heritage values			
Wanaruah LALC	Noel Downs/Suzie Worth	02-Sep-09	Fax sent confirming site meeting on the 9th September.
Aboriginal Native Title Consultants	John & Margaret Mathews	02-Sep-09	Fax sent confirming site meeting on the 9th September. (sent to WLALC as instructed)
Hunter Valley Culture Consultants	Christine Archibold	02-Sep-09	Fax sent confirming site meeting on the 9th September. (sent to WLALC as instructed)
Upper Hunter Heritage Consultants	Darrel Mathews	02-Sep-09	Letter sent express post as could not contact via phone
Yinarr Cultural Services	Kathleen Steward - Kinchela	02-Sep-09	Fax sent confirming site meeting on the 9th September.
Wanaruah Custodians Aboriginal Corporation	Reginald Eveleigh	02-Sep-09	Letter sent express post as could not contact via phone
Ungaroo Aboriginal Corporation	Tasha Layer	02-Sep-09	Fax sent confirming site meeting on the 9th September.
Giwiir	Rodney Mathews	02-Sep-09	Fax sent confirming site meeting on the 9th September.
Culturally Aware	Tracey Skene	02-Sep-09	Letter sent express post as could not contact via phone
Wattaka Wonnarua	Des Hickey	02-Sep-09	Email sent confirming site meeting on the 9th September
Ungaroo Cultural & Community Service	Rhonda Ward	02-Sep-09	Letter sent express post as could not contact via phone

Aboriginal Group Comments Received (Methodology)			
Organisation	Contact person	Date Rec'd	Comments
Yinarr	Kathleen Steward Kinchela	03-Aug-09	Supports Methodology
Cultually Aware	Tracey Skene	03-Aug-09	Supports Methodology
Giwirr	Rodney Mathews	03-Aug-09	Supports Methodology
Ungaroo Cultural & Community Service	Rhonda Ward	06-Aug-09	Supports Methodology
Stage 3 - Draft Reports for Review - Sent			
Organisation	Contact person	Date Sent	Feedback Received & Date

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Appendix F

Newspaper Advertisement

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Oakes, Geordie

From: classifieds.hvn@ruralpress.com
Sent: Tuesday, 14 July 2009 10:17 AM
To: Oakes, Geordie
Subject: Aboriginal Stakeholder ConsultationBayswater B Power Station ENSR Australia Pty Ltd trading as AECOM is seeking registrations of interest for Aboriginal Stakeholders wishing to be consulted in relation to a proposed Aboriginal Cultural Heritage Impac
Attachments: 1940396.jpg; booking_details.htm

ADVERTISING PROOF

Ref no: 361940396 Printed: 10:16:54 14/07/2009
Attention: GEORDIE OAKES
Attention: ENSR AUSTRALIA

BOOKING DETAILS

Name:	ENSR AUSTRALIA
Address:	PO BOX 73
City:	HUNTER REGION MC
State:	NSW
Postcode:	2310
Authorised by:	GEORDIE OAKES
PO Number:	GEORDIE OAKES
Cost:	$197.12
Size:	7 x 2
Class / section:	Notices (628)

APPEARANCE DETAILS

15/07/2009	Hunter Valley News	197.12 inc GST

AUTHORISATION

I have checked all details contained in the advertisement (including phone numbers
and spelling) and authorise you to proceed as per the booking details above.

Name: Geordie Oakes

Signature: [signature]

Date: 14/7/09

Comments

Please proof read and OK thanks Gail

Once authorised, please fax back to 0265434782
or reply with 'authorised' in the subject field to classifieds.hvn@ruralpress.com

Should you have any further enquiries please do not hesitate to contact me.

Aboriginal Stakeholder Consultation

Bayswater B Power Station. ENSR Australia Pty Ltd (trading as AECOM) is seeking registrations of interest for Aboriginal Stakeholders wishing to be consulted in relation to a proposed Aboriginal Cultural Heritage Impact Assessment associated with the development of a new base load power station near Muswellbrook, NSW. Interested stakeholders are requested to register their interest in writing to:

Geordie Oakes AECOM
PO Box 726,
PYMBLE NSW 2073
T: 02 8484 8999 F: 02 8484 8989
E: geordie.oakes@aecom.com

Expressions of interest should include current contact details. The closing date for registration is the 29th July, 2009.

- *Registration does not guarantee employment during fieldwork.*

Appendix G

Consultation Feedback from Stakeholder Groups

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Worldwide Locations

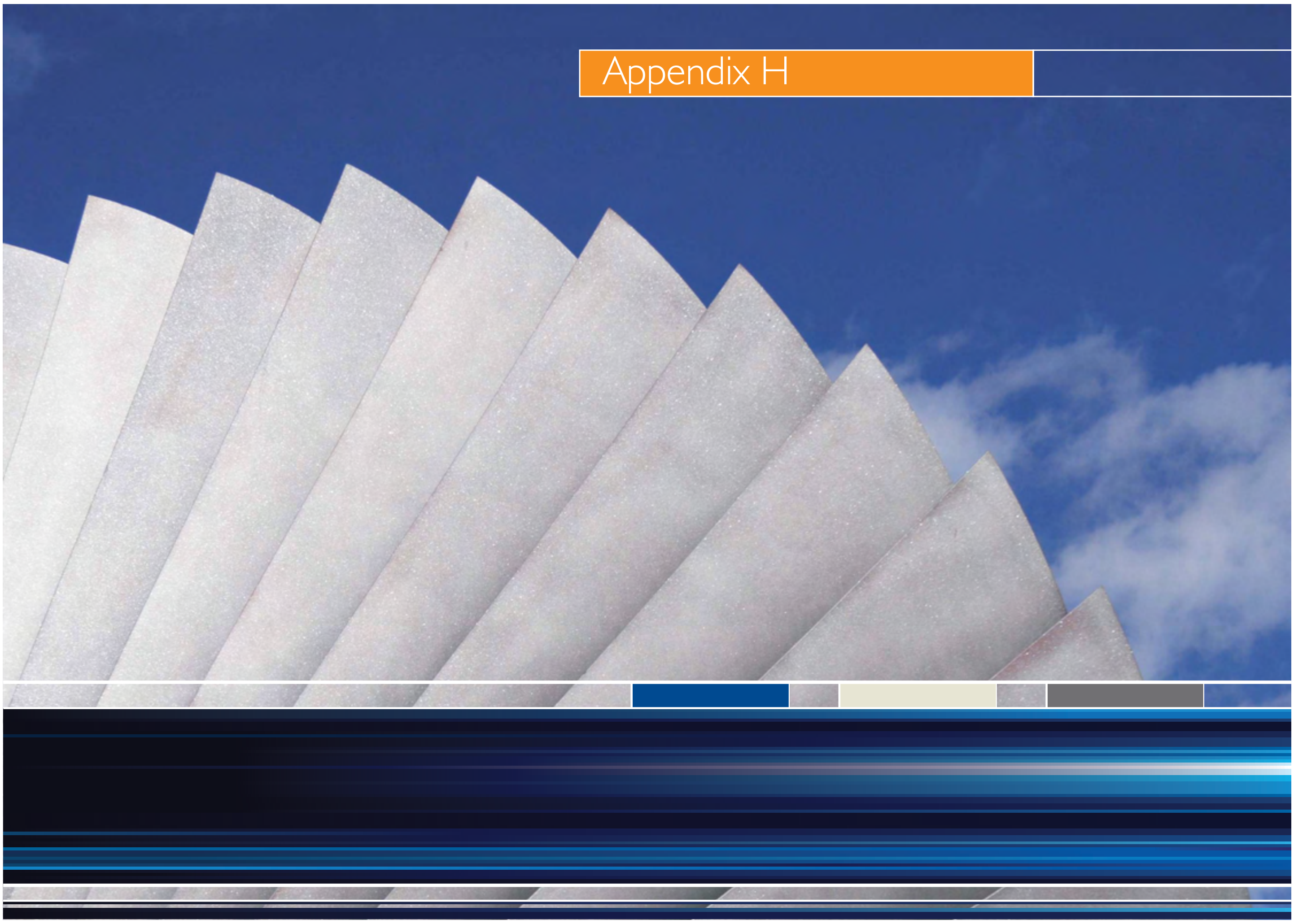
Australia	+61-2-8484-8999
Azerbaijan	+994 12 4975881
Belgium	+32-3-540-95-86
Bolivia	+591-3-354-8564
Brazil	+55-21-3526-8160
China	+86-20-8130-3737
England	+44 1928-726006
France	+33(0)1 48 42 59 53
Germany	+49-631-341-13-62
Ireland	+353 1631 9356
Italy	+39-02-3180 77 1
Japan	+813-3541 5926
Malaysia	+603-7725-0380
Netherlands	+31 10 2120 744
Philippines	+632 910 6226
Scotland	+44 (0) 1224-624624
Singapore	+65 6295 5752
Thailand	+662 642 6161
Turkey	+90-312-428-3667
United States	+1 978-589-3200
Venezuela	+58-212-762-63 39

Australian Locations

Adelaide
Brisbane
Canberra
Darwin
Melbourne
Newcastle
Perth
Singleton
Sydney

www.aecom.com

Appendix H



Preliminary Hazard Assessment and Plume Rise Assessment

Prepared for:

MacGen

Proposed Bayswater B Project - Preliminary Hazard Analysis

Final

AECOM

21 September 2009

Document No.: Appendix_H_S7008806_PHAFinal_21Sept09

Environment

Distribution

Proposed Bayswater B Project - Preliminary Hazard Analysis

21 September 2009

Copies	Recipient	Copies	Recipient
1	**John Marshall** **Macquarie Generation** PO Box 3416 Hamilton DC NSW 2303		

By
ENSR Australia Pty Ltd (trading as AECOM)
ABN: 34 060 204 702
PO Box 726 Pymble, NSW, 2072
Level 5, 828 Pacific Highway, Gordon, NSW, 2073
Ph: 0411 659 309 Fax: (02) 8484 8989

Steve Sylvester
Principal Risk and Safety Engineering

Technical Peer Reviewer:	Date:
	22/9/09
For **Michael England** Senior Principal, National Practice Leader Environmental Planning	

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AECOM

Contents

List of Figures

List of Tables

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Abbreviations

Abbreviation	Description
ALARP	As Low As Reasonably Practicable
AS	Australian Standard
bar	1 atmosphere (101kPa)
CCTG	Combined Cycle Gas Turbine
CO_2	Carbon Dioxide
DCS	Distributed Control System
DG	Dangerous Goods
EA	Environmental Assessment
EGPIDG	European Gas Pipeline Incident Data Group
ERPG	Emergency Response Planning Guideline
FDT	Fractional Dead Time
Hazmat	Hazardous Materials
HDPE	High Density Poly Ethylene
HIPAP	Hazardous Industry Planning Advisory Paper
HP	High Pressure
IBC	Intermediate Bulk Container
km	kilometres
km/yr	kilometres per annum
kPa	kilo Pascals
kV	kilo Volts
kW/m^2	kilo Watts per square metre
L	Litres
LEL	Lower Explosive Limit
LPG	Liquefied Petroleum Gases
m	metres
m^3	cubic metres
MAOP	Maximum Allowable Operating Pressure
mm	millimetres
MPa	Mega Pascals
MW	Mega Watts
NG	Natural Gas
p.a.	per annum
pg	packaging group

Abbreviation	Description
PHA	Preliminary Hazard Analysis
PMI	Person Machine Interface
pmpy	per million per year
ppm	Parts per million
QRA	Quantitative Risk Assessment
SEPP	State Environmental Planning Policy
V	Volts

Executive Summary

Introduction, Objectives and Scope

Macquarie Generation (MacGen) is seeking concept approval for the construction and operation of a power station to the west of the existing Bayswater Power Station in the Upper Hunter Region of NSW. The proposed project is known as Bayswater B Power Station. A preliminary Hazard Analysis (PHA) study has been prepared in support of the Environmental Assessment (EA) to demonstrate that the hazards that may be associated with the operation of a facility are adequately managed. Where the study identified areas where hazard management may be enhanced, recommendations are made.

The project is currently considering two options; a coal fired power station and a gas fired power station. Both options are assessed as part of this study.

The objectives of the study are to:

- Identify the hazards associated with the operation of the proposed power station,
- Assess the risks of the identified hazards to the adjacent properties to the proposed site;
- Compare the assessed risk impacts to the published risk criteria;
- Where required, identify risk reduction measures; and
- Report on the findings of the study for inclusion in the EA document.

This approach complies with the requirements of Hazardous Industry Planning Advisory Paper No.6, Hazard Analysis Guidelines.

The scope of work is for a PHA study of the proposed options for the Bayswater B Power Station Project. The scope includes the assessment of hazards and risks to the adjacent land uses from operation of both the coal fired and gas fired options.

Methodology

The zoning of the proposed Bayswater B Power Station is Rural General (1a), which does not prevent the development of hazardous and offensive industries. Notwithstanding this a review of the potential hazards must be performed to ensure the power station facility is adequate designed and operated to minimise the risk to the adjacent land uses and the environment. HIPAP No.6, Guidelines for Hazard Analysis (Ref.2) has been used as the basis for this assessment. A summary of the study approach is presented below, this has been summarised and reproduced from HIPAP No.6:

- Hazard Identification – the hazards associated with the storage and handling dangerous goods at the power station are identified;
- Consequence Analysis – the consequences from the identified hazards are assessed and the severity of impact at adjacent land uses determined;
- Frequency Analysis –where incidents are identified to have a potential impact offsite, the frequency of incidents are assessed;
- Risk Analysis – the consequence and likelihood values for each incident are then combined to identify the risk;

- Comparison with Risk Criteria – the assessed risk is then compares to the risks published by the regulatory authorities (HIPP No.4); and
- Risk Reduction and Review – apply risk reduction solutions and review the risks to ensure risks are below criteria.

Proposed Power Station Project – Summary Description

The proposed power station project consists of two options, a coal fired power station and a gas fired power station. The summary description of both options is presented below.

Coal Fired Power Station

The coal fired power station will operate with two boiler units feeding steam to two steam turbines. Water will be heated in the boiler circuit using coal, and turned into steam that will be fed to the turbines to power the turbine generators. Electricity will be generated and fed to the grid via generator transformers.

Gas Fired Power Station

The gas fired power station will operate with five gas turbine units, each connected to a heat recovery steam generator. The gas turbines will be powered by natural gas, fed to the plant from a lateral pipeline off the proposed Queensland to Hunter gas pipeline. The gas turbines will power turbine generators that will feed electricity into the grid via generator transformers. Waste heat from the turbines will generate steam via a heat recovery steam generator. The steam will be fed to steam turbines that will power turbine generators feeding electricity to the grid via generator transformers.

Hazardous and Dangerous Goods

In order to maintain effective system operations at the proposed power station options, it would be necessary to store and handle a number of hazardous materials (Hazmat) and Dangerous Goods (DGs). These are stored in various areas around the proposed power station options, but mainly in the chemical storage area adjacent to the water treatment plant. The Hazmat and DGs include the following:

- **Flammable and Combustible Liquids** – diesel (underground tank), petrol (underground tank) and acetone/kerosene/turpentine (minor quantities)
- **Flammable Gas** – acetylene (cylinders), hydrogen (cylinders) and Liquefied Petroleum Gas (LPG) (cylinders)
- **Toxic Gases** – ammonia (above ground tank) and chlorine (cylinders)
- **Non-Toxic and Non-Flammable Gas** – oxygen (tanks and cylinders), CO_2 (refrigerated liquid tanks) and argon (cylinders)
- **Corrosive Liquids** – Sulphuric Acid (tanks), Sodium Hydroxide (tanks), Sodium Hypochlorite (drums) and Ferric Chloride (tanks)
- **Natural Gas** – delivered to site by high pressure pipeline (gas fired option only).

Hazard Identification

To identify hazards associated with the storage and handling of the Hazmat and DGs, a hazard identification was conducted. The hazard identification commenced with a review of the DGs stored and handled at the site. The nature and properties of each Hazmat/DG were assessed and a number of postulated hazards developed. A hazard identification table was completed and those incidents identified to have a potential to impact offsite were listed. Each postulated hazard was then subjected to a hazard analysis to determine whether the proposed plant safeguards were adequate to protect against offsite impacts. Where safeguards were not considered qualitatively adequate to contain the postulated hazards, a consequence analysis was conducted. The incidents carried forward for consequence analysis were:

- Transfer of gasoline fuel to underground tanks, spill fire (both power station options);
- Transfer of diesel fuel to underground tanks, spill fire (both power station options);
- Gas pipeline – external interference incidents (gas fired option only);
- Gas Turbine enclosure explosion incidents (gas fired option only);
- Chlorine incidents (both power station options);
- Ammonia incidents (both power station options); and
- Transformer oil fire (both power station options).

Consequence Analysis

The consequence analysis identified the following:

- **Transfer of Gasoline/Diesel Fuel to underground tanks, Spill and Fire** – a gasoline/diesel fuel spill is the same postulated incident for both power station options. The transfer area is constructed with a speed-hum style bund and a spill would be contained within the bunded area at both option sites. The analysis identified that heat radiation impact of 4.7kW/m^2 from a fuel spill fire would reach a distance of 15.5m. The boundary is over 500m from the fuelling point, hence, there is no potential for impact offsite.
- **Gas Pipeline Release** – the majority of the 15km gas pipeline is located on MacGen land, however, sections of the pipeline traverse open countryside. The pipeline would be installed with a 30m pipeline easement. The consequence analysis conducted for a pipeline incident identified that impacts could result in fatalities up to 100m from the pipeline. Hence, the incidents would occur beyond the pipeline easement.
- **Gas Release within Turbine Enclosures** – in the event of a gas release within a turbine enclosure, there is a potential for delayed ignition and explosion. The consequence analysis identified that an explosion within a gas turbine enclosure would result in an explosion overpressure of 7kPa (the maximum permissible at the site boundary, (Ref.5) at 390m from the turbines. The closest site boundary (gas fired option) is 545m, hence there would be no impact exceeding accepted criteria for this incident.

- **Chlorine Incidents** – chlorine storage postulated incidents are the same for both power station options. Concentration of chlorine, exceeding 20ppm have the potential to cause fatality and 5ppm injury (Ref.24). Chlorine releases from the proposed storages were assessed and it was identified that in the worst case the chlorine concentrations for 20ppm would occur at 560m from the release point and for 5ppm 1560m from the release point. The chlorine storage facility will be located over 620m from the site boundary for the coal fires option, hence, there will be no fatality risk in this case. However, for the gas fired option the site boundary is only 545m from the proposed chlorine plant location. Hence, there is a potential for fatal offsite impact from the postulated chlorine releases at the gas fired option and a potential for injury impact at the site boundary from the postulated releases in both power station options.
- **Ammonia Releases** – the ammonia tank postulated incidents were the same for both power station options. Concentration of ammonia, exceeding 750 parts per million (ppm) (ERPG-3 value) have the potential to cause injury and, in extended exposure (>1hr), fatality. Ammonia releases from the proposed storage facilities were assessed and it was identified that the ammonia concentration > 750ppm did not reach the site boundary in the worst case incident. However, it was identified that concentrations of 150 ppm (ERPG-2 value) extended beyond the site boundary, hence there is a potential for injury from continued exposure at this concentration.
- **Transformer Fire** – in both power station options the bunded areas would ensure a fire would be contained within the transformer area. The analysis of the transformer fire identified that the heat radiation impact at the site boundary would not exceed $1kW/m^2$. The maximum permissible level of heat radiation impact at the site boundary is $4.7kW/m^2$ (Ref.5). Hence, the criterion is not exceeded.

Frequency Analysis

Three incidents were carried forward from the consequence analysis section and subjected to a detailed frequency analysis. The analysis included an assessed of the initiating event frequency and the probability of failure of the protection systems installed to maintain safe operations. A summary of the results of the frequency analysis are presented below:

- Gas pipeline incident leading to gas leak as a result of external interference (i.e. excavation impact) – pipeline release frequency = $1x10^{-5}$p.a. per 100m section of pipeline (note: a 100m section of line was used for frequency estimation as this is the maximum impact distance of a jet fire as a result of pipeline failure and gas release)
- Chlorine cylinder connection failure leading to chlorine release – chlorine release frequency = $7.3x10^{-6}$ p.a.
- Continued ammonia release from flanges, hose transfer connections and pipework – continued ammonia release frequency = $7.8x10^{-4}$ p.a.

These incidents were carried forward for risk analysis.

Risk Analysis

The selected fatality risk criterion for impact to sites adjacent to the proposed power station options is 50 chances of fatality per million per year (pmpy). The selected fatality risk criterion for impact to rural areas around the gas pipeline is 10 pmpy. Injury risk criterion is has been selected as 50 chances in a million per year (Ref.5).

The risk analysis of gas pipeline incidents identified that the risk of fatality adjacent to the pipeline would not exceed 3 pmpy.

The risk analysis of chlorine release incidents identified that at the site boundary the risk of fatality would not exceed 7.3 pmpy and the risk of injury would be less than 7.3 pmpy.

The risk analysis for ammonia releases identified that concentrations of ammonia at the site boundary could result in injury, the injury risk was estimated to be 0.39×10^{-6} chances of injury per million per year or 0.4 pmpy.

Conclusions and Recommendations

A review of the risk analysis results, in comparison to the accepted risk criteria (Ref.5), indicates that the assessed risks do not exceed the acceptable criteria. Hence, it is concluded that the proposed power station options (gas fired and coal fired) would only be classified as potentially hazardous and not actually hazardous and therefore would be permitted within the land zoning where the facilities are proposed to be located.

Notwithstanding the above conclusion, a number of recommendations are made regarding the design and operation of the proposed power station options, to ensure the risks associated with the power station remain within the As Low As Reasonably Practicable (ALARP) range. These are detailed below.

1. The operation of the underground fuel storage tanks requires delivery of fuel to the tanks. An incident involving a fuel spill during delivery, ignition and subsequent fire would impact to a distance of 12m from the fill points. It is recommended that the fill points and road tanker fill area be located no closer than 12m to buildings and structures at the proposed power station (both options).
2. The operation of the start-up diesel fuel tank (coal fired option) could result in a fuel leak, ignition and full bund fire (worst case incident). The analysis in the study identified that impact to buildings could cause fore growth would occur at distances closer than 22m. Hence, It is recommended that the start-up diesel fuel tank bund be located no closer than 22m to buildings and structures at the proposed coal fired power station.
3. The supply of natural gas, from the Queensland to Hunter Gas Pipeline, requires the construction of a lateral pipeline to the proposed gas fired facility. The selected pipeline route includes the traversing of open countryside with the potential for the pipeline to be installed close to rural residences. Although the risk to rural areas is considered low, and within the selected risk criteria, the following recommendations are made to ensure the risks are maintained within the ALARP range:
   a) The pipeline be located no closer than 100m to any property residence
   b) The depth of cover over the pipeline where the pipeline crosses roads or where property residences are at 100m from the pipeline, be increased in open land areas from the proposed depth of 900mm to 1200mm (the length of the increased depth should be 100m either side of the road and 100m in either direction from the perpendicular to the property residence).
   c) Installation of pipeline marker tape 300mm below the ground surface where the pipeline crosses roads (the marker tape should be installed for 50m either side of the road).

d) The distance between the signs located along the pipeline route be decreased such that signs are no more than 50m apart, notwithstanding any clear visibility along a straight flat section of the pipe route.

e) A safety management system element be developed specifically for the pipeline, this element should include regular pipeline route and equipment inspections, line pigging with intelligent pigs on a regular basis (every 5 years), inspection and checking of the impressed current corrosion protection system.

1.0 Introduction

1.1 Background

Macquarie Generation (MacGen) is seeking concept approval for the construction and operation of a power station to the west of the existing Bayswater Power Station in the Upper Hunter Region of NSW. The proposed project is known as Bayswater B Power Station with a generating capacity of 2000MW.

Bayswater B would store and handle a number of Dangerous Goods that are listed in the Australian Dangerous Goods Code (Ref.1). These goods are inherently hazardous to people and the environment and therefore in order to minimise the potential for impact to surrounding land uses it is necessary to assess the storage and handling operations to ensure the risks associated with such operations are commensurate with the protection required.

This document details Preliminary Hazard Analysis (PHA) study for the proposed Bayswater B Project, including study results, conclusions and recommendations.

1.2 Objectives

The objectives of the study are to:

- Conduct a PHA study in accordance with the requirements of Hazardous Industry Planning Advisory Paper (HIPAP) No.6 (Ref.2)
- Prepare a report on the results of the PHA study for inclusion in the environmental assessment conducted for the Bayswater B Project.

1.3 Scope of Work

The scope of work is for the preparation of a PHA study of the Bayswater B Project. The study has been prepared to assess the hazards and risks to the surrounding land uses from operation of the proposed power station. The study includes the assessment of the two proposed options; a coal fired power station and a gas fired power station.

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2.0 Methodology

2.1 State Environmental Planning Policy No.33 (SEPP33)

SEPP33 was developed by the Department of Planning (DoP) to provide a policy for the management of hazardous and offensive developments. The policy document is accompanied by a guideline, "Applying SEPP 33" (Ref.4). This guideline provides assistance to industry in the selection of the appropriate level of assessment. An extract from this guideline has been provided below to indicate one of the inputs to the selection of the assessment level selected for this study.

"It is considered that a qualitative PHA may be sufficient in the following circumstances:

- *Where materials are relatively non-hazardous (for example corrosive substances and some classes of flammables)*
- *Where the quantity of materials used are relatively small*
- *Where the technical and management safeguards are self-evident and readily implemented*
- *Where the surrounding land uses are relatively non-sensitive.*

In these cases, it may be appropriate for a PHA to be relatively simple. Such a PHA should:

- *Identify the types and quantities of all dangerous goods to be stored and used*
- *Describe the storage/processing activities that will involve these materials*
- *Identify accident scenarios and hazardous incidents that could occur (in some cases, it would also be appropriate to include consequence distances for hazardous events)*
- *Consider surrounding land uses (identify any nearby uses of particular sensitivity)*
- *Identify safeguards that can be adopted (including technical, operational and organisational), and assess their adequacy (having regards to the above matters).*

A sound qualitative PHA which addresses the above matters could, for some proposals, provide the consent authority with sufficient information to form a judgement about the level of risk involved in a particular proposal.

2.2 Multi Level Risk Assessment

In addition to the SEPP33 documents, the NSW Department of Planning (DoP) has also developed a number of guidelines to assist industry to assess potential hazardous and offensive facilities and to determine whether these facilities are commensurate with the land uses in the area in which the proposed facility would be located. Due to the wide range of facilities storing and handling Dangerous Goods (DGs), a single methodology approach is not effective for application to all sites. Hence, the Multi Level Risk Assessment (Ref.3) methodology was developed in the mid 1990's. This approach has proven successful in providing the correct level of assessment application, based on a variety of factors associated with the site under assessment.

Three levels of assessment are provided in the MLRA approach

- ***Level 1** – **Qualitative Analysis**, primarily based on the hazard identification techniques and qualitative risk assessment of consequences, frequency and risk*
- ***Level 2** – **Partially Quantitative Analysis**, using hazard identification and the focused quantification of key potential offsite risks*
- ***Level 3** – **Quantitative Risk Analysis (QRA),** based on the full detailed quantification of risks, consistent with Hazardous Industry Planning Advisory Paper No.6 – Guidelines for Hazard Analysis. (*Ref 2*)*

This can be presented in diagrammatic form as shown in **Figure 2-1**, which has been extracted from the MLRA document (Ref.3).

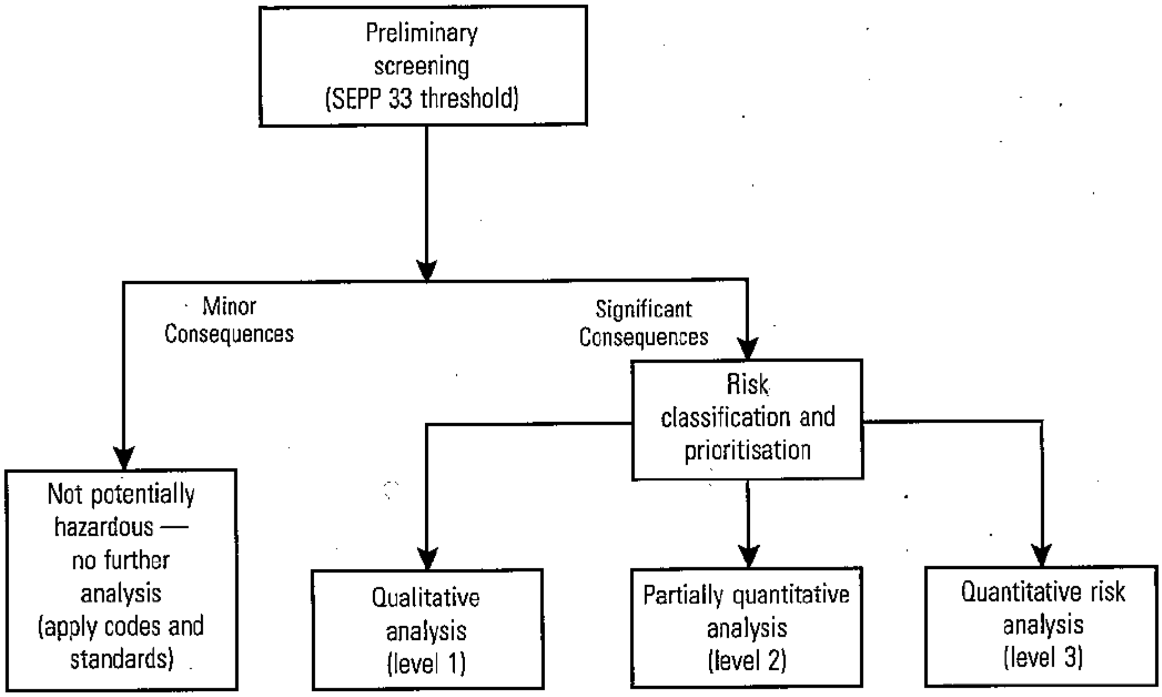

Figure 2-1: The Multi Level Risk Assessment Approach (Ref.3)

2.3 Selected Study Approach

The nature and operation of power stations dictates the type of DGs that are stored. Coal Fired Power Stations predominantly process large quantities of water, in a closed circuit, for the generation of steam. The quality of this water (i.e. purity) is critical in maintaining correct system operation and in preventing accelerated corrosion and damage to the Power Station components. Hence, the vast majority of Dangerous Goods that would be stored and handled at Bayswater B are water treatment chemicals. In comparison, the quantity of remaining chemicals (e.g. flammable/combustible liquids) is relatively low. These will be stored in underground tanks.

Water treatment chemicals include the storage and handling of toxic gases; ammonia and chlorine. **Table -1** lists the quantity of gases proposed for storage.

Table -1: Quantity of Ammonia and Chlorine Proposed for Storage at Bayswater B

	Power Station Type	
Toxic Gas	**Coal Fired**	**Gas Fired**
Anhydrous Ammonia	50,000 L	20,000 L
Chlorine	560 L	560 L

Notwithstanding the quantity of toxic gases stored, the surrounding land uses are not sensitive in relation to population. The area surrounding the proposed power station sites (both coal fired and gas fired) is open rural land with the closest residence located 5 km from the proposed power station facilities. The closest industrial area is the Drayton Mine, the mines southern boundary of which is located approximately 2 km from the proposed power station.

Hence, based on the nature of the stored materials (i.e. corrosives, flammable gases/liquids and toxic gases) and the fact that the adjacent land uses to the site do not contain a sensitive population, a Level 2 assessment has been selected for this PHA. The Level 2 analysis will permit a qualitative assessment of the corrosive materials to be conducted along with a detailed consequence analysis for the flammable gases/liquids and toxic gases to determine the impact at the closest sensitive receptor.

The analysis generally followed the approach below:

- **Hazard Analysis** – A detailed hazard identification was conducted for all site operations described in **Section 3**. Where an incident was identified to have potential offsite impact, it was included in the recorded hazard identification word diagram (**Appendix A**). The hazard identification word diagram lists incident type, causes, consequences and safeguards. This was performed using the word diagram format suggested in HIPAP No.6 (Ref.2). Each postulated hazardous incident was assessed qualitatively in light of proposed safeguards (technical and management controls). Where a potential offsite impact was identified, the incident was carried into the main report for further analysis. Where the qualitative review in the main report determined that the safeguards were adequate to control the hazard, or that the consequence would obviously have no offsite impact, no further analysis was performed.
- **Consequence Analysis** – For those incidents qualitatively identified in the hazard analysis to have a potential offsite impact, a detailed consequence analysis was conducted. The analysis modelled the various postulated hazardous incidents and determined impact distances from the incident source. The results were compared to the criteria listed in HIPAP No.4 (Ref.5). Where an incident was identified to result in an offsite effect, it was carried forward for frequency analysis. Where an incident was identified to have an offsite effect, and a simple solution was evident (i.e. move the proposed equipment further away from the site boundary), the solution was recommended and no further analysis was performed.
- **Frequency Analysis** – In the event a simple solution for managing consequence impacts was not evident, each incident identified to have potential offsite impact would be subjected to a frequency analysis. The analysis considered the initiating event and probability of failure of the safeguards (both hardware and software).

- **Risk Assessment and Reduction** – As the selected approach for this analysis was a Level 2 assessment (Ref.3), where incidents were identified to impact offsite and where a consequence and frequency analysis was conducted, the consequence and frequency analysis for each incident would be combined and compared to the risk criteria published in HIPAP No.4 (Ref.5). Where the criteria were exceeded, a review of the major risk contributors would be performed. Recommendations would then be made regarding risk reduction measures.
- **Reporting** – on completion of the assessment a report detailing the study outcomes, conclusions and recommendations was development in support of the EA.

3.0 Brief Description of the Proposed Project

3.1 Power Station Location and Surrounding Land Use

The proposed power station project would be located to the west of the existing Bayswater Power Station, which is located about 37 kilometres (km) northwest of Singleton, NSW. There are currently two options available for the development of the Bayswater B project; a coal fired or a gas fired power station. The coal fired option would consist of two boilers, each supplying a steam turbine generator that supplies power via a transformer. The gas fired option would consist of 5 gas turbines, each with a combined cycle steam turbine unit producing power via 5 transformers. **Figure 3-1** shows the regional location of the proposed power station project. **Figure 3-2** shows the location of the coal fired option in the Bayswater area and **Figure 3-3** shows the location of the gas fired option in the Bayswater area.

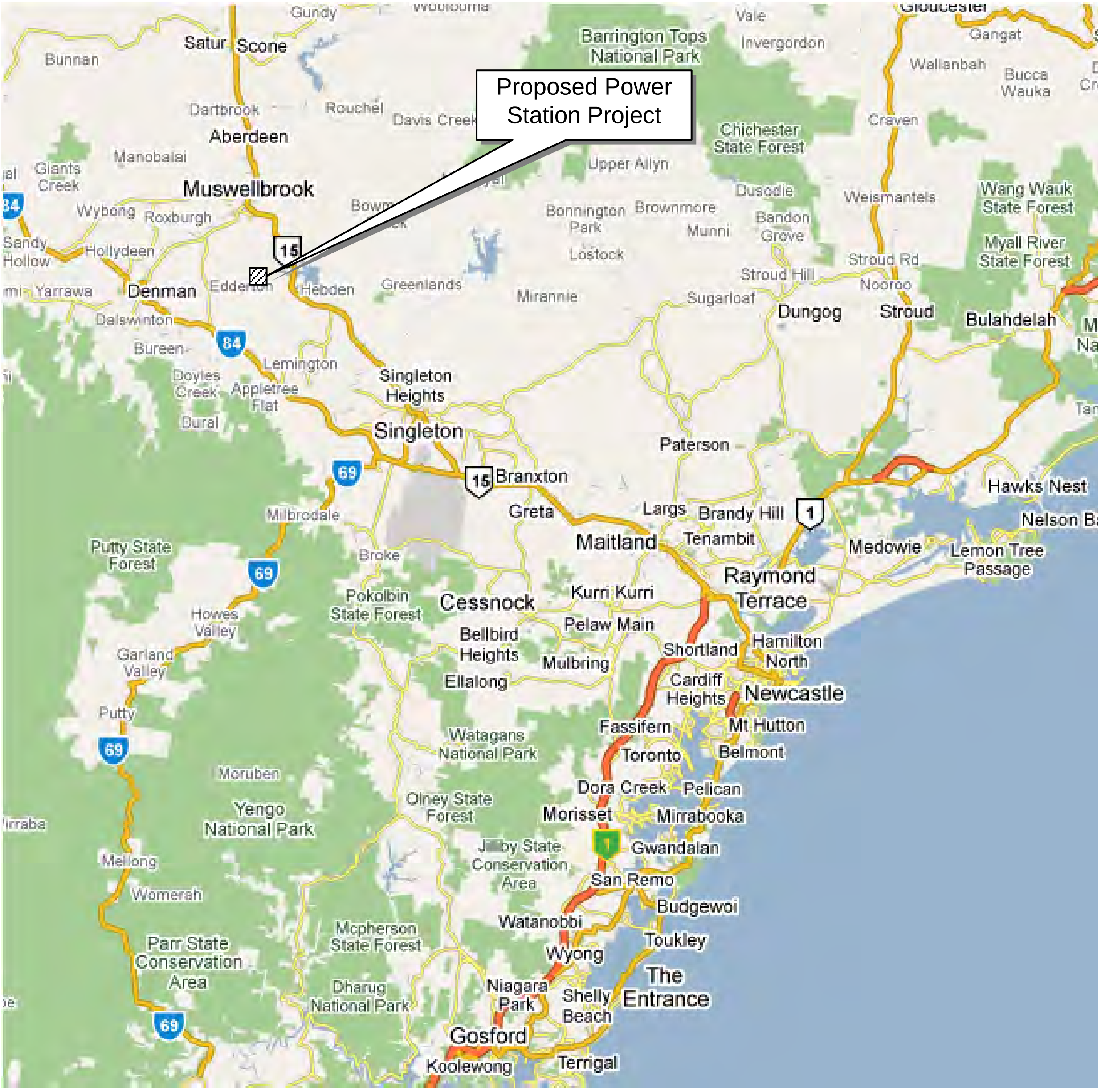

Figure 3-1: Regional Location of the Proposed Power Station Project

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Figure 3-2: Proposed Coal Fired Power Station Area Location – Bayswater

Figure 3-3: Proposed Gas Fired Power Station Area Location – Bayswater

Figure 3-4: MacGen Property Boundary and Proposed Power Station Location

The land on which the Project will be located is zoned Rural 1(a). An aerial photograph showing the MacGen property boundary in relation to the area where the options for the proposed power station will be located is shown at **Figure 3-4**.

Noting that the majority of the area directly surrounding the proposed power station location is open countryside and is owned by MacGen, the closest occupied surrounding land uses are shown in **Table 3-1** for both the coal fired and gas fired options.

Table 3-1: Distance to Land Uses Surrounding the Power Station Site

Direction	Land Use	Distance (m)	
		Coal fired option	Gas fired option
North	Boundary at Drayton open cut mine	2450	2270
West	Farm Property (Lot 5 DP843635)	620	545
South	Boundary at Cumnock open cut mine	4900	4980
East	Boundary at Cumnock open cut mine	4220	4300
	Existing Bayswater Power Station	3520	3600

A description of the proposed power station options is presented in the following sections.

3.2 Coal Fired Power Station Description

3.2.1 Coal Transport to Bayswater B

The proposed coal fired power station option will use pulverised coal as the boiler feed. The raw coal will be delivered to the Antiene Rail Coal Unloader and transferred to site via conveyor, where it will be stored in stockpiles ready for delivery to the power station.

3.2.2 Process Units

The process units will consist of two boilers, two turbines and two generator transformers.

The coal will be recovered from the stockpiles and delivered by conveyor to the coal pulverising plant. Mills will crush and pulverise the coal which will then be blown into the boiler and burnt in the boiler combustor space. The heat generated by the coal combustion will heat water in the tubes within the boiler unit. The water will then boil, generating steam that will be further heated by the combusting fuel, superheating the steam. The superheated steam will then be passed to the turbines, which consist of rows of blades on a drum (known as a rotor), contained within an external casing. The steam passes across the blades, providing driving force to turn the turbine rotor. The rotor shaft is connected to a generator, through which the electricity is generated. The electricity is then fed to a transformer which converts the electricity to the required voltage for transfer along the power transmission lines into the power grid.

Once the steam has transferred power to the turbine rotor, it will be condensed back to water via air cooled condensers. This water will then be recycled through the plant as feedwater for the boiler.

Combusted coal will generate ash that is collected by the ash handling plant. This plant also collects dense material from the pulverising mills as well as course and fine ash from the boilers. The ash from the boilers is collected in fabric filters (baghouses). Ash is conditioned and disposed of in open cut mine voids in the vicinity of the power station. The treated exhaust is discharged via a chimney/stack.

3.2.3 Electrical Power Plant

Power is generated in the two station generators, typically at 23,000 Volts (V) or 23 kV. The power is fed to the two generator transformers where it is transformed to 500,000 V or 500 kV with an output of 1000MW per transformer.

3.2.4 Other Plant and Equipment

Other plant and equipment includes:

- **Condensate Polishing and Regeneration Plant** – the continued use of water in the boiler/turbine circuit will result in a gradual degradation of the water to a point where its condition may have detrimental effects on the boiler and turbine systems. To ensure the water is maintained in optimum condition it will be treated with various chemicals to maintain the correct pH, mineral and chemical content.
- **Chemical Dosing Plant** – chemicals used in the treatment of the condensate/boiler water will be stored in a dedicated chemical dosing area. All storages will be designed and operated in accordance with the codes, standards and regulations applicable to the specific chemical stored. Details of the chemicals stored, handled and used at the Site are given in **Section 4.2**.
- **Diesel Fuel for Boiler Start-Up** – in order to start the boilers it will be necessary to commence the start-up using diesel fuel, as coal will not sustain a flame without initial boiler heat. Hence, a 3,600 kL diesel fuel tank will be installed adjacent to the chemical plant at the Coal Fired Power Station.
- **Fire Detection and Protection Systems** – A fire detection and protection system will be installed on site comprising automatic smoke and thermal detection alarms, automatic sprinkler and spray deluge systems, fire water storage/pumping systems and a fire main throughout the facility. The fire main and associated systems (pumps and tanks) will be installed in accordance with AS2419.
- **Hydrogen Plant and Compressed Air Plant** – heat produced as part of the electrical generation (i.e. within the generator) is extracted by circulation of hydrogen through the generator and cooler circuit. Hydrogen is held on site to maintain the required levels within the generator and is stored in cylinders adjacent to the turbine hall. A compressed air plant will also be installed comprising compressors and air receivers. The compressed air will be piped throughout the station for use in control systems and air operated equipment.
- **Station Control** – the power station will be controlled from a central control room that will interface with a distributed control system (DCS). The DCS will monitor and control the plant with interface from operators via person/machine interface (PMI) devices.

3.3 Gas Fired Power Station Description

3.3.1 Combined Cycle Gas Turbines

The gas fired power station will use a Combined Cycle Gas Turbine (CCGT) plant producing 2,000 MW. A total of 5 individual CCGT units will be installed, each producing 400 MW. Each CCGT will consist of the following:

- **Gas Turbine** – the gas turbine will consist of a rotary compressor which compresses air into the combustion chambers where fuel is added. The ignition of the gas/air mixture results in burning and expansion of the gas, which passes through a power turbine (blades) rotating the turbine shaft which is connected to the electrical generator and rotary compressor. The power is generated and the compressor rotated to produce more compressed air for combustion.
- **Heat Recovery Steam Generator** – the gases exhaust from the power turbine are passed through a heat recover boiler which heats the water in the boiler, generating steam. The steam is then passed through a steam turbine which is connected to an electrical generator, producing power.
- **Air Cooled Condensers** – steam exhausted from the turbine is cooled and condensed back to water, which is re-used and fed to the heat recovery steam generator.
- **Exhaust Stack** – the gases exhausted from the heat recovery steam generator will be discharged via individual stacks connected to each CCGT unit.

3.3.2 Electrical Generation

A total of 5 turbine generators will be installed, one for each CCGT set. The electricity will be produced by the turbine generators at around 23 kV and will be transformed to 500 kV in the transformers with an output power of 440MW (550MVA) per transformer. The power will be transmitted to a switchyard and then to 500kV transmission lines which convey the electricity to the distribution networks.

3.3.3 Fuel Supply

The gas fired power station will be fuelled by natural gas, supplied via a 15km long, 355mm diameter, 9.4mm wall thickness pipeline lateral from the Queensland to Newcastle gas pipeline, which runs north-east of the Bayswater B site. The pipeline will enter the site on the north-east corner, via a pressure reduction and metering station. The gas will then be distributed to the various turbines via individual metering stations at the turbine enclosure.

3.3.4 Other Plant and Equipment

Like the coal fired option, the gas fired option will require a number of auxiliary systems and equipment in order to operate. However, unlike the coal fired option, the gas fired option will not require certain systems due to the lower individual capacity of the CCGT units (e.g. chemicals). Other equipment includes the following:

- **Condensate polishing and regeneration plant** – the continued use of water in the heat recovery steam generator/turbine circuit will result in a gradual degradation of the water to a point where its condition may have detrimental effects on the water/turbine systems. To ensure the water is maintained in optimum condition it will be treated with various chemicals to maintain the correct pH, mineral and chemical content.

- **Chemical Dosing Plant** – chemicals used in the treatment of the condensate/boiler water will be stored in a dedicated chemical dosing area. All storages will be designed and operated in accordance with the codes, standards and regulations applicable to the specific chemical stored. Details of the chemicals stored, handled and used at the Site are given in **Section 4.2**.
- **Fire Detection and Protection Systems** – a fire detection and protection system will be installed on site comprising automatic smoke and thermal detection alarms, automatic sprinkler, spray deluge systems, inert gas drench systems, fire water storage/pumping systems and a fire main throughout the facility. The fire main and associated systems (pumps and tanks) will be installed in accordance with AS2419.
- **Compressed Air Plant** – a compressed air plant will also be installed comprising compressors and air receivers. The compressed air will be piped throughout the station for use in control systems and air operated equipment.
- **Station Control** – the power station will be controlled from a central control room that will interface with a distributed control system (DCS). The DCS will monitor and control the plant with interface from operators via person/machine interface (PMI) devices.

3.4 Proposed Safeguards at the Power Stations

A number of safeguards will be installed at the proposed power stations. Safeguards for each station are summarised in the following sub-sections.

3.4.1 Coal Fire Power Station

The following safeguards will be installed as part of the coal fired option:

- **Relief Valves** – high pressure steam relief valves would be installed on the main steam drum of the boiler to vent steam and will be of the maximum permissible operating pressure of the boiler, preventing steam explosion.
- **Corrosive Liquids** – the design and operation of corrosive liquids storage is specified in AS3780 (Ref.7). All corrosive liquids (acid and alkali) would be stored in accordance with this standard. Tanks would be located in bunded areas, preventing release of spills to the environment. AS3780 requires all bunds to be designed to contain the full contents of the largest tank in the bund.
- **Transformers** – all station transformers would be fitted with level detection (Bucholtz) to detect loss of oil level in the transformer. On detection of low oil level the transformer would be “tripped” and an alarm raised. All transformers would be installed in bunded areas with capacity to contain the full transformer oil contents. Transformers would also be fitted with blast walls to prevent the potential for incident growth in the event of transformer fire and/or explosion. In addition to the blast walls, all transformers would be fitted with deluge systems to apply fire water in the event of transformer fires.
- **Ammonia** – safeguards installed at chlorine storage facilities are specified in the ammonia standard (AS2022, Ref.25). The standard specifies the following components that will be included in the design; excess flow valves fitted to the tanks, anhydrous ammonia rated valves and tanks designed to AS1210 (Ref.16) (which includes pressure and weld testing). In the event of a pipeline rupture, the excess flow valves will close, preventing continued release. Gas detection would also be installed around the tank to identify any leaks and operate automatic valves closing of ammonia gas supply at the tank nozzle.

- **Chlorine** – safeguards installed at chlorine storage facilities are specified in the chlorine standard (AS2927, Ref.10). The standard specifies the following components, that will be included in the design; gas detection, alarms and automatic isolation in the event of a release. This will be performed by a system known as chlorguard, fitted to the storage drum/cylinder delivery valves. Chlorguard is a system for automatically isolating the chlorine delivery to the plant on the detection of gas release. The system closes the drum valve preventing gas continued release in the event of a leak.
- **Spill Containment on Site** – wastewater from the site would be collected and treated with clean water discharged to Plashett Dam for reuse in operations on site. There would be a series of water collection ponds located around the site which are summarised below:
  - Detention Basin (temporarily retains flows from rooves and other “clean” areas to ensure large storm water flows from these sealed surfaces are released in a regulated manner) – 4,500 $m^{3.}$
  - First Flush Pond (enables the capture and settlement of the majority of accumulated dirt/dust from sealed areas) – designed to capture runoff up to the first 10 minutes of a 10 year ARI storm.
  - Oil Catch Tank (to catch oil spills or contaminated water from sources which may contain oil or other contaminants) – 120% of the largest transformer on site.
  - Settlement Pond/s for long-term coal storage area.

3.4.2 Gas Fired Power Station

The gas fired option will utilise similar systems to those in the coal fired option, hence the safeguards listed in **Section 3.4.1** would also be installed at the gas fired facility. In addition, safeguards particular to Gas Turbine systems would be installed at the gas fired facility, including:

- **Gas Turbine and Auxiliaries** – lubrication oil tanks and control valve (hydraulic) systems will have flame and heat detectors that will activate an automatic sprinkler system.
- **Gas Turbine Exhaust and Bearing Tunnels** – heat detectors (continuous length) and inert gas drench within the exhaust and tunnel.
- **Combined Pump Block** – rate of heat rise detectors and inert gas drench around the pump block only.
- **Thermal Block Compartment** – Flame, heat and continuous length detectors and inert gas drench for the block compartment only.
- **Gas Let Down/Metering Station** – line of site gas detectors and automatic isolation of the incoming gas supply.

3.4.3 Common Safety Features to Both Power Station Options

In both power station options a number of safety features would be common, these are:

- **Fire Main and Fire Hydrants -** a fire main system would be installed throughout the site, including fire water tanks, pumps and hydrants positioned throughout the site in accordance with AS2419 (Ref.6).
- **Fire Extinguishers** – the selection and installation of fire extinguishers is performed in accordance with AS2444 (Ref.28 4). The site will be fitted with a range of extinguishers commensurate with the hazards at the site, including dry chemical powder (general fires & flammable liquid fires), foam (flammable liquid fires) and carbon dioxide (electrical fires).

4.0 Hazard Analysis

4.1 Hazard Identification Table

HIPAP No.6(Ref 6) requires the hazard analysis study to commence with a hazard identification table. This allows the hazards to be identified along with the qualitative assessment of consequences and safeguards. The table is used to identify those hazards that have the potential to impact offsite. The hazard identification table is presented at **Table 4-1**. The following sub-sections qualitatively assess the impacts associated with the identified hazards to determine whether further analysis is required.

4.2 Hazardous Properties of Materials Stored and Used

Table 4-1 list the hazardous and dangerous materials proposed for storage and use at the Bayswater B Power Station. The table contains details of both power station options.

Table 4-1: List of Dangerous Goods to be Stored and Used at Bayswater B

Depot Type	UN No.	Name	Class	PG	Maximum Qty Stored (Litres/Kilograms)	
					Coal fired	Gas fired
Transformer	00C1	Transformer Oil	C2	-	80,000 L	40,000 L
Transformer	00C1	Transformer Oil	C2	-	80,000 L	40,000 L
Transformer	00C1	Transformer Oil	C2	-	80,000 L	40,000 L
Transformer	00C1	Transformer Oil	C2	-	20,000 L	40,000 L
Transformer	00C1	Transformer Oil	C2	-	20,000 L	40,000 L
Transformer	00C1	Transformer Oil	C2	-	-	5,000 L
Transformer	00C1	Transformer Oil	C2	-	-	5,000 L
Transformer	00C1	Transformer Oil	C2	-	-	5,000 L
Transformer	00C1	Transformer Oil	C2	-	-	5,000 L
Transformer	00C1	Transformer Oil	C2	-	-	5,000 L
Transformer	00C1	Transformer Oil	C2	-	-	20,000 L
Cylinder Store	1049	Hydrogen, Compressed	2.1	-	58,300 L	N/A
Above Ground Tank	1005	Anhydrous Ammonia	2.3	-	50,000 L	20,000 L
Cylinders	1017	Chlorine	2.3 (8)	-	620 L (420 kg)	620 L (420 kg)
Above Ground Tank	2528	Ferric Chloride	8	III	30,000 L	30,000 L
Above Ground Tank	1824	Sodium Hydroxide Soln.	8	II	93,000 L	25,000 L
Above Ground Tank	1824	Sodium Hydroxide Soln.	8	II	93,000 L	-
Above Ground Tank	1824	Sodium Hydroxide Soln.	8	II	46,000 L	-
Above Ground Tank	1830	Sulphuric Acid	8	II	32,600 L	16,000 L
Above Ground Tank	1824	Sodium Hydroxide Soln.	8	II	20,000 L	10,000 L

Depot Type	UN No.	Name	Class	PG	Maximum Qty Stored (Litres/Kilograms)	
					Coal fired	Gas fired
IBC	1824	Sodium Hydroxide Soln.	8	II	1,000 L	1,000 L
IBC	1824	Sodium Hydroxide Soln.	8	II	1,000 L	
IBC	1824	Sodium Hydroxide Soln.	8	II	1,000 L	
IBC	1824	Sodium Hydroxide Soln.	8	II	1,000 L	
Above Ground Tank	1830	Sulphuric Acid	8	II	68,000 L	68,000 L
Above Ground Tank	1830	Sulphuric Acid	8	II	7,000 L	68,000 L
Above Ground Tank	1830	Sulphuric Acid	8	II	-	3,500 L
Cylinder Store	1975	Petroleum Gases, Liquefied	2.1	-	500 L	500 L
Under Ground Tank	1270	Petrol	3	II	20,000 L	15,000 L
Under Ground Tank	00C1	Diesel	C1	-	30,000 L	20,000 L
Cylinder Store	1001	Acetylene Oxygen Argon	2.1 2.2 2.2	- - -	250 L* 500 L* 500 L*	250 L* 500 L* 500 L*
Flammable Liquid Roofed Store	1299 1090 1223 1300	Turpentine Acetone Kerosene Turpentine Substitute (white spirit)	3 3 3 3	III II III III	1000 L 1000 L 2000 L 1000 L	1000 L 1000 L 2000 L 1000 L
Corrosive Liquids Roofed Store	1823 1830 1791 2627 3264 2209	Sodium Hydroxide Soln. Sulphuric Acid Hypochlorite Solution Ammonia Solution Corrosive Liquid NOS Formaldehyde Solution	8 8 8 8 8 8	II II II II II III	1000 L 10 L 720 L 3,200 L 320 L 120 L	1000 L 10 L 720 L 3,200 L 320 L 120 L
Cylinder Store	2187	Carbon Dioxide, compressed	2.2	-	8,000 L	4,000 L
Cylinder Store	2187	Carbon Dioxide, Compressed	2.2	-	8,000 L	4,000 L
Cylinder Store	2187	Carbon Dioxide, compressed	2.2	-	15,000 L	4,000 L
Cylinder Store	2187	Carbon Dioxide, compressed	2.2	-	15,000 L	4,000 L
Cylinder Store	1072	Oxygen, Refrigerated Liquid	2.2 (5.1)	-	50,000 L	25,000 L
Cylinder Store	2187	Carbon Dioxide, compressed	2.2	-	-	2,000 L
Cylinder Store	2187	Carbon Dioxide, Compressed	2.2	-	-	2,000 L

Depot Type	UN No.	Name	Class	PG	Maximum Qty Stored (Litres/Kilograms)	
					Coal fired	Gas fired
Cylinder Store	2187	Carbon Dioxide, compressed	2.2	-	-	2,000 L
Cylinder Store	2187	Carbon Dioxide, compressed	2.2	-	-	2,000 L
Combustible Liquid	00C1	Diesel Fuel	C1	-	3,600kL	-

Table 4.2 lists the nature of the Dangerous Goods stored and used at the site to enable an effective hazard analysis to be conducted.

Table 4-2: Nature of the Dangerous Goods to be Stored and Used at Bayswater B

Type of Storage	Chemical Name	Hazardous Nature of the Chemical	Class	Packaging Group*
Transformer Tanks	Transformer Oil	Used for cooling – oil may have immediate effect to the biophysical environment. If ignited, oil can burn with large quantities of smoke, in the event of large spills, there is a potential for long term impact to the environment. Minor impacts to health and safety.	C2	-
Above Ground Tank	Ammonia (anhydrous)	Used for water treatment – Ammonia is a hygroscopic toxic gas, impact to people may be severe depending on concentrations, high concentrations could cause severe damage to mucous membranes (eyes, nose, throat), ammonia is explosive at concentrations in excess of 27% in air if confined within rooms. Low impact on the environment in gaseous form. Potential corrosive effect in liquid form (i.e. mixed with water)	2.3	-
20L Drums Underground Tank	Kerosene/ Turpentine/ Gasoline	Minor quantities, general use – the storage of these materials is in minor quantities only (as defined in the relevant standards). In the event of a release, a flammable liquid will form a pool, if ignited, a pool fire would result with the potential to impact adjacent areas. The potential long term contamination of soil is minimal. Irritation if contact with skin could occur but would also be low risk..	3	III
Above Ground Tanks and Underground Tanks	Diesel Fuel	Used for vehicle fuel and boiler start up in the coal option – diesel fuel may have immediate effect to the biophysical environment. If ignited, diesel can burn with large quantities of smoke, in the event of large spills, there is a potential for long term impact to the environment. Minor impacts to health and safety.	C1	-
Above Ground Tank, IBC, Packages	Sodium Hydroxide	Used for water treatment – Sodium hydroxide is a corrosive alkali. PGIII indicates low risk, damaging to the environment may occur in larger spills. PGIII impacts to people would be low as long as washed off immediately. Continued exposure for 1-2 hours could result in chemical burns	8	III
Above Ground Tank	Sulphuric Acid	Used for water treatment – sulphuric acid is a corrosive acid. PGII indicates moderate risk, damaging to the environment may occur in larger spills. PGII impacts to people would be low as long as washed off immediately. Continued exposure for 3-60 minutes could result in chemical burns. Sulphuric acid results in an exothermic reaction with water (i.e. generates heat).	8	II
Refrigerated Above Ground Tanks	Caron Dioxide (compressed)	Used for inert gas drench – Carbon Dioxide (CO_2) is a Non Toxic/Non Flammable gas which is heavier than air. The gas itself is not toxic however, it can exclude oxygen resulting in a potential for asphyxiation.	2.2	-

Type of Storage	Chemical Name	Hazardous Nature of the Chemical	Class	Packaging Group*
Above Ground Tank	Oxygen	Used for water treatment – Oxygen is a non-toxic/non-flammable gas. The gas itself is not combustible, however, it can assist combustion causing larger fire events. In the event of release, oxygen will dissipate into the surrounding atmosphere. Confinement of the gas (i.e. in a room) could result in an asphyxiation hazard.	2.2 (5.1)	-
205 L Drums	Hypochlorite Solution	Used for water treatment – Hypochlorite liquid has a chlorine odour and evolves very toxic gases (e.g. chlorine, phosgene) on contact with acid and or excessive heat such as fire. It is mildly corrosive to metals and can cause impact to the biophysical environment in large release events.	8	III
205 L Drums	Ammonia Solution	Used for water treatment – Ammonia solution is a corrosive, colourless liquid with a bleach smell. It is corrosive to noble metals (zinc, copper, tin, etc.) but low corrosion to steel/iron. The liquid is harmful if swallowed and excessive vapours could cause injury (i.e. confined in rooms). Minor impact to the environment if released as indicated by the PGIII designation.	8	III
Cylinders	Petroleum Gas, Liquefied	Used for boiler start – LPG is a flammable gas that is heavier than air. In the event of release, the gas can form a cloud resulting in explosion if ignited in a confined areas. When ignited upon immediate release it burns with a jet fire. Flash fires may occur if the gas cloud occurs in the open. As the liquid vaporised, there is no impact to environment.	2.1	-
Cylinders	Hydrogen Compressed	Used for generator cooling – Hydrogen is the lightest element. It rises rapidly when released and burns with a clear jet flame. The gas is difficult to contain and does not readily form a gas cloud.	2.1	-
Cylinders	Acetylene/ Propane	Used for maintenance – Acetylene/propane behave in a similar manner to LPG (see above)	2.1	-
Cylinders (70kg)	Chlorine	Used for water treatment – Chlorine is a yellow toxic gas (non-flammable) which is heavier than air. The toxicity of chlorine is severe and impact to people may occur at very low concentrations (i.e. sever impact to mucous membranes - eyes, nose, throat). Releases are detectable by smell at less than 2 parts per million (ppm). Concentrations in excess of 20ppm may be fatal. The gas may be absorbed into water which becomes corrosive.	2.3	-

*Packaging Group indicates risk: I – High Risk, II – Medium Risk, III – Lo Risk

4.3 Detailed Hazard Identification

Based on the hazards identified in the Hazard Identification Table (**Table 4-3)**, a detailed hazard analysis was conducted, the results of which are detailed kin the following sub-sections. The analysis assesses each DG in turn and determines the potential for offsite impact based on the safeguards proposed for inclusion in the design and operation of the power station(s). Where the hazard analysis identified a potential for offsite impact the incident is carried forward for consequence analysis (**Figures 4-1** (coal fired option) and **4-2** (gas fired option) may be used to identify the location of the various storages at the site).

4.3.1 Transformer Oil

Each of the power station options would include the installation of station and site transformers. **Table 4-1** lists the quantity of oil that would be held in each transformer in the two power station options. There would be three main transformers and two auxiliary transformers for the coal fired option (total 5) and five main transformers and five auxiliary transformers for the gas fired option (total 11). The transformer oil proposed for use would be classified as a C1 combustible liquid by the Australian Dangerous Goods Code (Ref. 1) and AS1940-2004 (Ref.9). Hence, if heated and ignited the transformer oil can result in a severe fire which is difficult to extinguish.

Whilst the oil would be contained within the transformer casing the oil presents no hazard, however, in the event of a release, there is a potential for ignition of the oil and fire in the bunded area under the transformers. Transformer casing and pipework leaks may occur in the transformer equipment leading to a loss in oil to the transformer bund. Loss of oil level could result in exposure of internal windings, spark, ignition and fire.

Transformers of the size and capacity to be installed at the power station facilities would be fitted with Buchholtz switches, which are low oil level switches installed to isolate power to the transformer in the event of low oil. In the event the switch fails, and an oil leak occurs, the exposed windings in the transformer could overheat causing ignition of the oil and explosion/bund fire. Heat radiation from such a fire could impact offsite, however, it is noted that the site boundaries in both the coal fired and gas fired options are a significant distance from the transformers. Notwithstanding this, the transformer incident has been carried forward to ensure the fire is a safe distance from the boundary.

4.3.2 Ammonia (Anhydrous)

Anhydrous ammonia would be used for water treatment in both power station options and would be stored in a pressurised above ground steel tank (vessel) in the chemical dosing area at each of the power station options. The tank at the coal fired facility would store a maximum of 50,000 L; the tank at the gas fired facility would store a maximum of 20,000 L. In both cases, the tanks would be filled by a 20-25 tonne road tanker only two or three times per year.

As noted above, both power station options use the ammonia for water treatment. In both cases, the use would be the same. Gaseous ammonia would be drawn from the top of the tank and delivered to the water treatment (addition) facility by 50mm pipeline. The pipeline would initially run from the top of the tank into a dosing building adjacent to the plant.

In the event a release of ammonia occurs, there is a potential for the gas to form a cloud. Whilst it is noted that ammonia, by chemical formula is lighter than air, the ammonia is hygroscopic (i.e. attracts water) and the water vapour in air combines with the ammonia molecule forming a heavier than air toxic gas cloud. In the event people are impacted by the cloud, injury or fatality may occur where personnel are exposed to high concentrations of the gas. The formation of an ammonia gas cloud could result in the cloud being carried downwind and offsite. This could impact adjacent land uses causing injury and/or fatality.

Ammonia would be transferred to the tank from a road tanker located adjacent to the tank bund. The filling point would be provided in both power station options. The filling point would be protected by impact barriers and use dedicated as filling lines/filling connections. The ammonia delivery driver would be used for the transfer operation. A tanker mounted pump would be used to transfer the ammonia from the truck tank to the storage tank via the flexible hose.

As noted above, spills from the tank and associated pipework or as a result of ammonia transfer operations would evaporate, leaving little or no residue. Hence, there would be no impact to the biophysical environment from incidents at the ammonia storage and therefore release events impacting the environment have not been assessed further in this study.

Incidents involving the development of a toxic gas cloud that could be carried offsite by the wind have been carried forward for consequence analysis.

4.3.3 Acetone/Kerosene/Turpentine – Flammable Liquids Store

Acetone, kerosene and turpentine would be used on both power station option sites in workshop areas and within the plant for maintenance of equipment. The quantity of these materials is small as they are only used for cleaning and thinning of paints. A dedicated flammable liquids store would be constructed for the storage of flammable liquids at the site, the store would comply with the requirements of AS1940 (Ref.9), including spill control, fire walls and separated from other storage areas. A range of containers would be used for the storage of flammable liquids (i.e. 1 L, 5 L, 20 L, etc.), all relatively small and, hence, spills would be limited to the immediate vicinity of the store.

The store will be designed to hold a maximum of 5,000 L, however typical storage quantities would be in the order of 500 L. This would be the same for both power station options. In the event of a container failure (e.g. leak) flammable liquid would spill into the bunded area constructed as part of the store, hence, there would be no release off-site. In the event the release was Ignited, a pool fire would occur in the store. As the store would be designed with fire walls, there would be no impact boyoind the confines of the store and there would be no potential for fire growth to adjacent areas.

The flammable liquids store would be located over 500 m from the closest site boundary (both power station options), hence, there would be no impact offsite as a result of incidents at the flammable liquids store. Incidents at the flammable liquids store are not carried forward for further analysis.

4.3.4 Gasoline

Gasoline is not used as a process fuel on site, it is stored purely for the use of site vehicles and would be stored in a 20,000 L underground storage tank in both power station options. The underground tank would be a double skin tank, with leak detection and alarm between the tank shells. In the event of a leak of petrol from the inner shell into the annulus space, the leak detection device would raise an alarm in the central control room, initiating response. Hence, the potential for release to sub-surface soils is negligible and the proposed safeguards are considered to control the risks within the ALARP range. Hence, this incident has not been carried forward for further analysis.

In both power station options, fuel would be delivered in 20,000 L road tankers. The main hazard with underground tanks is not the tanks itself but the tasks associated with the tank filling operations. The transfer of fuel from the tanker to the tank requires the connection of flexible hoses and the transfer of the fuel by gravity from the tanker truck into the underground tank.

Whilst unlikely, hose failures may occur (e.g. leaks, premature disconnection at the tanker or tank connection, hose rupture) resulting in spillage of fuel into the tanker unloading area. As an operator (tanker driver) is present during the transfer of fuel, the operation can be stopped immediately. This would prevent pool formation under the tanker transfer point. Incidents have occurred in the past whereby tankers have been driven away from the transfer area whilst still connected, this could lead to hose rupture and loss of fuel to the ground. To prevent this, tankers are fitted with drive-away protection, which consists of a bar across the loading connections. When the flexible hose is connected to the tanker transfer connections, a bar must be moved down to access the connection. The bar is connected to an air valve, which releases the air within the brake system, applying the truck brakes. Hence, the truck cannot be driven away unless the hose is disconnected and the bar raised.

It is noted that both power station options will be constructed with a number of water retention and treatment systems, including a first flush pond capable of containing around 900 m^3. As hoses only contain around 100 to 200L, a spill from a hose would be minimal and the first flush pond would be more than capable of containing the spill. Hence, there would be no impact offsite as a result of a spill in the gasoline delivery area.

Whilst spills to the environment would be contained on site, in the event of an ignition of a gasoline spill, a pool fire would form, radiating heat to the surrounding areas. Whilst the fuel transfer point is well clear of the site boundary, there is a potential for heat radiation to impact extended distances. Hence, this incident has been carried forward for further analysis.

4.3.5 Diesel Fuel

Vehicle Fuelling - Underground Tank

Diesel would be used for fuelling site trucks and would be stored in a 30,000 L underground storage tank in the coal fired option and a 15,000 L underground storage tank in the gas fired option. In both power station options, as for gasoline (see **Section 4.3.4**), the underground tanks would be double skin tanks, with leak detection and alarm between the tank shells. In the event of a leak of diesel from the inner shell into the annulus space, the leak detection device would raise an alarm in the central control room, initiating response. Hence, the potential for release to sub-surface soils would be negligible and the proposed safeguards are considered to control the risks within the ALARP range. Hence, this incident has not been carried forward for further analysis.

The hazards associated with diesel fuel, stored in underground tanks, are the same as those detailed in **Section 4.3.4** for gasoline. Hence, the results of the assessment conducted in **Section 4.3.4** can be applied to the diesel fuel storage and handling risks. Fires in the diesel storage handling area (i.e. tank filling) have therefore been carried forward in this study.

It is noted that the fuel transfer operations for gasoline and diesel are virtually identical, hence, a the hazard has been carried forward as a combined incident analysis in the consequence assessment section of the study.

Boiler Start-Up – Above Ground Tank

During the plant start-up phase, it will be necessary to start the boilers using diesel fuel. Once the boilers have reached a temperature whereby coal burning can be self sustaining, the coal feed will be started and the diesel shut-down. Diesel will be stored on site in a 3,600 kL above ground tank that would be located adjacent to the chemical storage area. The diesel would be delivered to site in tankers and transferred to the above ground tank using taker mounted pumps.

The hazards associated with the storage of diesel fuel in above ground tanks are associated with fuel spillage into the tank bund and the potential for escape of the fuel to the environment, resulting in environmental damage. In the event of an ignition, there is a potential for a pool fire in the bund, resulting in the potential for offsite heat radiation impact. It is noted, however, that the tank would be bunded to contain a minimum of 100% of the tank contents, hence, there would be no escape of diesel offsite and therefore no impact to the environment. This incident has not been carried forward for further analysis. However, in the event of a fire, a full bund fire may result in heat radiation at the site boundary greater that the acceptable limit of 4.7 kW/m^2 (i.e. acceptable without further analysis). Hence, a full bund fire in the start up diesel tank has been carried forward for further analysis.

As discussed in the underground tank, incidents resulting in spills during transfer of diesel when unloading may result in release to the environment. However, like the underground tanks, the above ground tank transfer area will be bunded to contain any spills and there will be no release to the environment. Hence, this incident has not been carried forward for further analysis. In the event of an ignited spill of diesel during transfer, a pool fire would form in the spill area. This incident may radiate heat to the surrounding areas, however, it would be considerably smaller than the full bund fire discussed above. This incident has not, at this stage, been carried forward for further analysis as the worst case incident (full bund fire) has been carried forward for assessment. In the event this incident has the potential to impact offsite, a review of the fuel transfer fire would be conducted.

4.3.6 Sodium Hydroxide

Sodium hydroxide would be used for pH control of the boiler water circuit at the power station. Four tanks would be installed at the coal fired facility with capacities of 93,000 L (x2), 46,000 L and 20,000 L. A number of Intermediate Bulk Containers (IBCs x 4) containing sodium hydroxide would also be stored at the site. At the gas fired facility two tanks would be installed with capacities 25,000L and 10,000 L. An IBC (1) would also be stored at the site. The relevant Australian Standard for the storage of corrosive substances (alkali) is AS3780 (Ref.7). This standard requires the installation of spill retention bunding, which will be constructed in both power station options. Hence, in the event of a spill from the storage facilities, the release would be contained within the tank/IBC bunds. Sodium hydroxide (caustic) would be delivered to site in 20,000 L tankers. A tanker mounted pump would be used to transfer the (caustic) from the tanker to the tank via flexible hose. The tank would be located adjacent to a site road so that the tanker could park on the road adjacent to the tank and transfer the liquid via a flexible hose. The road area would be graded to collect any spills and direct them to a pit with capacity to contain the tanker contents. As noted in the gasoline transfer assessment, the site would also be constructed with a number of spill retention systems, including a first flush pond that would have a capacity of $900m^3$. Hence, the potential for offsite release and impact to people and the environment beyond the power station boundary (both options) is negligible. The proposed spill retention systems and controls are considered adequate for the caustic operations and therefore this incident has not been carried forward for further analysis.

4.3.7 Sulphuric Acid

Like the caustic, Sulphuric Acid would be used for the pH control of the boiler water circuit at the power station. Three tanks would be installed at the coal fired power station with capacities of 32,600 L, 68,000 L and 7,000 L. At the gas fired power station four tanks will be installed with capacities of 16,000 L, 35,000 L (x2) and 3,500 L. The relevant Australian Standard for the storage of corrosive substances (acids) is AS3780 (Ref.7). This standard requires the installation of spill retention bunding, which will be constructed in both power station options. Hence, in the event of a spill from the storage facilities, the release would be contained within the tank/IBC bunds. Sulphuric Acid would be delivered to site in 20,000 L tankers. A tanker mounted pump would be used to transfer the acid from the tanker to the tank via flexible hose. The tank would be located adjacent to a site road so that the tanker could park on the road adjacent to the tank and transfer the liquid via a flexible hose. The road area would be graded to collect any spills and direct them to a pit with capacity to contain the tanker contents. As noted in the caustic transfer assessment, the site would also be constructed with a number of spill retention systems, including a first flush pond that would have a capacity of 900 m^3. Hence, the potential for offsite release and impact to people and the environment beyond the power station boundary (both options) is negligible.

It is noted that the caustic and Sulphuric Acid transfer systems would be separate facilities, preventing the potential for the mixing of these two products, which could lead to an exothermic reaction (i.e. heating). Caustic and Sulphuric Acid transfers would not be conducted simultaneously and, hence, as the two transfer points would be separate and there would be no simultaneous transfer of the two products, there is no potential for mixing of these products in the event of a localised spill.

The proposed spill retention systems and controls are considered adequate for the caustic operations and therefore this incident has not been carried forward for further analysis.

4.3.8 Ferric Chloride

Ferric chloride would also be used for water treatment on site. The material would be stored as a liquid in a single tank (30,000 L in the coal fired option and 15,000 L in the gas fired option), which would be bunded to contain the full tank contents. Ferric chloride would also be delivered to site in 20,000 L road tankers and would be transferred to the tank via a flexible hose and tanker mounted pump.

The tank farm, in which the tanks are located, would be fitted with a dedicated loading bay which would be fully bunded to contain the full contents of the tanker in the event of a spill. In addition to the local spill containment, the site would be fully contained with all drains reporting to the site first-flush pond. The first flush or holding pond would have a freeboard capacity of 900 m^3. Hence, the potential for offsite release would be negligible. This incident has not been carried forward for further analysis as the existing hazard control measures are considered adequate for this section of the plant.

4.3.9 Corrosive Liquids Store

A corrosive liquids store would be constructed for both power station options. This store would hold a number of corrosive materials in 200 L to 20 L drums. The materials proposed for storage in this depot include Sodium Hydroxide Soln., Sulphuric Acid, Hypochlorite Solution, Ammonia Solution, Corrosive Liquid NOS and Formaldehyde Solution. The materials stored in the corrosive liquids store will be used for the preparation of the boiler water treatment solution. The drums store would be located within the main stores compound and would be fully bunded to contain 25% of the capacity of liquids stored in the depot. In the event of a drum leak, the spillage would be fully contained by the bund. The store would be fitted with a roof, which would prevent the ingress of rainwater into the bund and the potential for overfilling of the bund and escape to the site drainage system. During drum loading and unloading there would be potential for a drum to fall from a truck, resulting in split and spill outside the containment of the depot. In this case there would be potential for liquid to reach drains. However, personnel would be in attendance during drum handling and spill containment equipment is provided in the stores compound. Use of this equipment would minimise the spill quantity. Notwithstanding this, there is a potential for some liquid to enter drains, however, the site is fully contained and all drains report to the site first-flush pond. The first flush or holding pond has a freeboard capacity of 900m^3. Hence, the potential for offsite release is negligible. Further, the spill of 200 L into the large capacity ponds would result in dilution to a point where the spilt chemical would not be detectable. This incident has not been carried forward for further analysis as the existing hazard control measures are considered adequate for this section of the plant.

4.3.10 Petroleum Gas, Liquefied (LPG)

In both power station options, LPG would be stored in cylinders, located in a depot separated from other on-site areas. A review of the quantity of LPG stored in the proposed depot, at each power station option, indicates that the storage would be classified as minor under the provisions of AS4332 (Ref.8). The individual cylinder capacity would be considered low ($\approx$18 kg) and incidents involving cylinders in this depot would not cause impact beyond the immediate area of the depot. The depot will be located well clear of other areas on site and well clear of the site boundary. The depot would be located kilometres from the nearest adjacent site and impacts at the adjacent sites from LPG cylinder would be negligible. Hence, incidents at the LPG cylinder store have not been carried forward for further analysis.

4.3.11 Carbon Dioxide

Carbon dioxide would be used in both power station options as an inert gas drench system in areas subject to high fire risk (e.g. gas turbine enclosures). The gas is compressed and stored in cylinder banks in a number of locations around the power station option sites.

Each of the CO_2 cylinder banks would be monitored by pressure instruments to ensure gas pressure is maintained within the system. Leak and loss of CO_2 would result in a gas pressure reduction in the delivery line and therefore an alarm would be raised in the control room. This would enable onsite emergency response to be initiated and the incident effectively controlled.

CO_2 is a normal component of air, making up about 12% of normal atmospheric air components. The molecular weight of CO_2 dictates that it is heavier than air, hence, on release the gas will fall towards the ground and be dispersed by wind and air movements. The CO_2 storage cylinders would be located over 620m (coal fired option) and 545 m (gas fired option) from the site boundary, hence, the likelihood of CO_2 impact at the site boundary is very low. It is noted that the CO_2 is stored as a compressed gas in cylinders and, therefore, In the event of a release of CO_2 the gas would disperse into air over the distance between the release point and the site boundary. Based on low likelihood of offsite impact, this incident has not been carried forward for further analysis.

4.3.12 Oxygen Storage

Oxygen would be used in the treatment of boiler feedwater in both power station options. The oxygen would be stored in a refrigerated liquid tank of 50,000 L water capacity for the coal fired option and 20,000 L capacity for the gas fired option. The tank would be located in the chemical treatment area of the selected option and would be installed in accordance with the requirements of AS1894 (Ref.11).

Oxygen is not a flammable substance and would not burn in the event of release. However, in the event that a release occurs in the vicinity of a fire, the oxygen would enhance the fire event, causing a more intense incident with the potential for increased consequences. In the event of a release of oxygen that accumulates and forms a cloud, there is a potential for injury or fatality to personnel due to an oxygen rich atmosphere.

The refrigerated liquid tank proposed for use, at both of the power station options, would be a double skinned tank, with insulation in the annulus space between the tank shells. Hence, the potential for release of oxygen via a tank leak is minimal. However, leaks may occur as a result of fitting or joint failure. To minimise the potential for leak in pipe work, metal to metal joints would be used instead of flanges.

As the oxygen would be stored as a refrigerated liquid, releases (both from the static tank and during tank filling) would not result in an immediate and massive expansion of gas. Refrigerated liquid would release and form a pool under the release point. The liquid would then absorb the heat from the surrounding area releasing oxygen gas at the liquid surface.

As oxygen is slightly heavier than air, the gas would disperse slowly and be dissipated by air movements and wind. As the closest site boundary would be over 620 m (coal fired option) and 545 m (gas fired option) from the oxygen tank the likelihood of impact at the site boundary is very low and the risk would be considered negligible. This incident has therefore not been carried forward for further analysis as the risk of offsite impact is low and there will be minimal environmental impact (as a result of an accidental release) as oxygen is a normal constituent of air.

4.3.13 Compressed Hydrogen

Hydrogen would be stored at the coal fired facility only. The capacity of the coal fired generators (1000 MW each) would dictate the use of a hydrogen cooling circuit. However, the smaller generators at the gas fired facility (<400 MW) would not require a hydrogen cooling circuit. The hydrogen would be stored as a compressed gas in cylinders located adjacent to (and on the exterior of) the turbine hall. The maximum quantity of hydrogen gas in the cylinders would be 58 m^3 (liquid capacity of cylinders). Hydrogen is used in the cooling of large generators as it is an effective heat transfer medium and provides for smaller cooling circuits in the generator system.

Hydrogen gas is the lightest element and as the cylinders would be located externally, any leaks would result in the gas immediate rising into the atmosphere above the storage, dissipating without the formation of a cloud. Hence, the potential for an explosion of a hydrogen gas cloud in negligible.

In the event of a hydrogen release and immediate ignition, a jet fire would result. As hydrogen does not contain any carbon, it combines with oxygen to form water and heat. The flame produces no soot and is clear and invisible. The intensity of the flame is usually high due to the high pressure of the storage, however, the heat radiation is very localised with the impacts from the fire only projecting short distances from the jet flame. The site boundary is about 620 m from the hydrogen storage in the coal fired facility 545 m from the hydrogen storage in the gas fired facility.

In summary, there would be no impact beyond the site boundary from incidents at the hydrogen cylinder store. Hence, incidents in the hydrogen storage area are not carried forward for further analysis.

4.3.14 Flammable and Non-Flammable Gas Cylinder Store

Acetylene, oxygen and argon cylinders would be required in both power station options. The materials would be stored in a cylinder store located in the main stores compound, at the power station, and would be used mainly for maintenance purposes (i.e. welding) The maximum storage quantity of cylinders in both power station options would be the same and would be well below the threshold quantity for minor storage as listed in AS4332 (Ref.8).

Leaks of flammable gas (acetylene) from stored cylinders may occur around the valves at the cylinder top. Ignition of such leaks would result in a jet flame at the cylinder valve. This flame would be limited in duration as the cylinder stores a finite quantity. Whilst this scenario is feasible, the likelihood is low due to the cylinder store being located in a dedicated area away from ignition sources and secured by a wire mesh cage. The facility complies with the requirements of AS4332 (Ref.8).

The closest site boundary to this facility is about 620m for the coal fired option and 545m for the gas fired option. Incidents in the cylinder store would have no offsite impact and little if any onsite impact. Incidents in the cylinder store have not been carried forward for further analysis due to the relatively small quantities stored and the separation distances provided by the store location.

4.3.15 Chlorine

In both power station options, chlorine is used for water treatment. The chlorine storage and handling facility would be the same for both options. A dedicated facility (building) would be constructed for the storage of chlorine, which will be stored in 70 kg cylinders. Six (6) cylinders would be stored in the depot that would be designed to comply with the requirements of AS2927 (Ref.10). Chlorine would be used for water treatment (control of algae growth) and would be dosed to the water cooling circuit using a vaporisation facility and dosing pump. There would be two cylinders connected to a manifold, one duty and one stand-by, which deliver the chlorine to the water dosing system. As chlorine is used and the on-line cylinder empties, the second cylinder would be automatically brought on line once the chlorine flow reduces in the online cylinder.

The chlorine storage system will be established to provide notification to the plant control room once a cylinder is empty. Operators will then attend the chlorine storage area and exchange the empty cylinder with a full one. To minimise the storage of chlorine at the site, once two empty cylinders have accumulated at the depot, two full cylinders would be ordered and delivered to site by flatbed truck from Orica in Sydney.

Chlorine is a highly toxic gas that is heavier than air. In the event of release, it falls to ground level forming a cloud that disperses downwind. Concentrations of chlorine at relatively low levels (e.g. 20 ppm) may cause fatalities if people are exposed for extended periods. In the event of a release of chlorine, a gas cloud could form and, in the right wind conditions, be carried downwind to a point where the concentration at the site boundary could exceed harmful levels.

Impacts to the environment from chlorine releases are low potential as the chlorine is stored as a liquefied gas that evaporates and dissipates in the air without impact to the biophysical environment. Hence, environmental incidents have not been assessed further in this study.

However, as discussed above, a chlorine release could reach the site boundary at harmful concentration levels, hence, chlorine release incidents have been carried forward for consequence analysis.

4.3.16 Natural Gas Supply (Gas Fired Option Only)

The gas fired power station would be supplied by natural gas from a lateral pipeline running off the Queensland to Hunter gas pipeline. The main pipeline (Queensland to Hunter) is proposed to be constructed from X42 steel with a diameter of 500mm and wall thickness of 12.7mm. The operating pressure of the proposed Queensland to Hunter gas pipeline is 153MPa. The gas use at the proposed gas fired power station would not require a pipeline of this diameter or operating pressure, hence a smaller diameter pipeline would be installed with a pressure let down station at the lateral off take. The proposed lateral pipeline design and operational details are listed below:

- Operating Pressure – 5,000 kPa or 50bar (50 atmospheres);
- Diameter – 355 mm;
- Wall thickness – 9.4 mm; and
- Material – X42 Grade Steel.

There is historical evidence of gas transmission pipeline failure both in Australia and overseas. Historical evidence (Ref.12) indicates that there are a number of factors that can lead to pipeline leak and subsequent release of gas. The details below summarise those incidents that have historically led to pipeline failure and gas release:

- **External Interference** – external interference leads to the majority of release incidents in gas transmission pipelines (Ref.12). Excavators, front end loaders, augers and other digging equipment can strike pipelines leading to gas release, ignition and jet fire. At this stage of development in the area there are few if any adjacent sites. Hence, there is a low likelihood of external impact. Development in the area would be limited as the majority of the pipeline would be located on power station controlled land. Notwithstanding this, external impact has been carried forward for further analysis.
- **Flood Damage** – this may occur where the pipeline traverses river beds or watercourses. The potential for fast running water could lead to scouring above the pipeline exposing the pipe to potential impact from rocks and debris moving in the water stream. In addition, surface flooding could lead to the pipeline floating from the trench, leading to pipeline damage. A review of the pipeline route indicates that it will not cross any continuously running watercourses and there is no potential for extensive flooding along the proposed route. Hence, subsidence and flood damage in the Bayswater B pipeline corridor has not been carried forward for further analysis.
- **Subsidence Damage** – where pipelines are installed near or in banks and levees, wash away may expose the pipeline and uneven weight could cause severe pipeline damage. However, the pipeline is not installed in a bank or levee, hence, incidents resulting from subsidence have not been carried forward for further analysis
- **External Corrosion Damage** – many soils are acidic and pipeline installed without external protection are susceptible to corrosion and eventual failure (leaks). Whilst it is recognised that the pipeline will be coated with high density polyethylene (HDPE), known as “yellow jacket”, external impact such as rocks falling into the trench when backfilling occurs or minor impact from digging (without breaching the pipe) could lead to chips and dents in the pipe surface, exposing the steel to acidic soils. Hence, damage to a pipeline coating could lead to accelerated and preferential corrosion and premature pipeline failure. These incidents are covered in the external impact assessment carried forward for further assessment. Installation of the “yellow jacket” is considered to reduce the potential for external corrosion to negligible levels. Incidents involving external corrosion (excluding impact) have not been carried forward for further analysis.

- **Internal Corrosion Damage** – the introduction of corrosive gas to the pipeline could result in accelerated corrosion or moisture in the gas could lead to corrosion impact on the pipe internal surface. However, gas would be fed from the main Queensland to Hunter pipeline and the gas is dry and non-corrosive, having passed over 800 km through this line. Hence, the likelihood of corrosion from this source is considered negligible. Incidents as a result of corrosion have therefore not been carried forward for further analysis.
- **Faulty Material** – the use of faulty materials, such as pipeline with manufacturing defects, could lead to premature pipeline failure resulting in rupture. However, pipe material would be purchased from a quality assured organisation, which minimises the potential for faulty materials. Further, the pipeline would be fully tested in accordance with the requirements of AS2885 (Ref.13), including a pressure test to prove pipeline will operate safely and without failure at maximum allowable operating pressure (MAOP). The quality assurance testing regime required under AS2885 (Ref 13) minimises the potential for pipeline failure as a result of material defects. Hence, these potential incidents have not been carried forward for further analysis.
- **Faulty Construction** – like the faulty materials incidents details above, faulty construction can also lead to failure of the pipeline. For example, faulty welding can lead to premature failure and gas release. However, pipeline welds would be subjected to X-Ray inspection minimising the potential for failure from this source. Further, the pipeline would be subjected to a testing regime required by AS2885 (Ref.13), further minimising the potential for faulty construction failure. Additional construction problems, such as poor trench design, incorrect backfilling, etc. would be minimised by strictly following the requirement of AS2885 (Ref.13). Hence, incidents as a result of faulty construction have not been carried forward for further analysis.
- **Ground Movement** – this may occur where pipelines are installed in an earthquake zone. Earthquakes and excessive ground movement may lead to buckled pipework or, in the worst case, rupture. However, the pipeline is not installed in an earthquake zone. The northwest Hunter area is relatively stable and earthquakes of the magnitude that could result in pipeline rupture are rare and, hence, the risk is considered negligible. Whilst it is recognised that a major earthquake has occurred in Newcastle, NSW, the impact of this earthquake were not severe in the Upper Hunter region and pipelines installed in this area was not damaged during the Newcastle earthquake incident (1989). Incidents as a result of earthquake of excessive ground movement have not been carried forward for further analysis.
- **"Hot Tap" by Error** – "hot tap" is the connection to a live gas line during operation. When this is conducted by expert personnel the risk is negligible. However, failure to identify a live gas pipeline and attempts, by error, to connect to this pipeline could lead to pipeline breach and gas release. However, this only occurs where there are multiple pipelines in a single trench. The gas pipeline used to supply fuel to the gas fired power station would be the only pipeline in the trench. Hence, this incident is eliminated as there would be no other pipelines in the trench which could result in mistaken pipeline identity. This incident has, therefore, not been carried forward for further analysis.

The above analysis is supported by the results of studies conducted by the European Gas Pipeline Incident Data Base (Ref.12), which conducts research into gas pipeline incidents both in Europe and overseas. The results of these studies indicate that the majority of pipeline incidents (>50%) occur as a result of external interference.

4.3.17 Gas Release in the Gas Turbine Enclosure (Gas Option Only)

Natural gas (NG) fuel, supplied by pipeline from the main supply line, would be used to supply the gas turbines. The fuel would be piped internally within the turbine enclosure and hence any leaks of gas would have the potential to accumulate within the enclosure resulting in the formation of a flammable gas cloud. Ignition of such a cloud could result in explosion and significant damage to the enclosure as well as offsite impact from explosion overpressure and/or “missiles” projected from the destruction of parts of the enclosure.

To minimise the potential for such an incident, the gas turbine enclosure would be fitted with ventilation, which will continually provide air exchange within the enclosure. Hence, any leaks would be diluted to below lower flammable limits (LEL) and discharged from the enclosure. Further, the enclosure would be fitted with hydrocarbon detectors, which would activate an alarm at 5% LEL and initiate gas turbine fuel supply shut down (from outside the enclosure) at 50% LEL. Hence, any leaks would either be diluted and / or isolated before reaching potentially hazardous levels.

Notwithstanding the fact that detection and protection measures would have been installed, in the event such measures fail, there is a potential for an explosion within the enclosure and jet fire at the leak source. Hence, explosion and fire incidents at the gas turbine enclosure have been carried forward for further analysis.

4.4 Incidents Carried Forward for Consequence Analysis

The following incidents have been identified to have the potential to impact offsite:

- Ammonia incidents (release and toxic impact downwind);
- Gasoline fuel incidents (spill & fire whilst transferring to U/G tank);
- Diesel fuel incidents (spill & fire whilst transferring to U/G tank);
- Chlorine incidents (release and toxic impact downwind);
- Transformer incidents (oil spill and pool fire in bund);
- Gas pipeline – external interference incidents; and
- Gas Turbine enclosure explosion incidents.

A consequence analysis has been conducted in **Section 5** for each incident listed above.

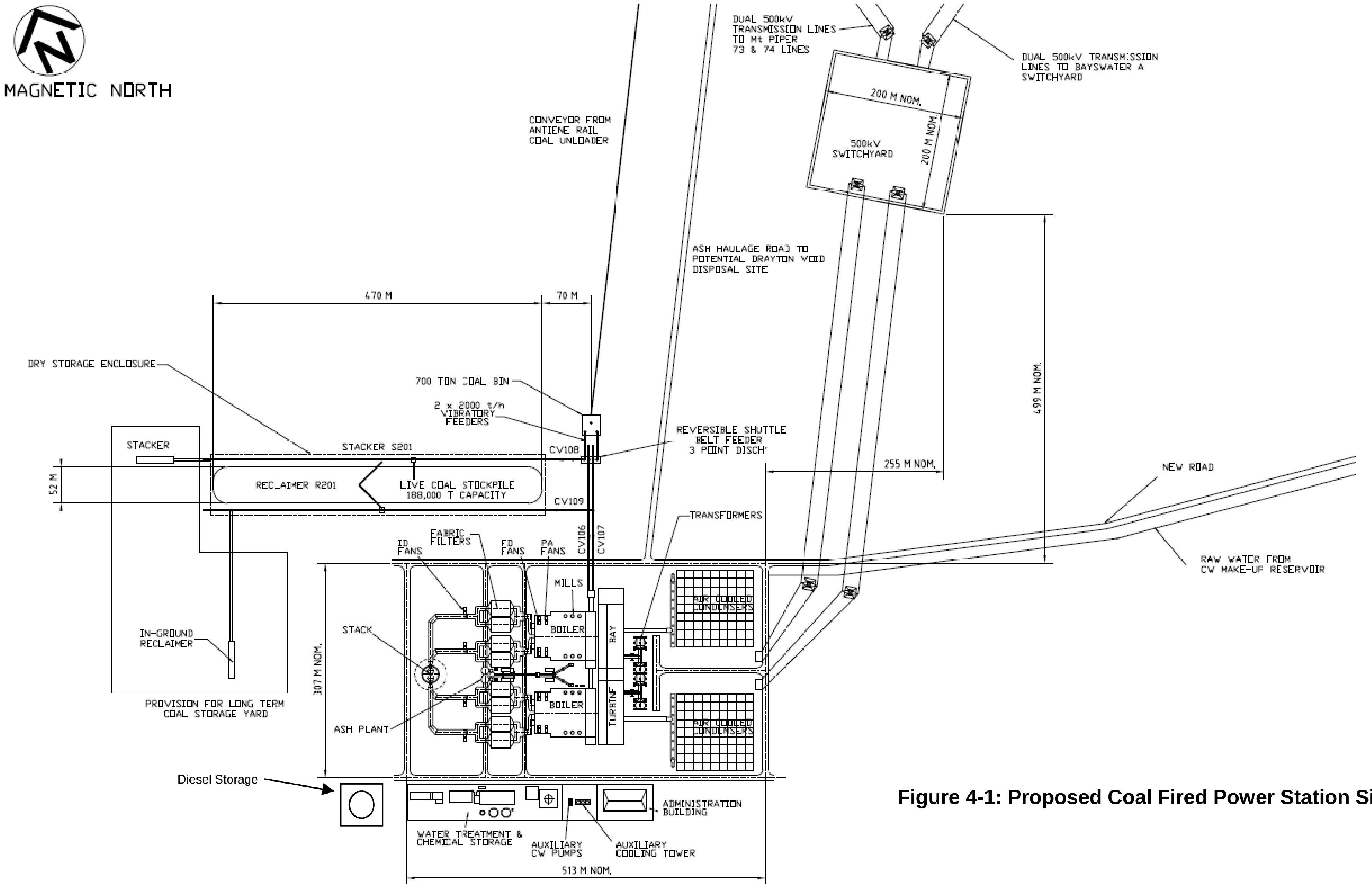


Figure 4-1: Proposed Coal Fired Power Station Site Layout

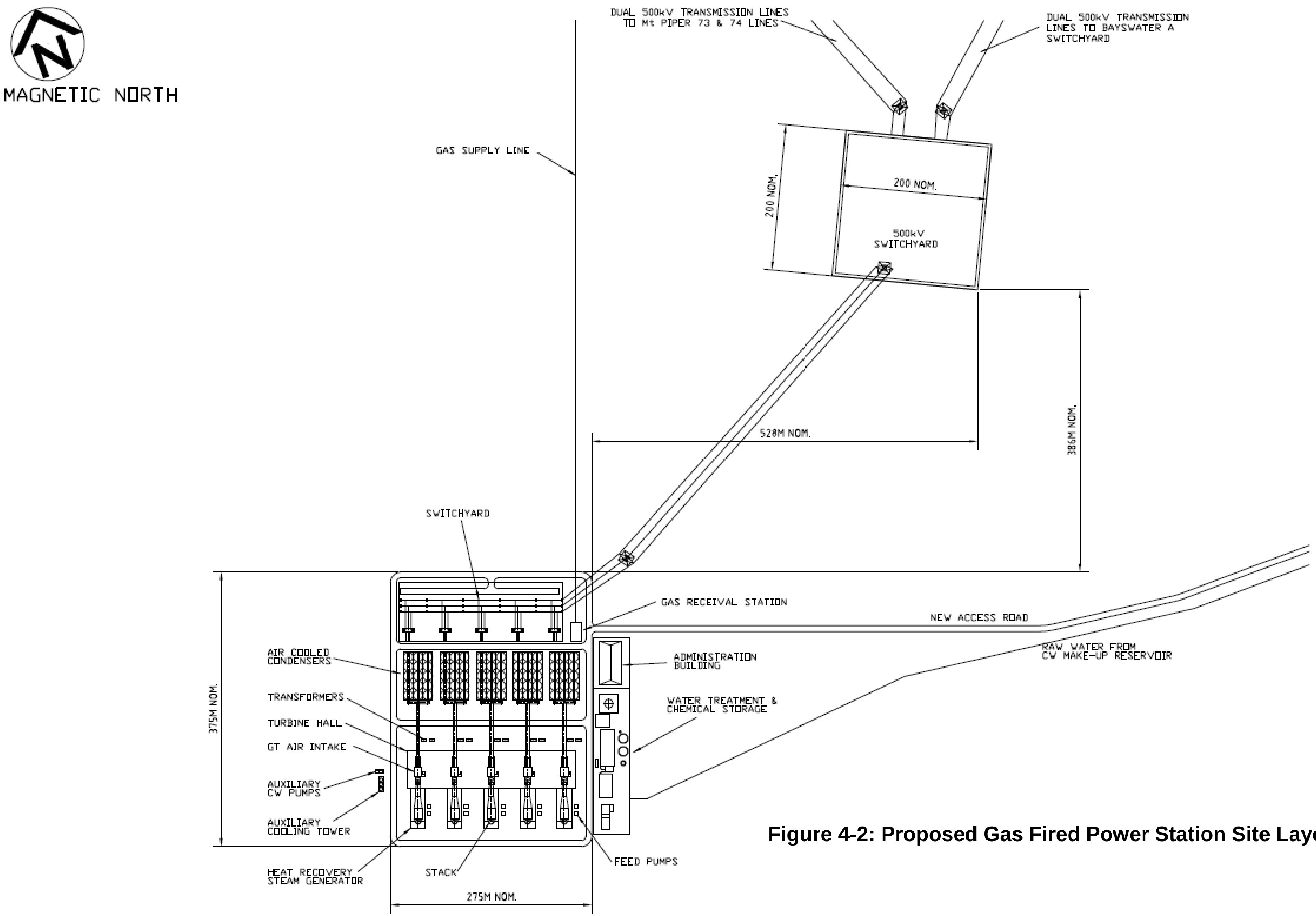


Figure 4-2: Proposed Gas Fired Power Station Site Layout

Table 4-3: Hazard Identification table

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Corrosive Materials – Class 8 (Sodium Hydroxide, Sulphuric Acid, Ferric Chloride)			
Failure of tank or pipe in the storage area resulting in leak/release	Hole in tank, gasket failure, pipe damage (physical), internal/ external corrosion of storage	Environmental impact as a result of leak from tank into the surrounding area	• Corrosive liquids tanks will comply with AS3780 • Tanks will be bunded to contain 100% of the largest tank in the bund (IAW AS3780) • Plant maintenance regime (PM) will be implemented to regularly inspect tanks • Corrosion resistant materials will be selected for tank and equipment components (as per AS3780) • Power station site (both options) will be bunded ($900m^3$ first flush pond)
Failure of component during corrosive materials transfer (filling tanks)	Drive-away whilst connected, Flexible transfer hose leak/failure	Corrosive materials impact to operators transferring from road tankers to tanks Spill of corrosive material in areas adjacent to the corrosive materials storage and potential release to the environment	• Operator will be present during transfer operations • All corrosive material unloading/transfer areas will be bunded to prevent release beyond immediate area of the spill • Power station site (both options) will be bunded ($900m^3$ first flush pond) • Operator will wear PPE • Regular testing of hoses will be performed • Drive-away protection will be provided on delivery vehicles (drop bar on delivery connections)

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Incompatible materials delivered to storage (i.e. delivery of acid into alkali tank or vice versa)	Operator error, incorrect signage, unfamiliar with site	Excessive heat from exothermic reaction, potential tank failure, release of acid/alkali from tank containment (Note: the materials held at the site will not result in a toxic gas generation, hypochlorite is not delivered in bulk)	• Clear signage will be provided at all delivery points • DG Placards will be located adjacent to the delivery connections • Single truck delivery only (i.e. mixed products not delivered in a single truck) • Tanks will be bunded to contain 100% of tank contents • Dedicated acid/alkali drivers, trained in product transfer operations
Transformer Oil – C1 Combustible Liquid			
Oil Leak from Transformer	Leaking join, pipe, casing	Level of oil falls in the transformer exposing the windings, overheating the transformer and igniting the oil resulting in a pool fire in the bund	• Buckholtz Protection - Low oil level switch, alarm and automatic transformer shut down • Transformers installed in bunds, drain to collection pits (full transformer contents) • Deluge system over transformer (prevents fire growth) • Fire main, hydrants and hoses through out the site

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Oil Leak from Transformer	Leaking join, pipe, casing	Level of oil falls in the transformer exposing the windings, overheating the transformer and igniting the oil resulting in transformer explosion and projectiles impacting adjacent transformers – incident growth	• Buckholtz Protection - Low oil level switch, alarm and automatic transformer shut down • Blast walls between transformers (as per NFPA standard) • Deluge system over transformer (prevents fire growth) • Fire main, hydrants and hoses through out the site
Carbon Dioxide – Class 2.2			
Leak and release from a cylinder or pipe in the storage area	Joint fails, tank hole, pipe damage (physical), internal/ external corrosion of storage	Leak from tank into the surrounding area, potential for asphyxiant cloud developing impacting personnel in the surrounding area No impact to the environment	• CO_2 will be stored as a gas in cylinders, limiting quantity of release • Cylinders storage areas will be regularly inspected and tested (fire protection system) • Corrosion resistant materials selected for tank and equipment components • Joints will be metal to metal face (no gaskets) • Storage area would be open with little confinement (i.e. good dispersion of gas)
Note: Once cylinders are filled, they are not re-filled unless a discharge occurs. Cylinders would then be replaced, not filled. Hence, no refill hazards.			

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Hydrogen Storage – Class 2.1			
Leak of hydrogen, ignition and fire	Hydrogen line failure, joint failure	Jet fire impinging on adjacent lines/cylinders resulting in fire growth, cylinder explosion Personnel walk through clear hydrogen flame resulting in burns	• Hydrogen is extremely light and the open storage area will prevent accumulation of gas • Joints and cylinder equipment will be located at the top of the cylinders minimising potential for jet fire impact on adjacent cylinders • Pipe work and equipment will be located at top of cylinders, about 5m above grade • Area will be fenced with 2m chain wire mesh preventing unauthorised personnel access • Cylinders will be deluged (sprinklers) used to cool the area in the event of fire
Leak of hydrogen from transfer pipe work, ignition and fire	Hydrogen line failure, joint failure	Jet fire impinging on areas adjacent to the transfer pipe work	• Pipe work will be fully welded along the transfer pipe work route • Pipe work will be located in an underground trench, minimising impact to adjacent equipment • No ignition sources in the trench • Trench will be located in open areas (no potential for containment of hydrogen)

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
LPG Storage – Class 2.1			
LPG leak	Cylinder valve leak	Gas cloud, delayed ignition and explosion Gas cloud delayed ignition and flash fire Gas release and immediate ignition – jet fire	• Cylinder store will be classified as minor by AS4332 (Ref.8) • Cylinders will be stored in a location isolated from plant operations • Quantity of gas in each cylinder will be low (18kg) • Fire fighting equipment will be located adjacent to the store
Ignited LPG Leak	Cylinder valve leak Dropped cylinder during delivery	Jet flame impinges on adjacent cylinders causing cylinder failure and explosion	• Quantity of gas will be low (18kg) limiting incident magnitude • Storage area will be isolated with negligible impact on adjacent facilities at the power station • Cylinders will be fitted with a valve guard, preventing impact damage to valves

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Kerosene/Turpentine – Class 3			
Leak of flammable liquid during storage or handling	• Corroded drum or container • Dropped drum	Spill leaks in the immediate area of the drum (note: drum size is limited, spread of spill limited by quantity of material in the drum)	• Quantities will be minor in nature (typically in 20L drums and small containers) • Flammable liquids will be stored in a dedicated and secured DG store • DG Store will be bunded to contain a minimum of 1000 L spilled materials (no release to the environment) • DG Store will be separated from adjacent facilities by a minimum of 3m • DG Store will comply with the requirements of AS1940-2004 (Ref.5) • Fire extinguishers, fire hydrants, hose reels will be provided adjacent to the storage • All drums will be inspected on arrival, damaged drums will be quarantined for return to the supplier • Site will be bunded (zero release facility)

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Leak of flammable liquid during storage or handling – ignition of leak	• Corroded drum or container • Dropped drum • Ignition from faulty electrical fitting near the store		• As above, plus: • Electrical systems comply with the requirements of AS2430 (Ref.6) • Personnel will be present during transfer and handling (i.e. raise the alarm/response) • Spill quantities will be small and do not project beyond the immediate spill area

Hazard Identification Table – Bayswater B Power Station and Expansion Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Acetylene/Propane Cylinders – Class 2.1			
Ignition of a leak of gas from cylinder valve	Dropped cylinder, Leak from faulty valve, valve not closed correctly (human error), crack in valve body Ignition from faulty electrical fittings adjacent to the store	Jet fire impinges on adjacent cylinders resulting in cylinder rupture and BLEVE (no impact to the environment)	• Typical quantities of gas stored will be minor (<500 L water capacity of cylinders) • Area will be well ventilated • Cylinders will be stored in a secured caged area • Store will be constructed from non-combustible materials • Electrical equipment will comply with the requirements of AS2430 (Ref.6) • The storage area will comply with the requirements of AS4332 (Ref.7)

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Ammonia Solution – Class 8			
Leak from drum	Dropped drum, corroded drum	Spill of material in the leak area, potential for run off into the environment (Note: vapours from the ammonia solution will not have significant respiratory impacts on personnel)	• Drum size will limit spill (200L) • DG Store will be bunded to contain a minimum of 1000 L spilled materials (no release to the environment) • DG Store will be separated from adjacent facilities by vapour barrier (fire wall FRL240/240/240) • DG Store will comply with the requirements of AS3780-1994 (Ref.8) • All drums will be inspected on arrival, damaged drums will be quarantined for return to the supplier • Site will be bunded (zero release facility) • PPE will be worn during handling (i.e. gloves, face shield, apron, etc.)

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Hypochlorite Solution			
Leak from drum	Dropped drum, corroded drum	Spill of material in the leak area, potential for run off into the environment (Note: vapours from the hypochlorite solution will not have significant respiratory impacts on personnel)	• Drum size limits spill (200L) • DG Store will be bunded to contain a minimum of 1000 L spilled materials (no release to the environment) • DG Store will comply with the requirements of AS3780-1994 (Ref.8) • All drums will be inspected on arrival, damaged drums will be quarantined for return to the supplier • Site will be bunded (zero release facility) • PPE worn during handling (i.e. gloves, face shield, apron, etc.)
Petroleum Fuel – Class 3 and Diesel Fuel - Class C2			
Leak of gasoline/Diesel (underground tank)	Tank corrosion (internal from water in fuel/external from moisture in the soil) Uneven pressure on tank external surface from compacted soil	Gasoline/Diesel contaminates the soil surrounding the tank resulting in chronic contamination over a long period of time	• Tanks will be double skin and corrosion protected externally, not contact between tank and soil • Tanks will be surrounded by sand • Tanks will be pressure tested regularly • Regular ground water sampling will be conducted at the station from dedicated bore holes • Leak detection and alarm will be installed in the vapour space between tank "skins"

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Spill of fuel during delivery (above ground and underground tanks)	Transfer hose failure, operator error, drive-away whilst still connected	Fuel spill in the area surrounding the tank fill point and bowsers, potential for gasoline/diesel to enter the drains and release to the environment	• Driver/operator will be in attendance during full delivery operation (emergency response activated by driver) • Driver/operator will have an emergency response plan as part of the delivery safety management systems • Drivers will be registered DG transport contractors • Drive-away protection fitted to delivery tankers • Drains report to the site containment pond (no offsite release) • Site containment pond capacity has a capacity of 4.600m^3 (clean water) and 900m^3 (contaminated water)
Ignition of a spill during delivery (above ground and underground)	Transfer hose failure, operator error, drive-away whilst still connected, fuel runs into gutters and drains and is ignited at a distance from the release by vehicles or electrical systems	Pool fire adjacent to the transfer area, impact on adjacent structures and delivery vehicle	• Driver/operator will be in attendance during full delivery operation (emergency response activated by driver) • Driver/operator will have an emergency response plan as part of the delivery safety management systems • Drivers will be registered DG transport contractors • Drive-away protection fitted to delivery tankers • First attack fire fighting equipment will be fitted to the fuel delivery tanker (dry chemical powder extinguishers) • Fire hydrants and hoses will be available on site for fire response

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Ignition of leak into the above ground tank bund	Tank leak, gasket leak, overfill of tank Ignition from electric fault in the electrical components in the bund	Full bund fore (worst case) radiating heat to surrounding areas (potentially offsite)	• Tank is fully bunded to contain >100% of tank contents • Tank will be tested and inspected regularly under tank planned maintenance programme • Diesel fuel is inherently safer than flammable liquids (i.e. flash point >60.5°C) • Equipment and instruments in the bund will be reviewed for appropriate hazardous area classification • Fire hydrants installed throughout the site with fire pump and onsite fore water tank.
Anhydrous Ammonia – Class 2.3			
Ammonia leak	Flange failure, valve stem failure, pipeline corrosion, nozzle leak (weld), PSV release	Toxic cloud forms and is dispersed downwind Concentrations of ammonia exceed injurious and/or fatal levels Injurious/fatal levels of ammonia extend offsite impacting adjacent facilities	• Facility will comply with AS2022 (Ref.14)] • Excess flow valves will be installed internally on the tank (close automatically on pipeline rupture) • All liquid lines on the tank will be isolated after delivery • PSV will be fitted with extension tubes (discharge at 5m) • Delivery lines will be vapour only (i.e. minimise release quantities) • Delivery lines are welded from the tank to the process

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Ammonia leak during delivery	Hose leak/failure, connection failure, drive-away whilst connected	Toxic cloud forms and is dispersed downwind Concentrations of ammonia exceed injurious and/or fatal levels Injurious/fatal levels of ammonia extend offsite impacting adjacent facilities	• Operator will be in attendance during full delivery cycle • Operator will have access to an emergency shut down "button" (stops transfer and isolates valves) • Globe vales will be used on delivery system (these valves act as non-return valves) • Regular testing of hoses will be performed • Fire hoses close to the transfer point (fog spray application to prevent toxic cloud formation)
Chlorine Storage – Class 2.3			
Chlorine leak	Pigtail line failure, valve stem failure, delivery pipeline corrosion (weld/gasket), Drum failure (corrosion/impact)	Toxic cloud forms and is dispersed downwind Concentrations of ammonia exceed injurious and/or fatal levels Injurious/fatal levels of ammonia extend offsite impacting adjacent facilities	• Facility will comply with AS2927 (Ref.15)] • Drums will be installed in a building • Gas detectors will be installed in the building • Gas detectors will be regularly tested (every 3 months) • Chlorguard automatic shut down system will be installed on all drums • Chlorine alarms will be attached to gas detectors • Small bore lines will be used to transfer chlorine (6mm NB)

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Chlorine leak from damaged cylinder during delivery	Dropped cylinder	Toxic cloud forms and is dispersed downwind Concentrations of chlorine exceed injurious and/or fatal levels Injurious/fatal levels of chlorine extend offsite impacting adjacent facilities	• Robust cylinders will be used for chlorine transport • Chlorine delivered and handled by Orica • Orica personnel are experienced in drum handling • Drum delivery personnel will be have emergency plans and procedures for responding to damaged cylinders • Drum valves will be protected by an external cap screwed onto the top of the cylinder
Oxygen Storage – Class 2.2 (Sub-Risk 5.1)			
Leak and spill from a tank or pipe in the storage area	Joint fails, tank hole, pipe damage (physical), internal/ external corrosion of storage	Leak from tank into the surrounding area, potential for oxygen rich cloud developing impacting personnel in the surrounding area (injuries/fatalities No impact to the environment Oxygen enhances burning in combustible materials fire	• O_2 would be stored as a refrigerated liquid (i.e. does not rapidly form a gas cloud) • Tank would be double walled with insulation between • Tanks to be regularly inspected • Corrosion resistant materials selected for tank and equipment components • Joints to be metal to metal face (no gaskets) • Storage area would be open with little confinement (i.e. good dispersion of gas) • Tank to be located clear of combustible materials • Fire fighting equipment located adjacent to the O_2 tank

Hazard Identification Table – Bayswater B Power Station Project			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
Leak during unloading of liquid oxygen	Flexible transfer hose leak/failure, driveaway whilst connected	Leak from hose or transfer fitting into the surrounding area, potential for oxygen rich cloud developing impacting personnel in the surrounding area No impact to the environment	• Operator to be present during transfer operations • Regular testing of hoses (as per ADG, Ref.1) • Operator to wear PPE (i.e. protection against impact of refrigerated liquid, potential burns) • Emergency shut of systems available of tanker transfer systems • Drive-away protection provided on delivery vehicles

5.0 Consequence Analysis

5.1 Incidents Carried Forward for Consequence Assessment

The hazard analysis conducted in **Section 4** identified that seven (7) incidents had the potential to impact offsite, hence, these incidents were carried forward for consequence analysis. The consequence of each hazard is assessed in detail in the following sections. In each assessment, the worst case incident was analysed to ensure the maximum severity was identified. Hen e, where the worst case incident did not result in offsite impact, incidents of a lesser consequence were the discounted as being of low risk. These were identified as:

- Chlorine incidents (release and toxic impact downwind);
- Gas pipeline – external interference incidents; and
- Gas Turbine enclosure explosion incidents.

5.2 Ammonia Incidents

Tanks and systems for the supply of Ammonia in power station are relatively standardised (AS2022 – Ref 25) and many of the ammonia supply systems are similar in nature and design. The hazard analysis identified that there is a potential for failure of components in the ammonia system leading to leaks. These have the potential to occur in gaskets, pipework or flexible transfer hoses (during tank filling).

5.2.1 Pipework Leaks

Corrosion in pipework could cause leaks, commencing as a pinhole leak and growing to a hole over a short period (i.e. the minor leak causes wear on the side of the whole causing hole growth with time). Whilst the hole would grow slowly with time, continued growth of the hole would be limited as the pressure in the ammonia system is not sufficient to propagate the hole causing rupture the pipe (Ref.17-main report). Hole diameter of a leak would be in the order of 5% of the cross sectional area of the pipe (Ref.15-main report).

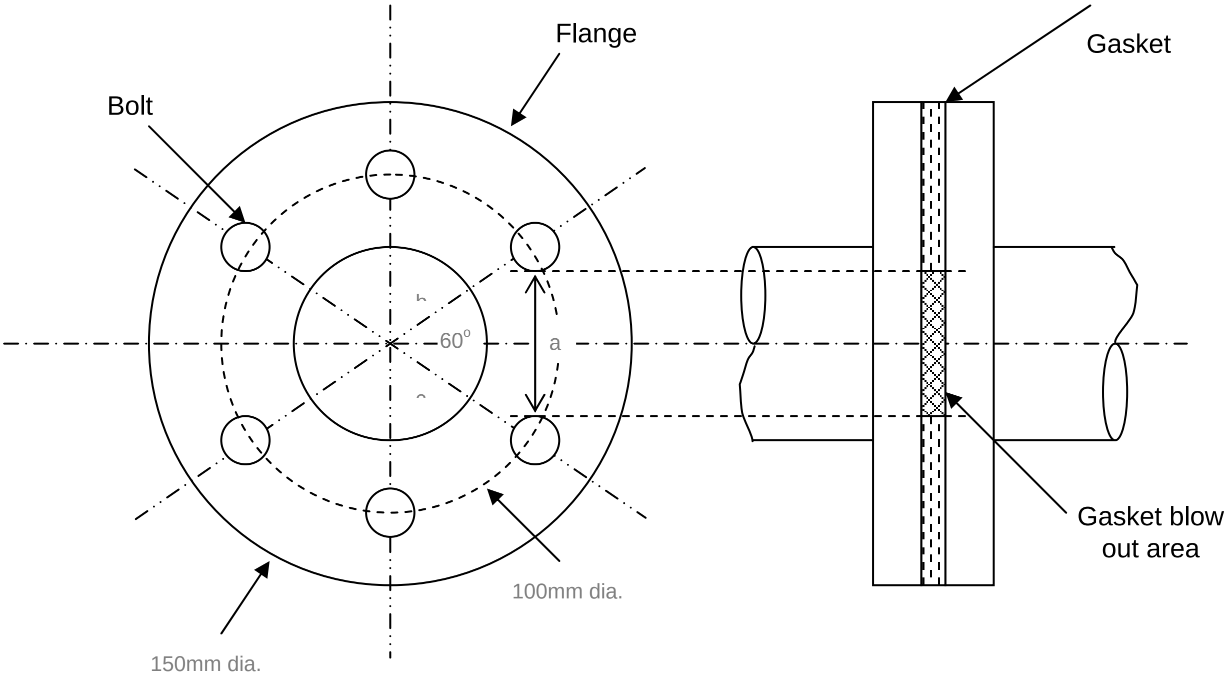
Cross Sectional Area of the pipe = $\pi/4\ D^2 = \pi/4\ (0.05)^2 = 1.96\text{x}10^{-3}\text{m}^2$

5% cross section area = $0.05 \times 1.96\text{x}10^{-3}\text{m}^2 = 9.8\text{x}10^{-5}\text{m}^2$

Diameter of hole = $(4/\pi \times 9.8\text{x}10^{-5})^2$ = 11mm

5.2.2 Gasket Leaks

The pipework size in the power station ammonia supply would be around 50mm nominal bore (NB). The first flange attached to a nozzle on the vessel would be 150mm outside diameter and contain six bolts, this is a standard flange size. A weak gasket may blow out under pressure between the bolts in the flange. **Figure 5-1** shows a bolted flange and the cross sectional area between the flange bolts.



By the cosine rule: $a^2 = b^2 + c^2 - 2.b.c.Cos$

$a = (50^2 + 50^2 - (2 \times 50 \times 50\ Cos60))^{0.5}$

a = 50mm

Figure 5-1: Ammonia Flange – Gasket Leak Area

A gasket for the ammonia flange would be about 3mm thick. Hence, the total area of release would be 0.05m x 0.003m = $1.5 \times 10^{-4} m^2$.

The equivalent release diameter is:

$1.5 \times 10^{-4} m^2 = \pi/4\ D^2$

D = 14mm

5.2.3 Hose Leaks

Hoses used in the bulk liquids transfer industry are continually loaded on and off truck leading to the potential for the hoses to wear on the external surface and potential for puncture and gas release. Hoses are steel braided and reinforced, preventing rupture and major release. Hence, release magnitude would be similar in size to that detailed in **Section 5.2.1** (i.e. 11mm hole diam.). Release incidents would be limited by the attendance of the driver at the transfer operation, who would activate the emergency shut down of the transfer in the event of a leak (i.e. emergency stop button on the truck).

5.2.4 Incident Selected for Modelling

A review of the above incidents identifies that the worst case incident is the leak at the gasket or flange. This could occur at a liquid flange releasing liquid ammonia from a hole of equivalent diameter 14mm.

Release rate from a 14mm hole is estimated as follows.

Liquid Release rate $G_L = C_d A(2.\rho.\delta P)^{0.5}$ (Ref.15)

Where: C_d = Co-efficient of discharge (0.6)

A = cross sectional area of the release hole (m^2)

ρ = density of the liquid (kg/m^3)

δP= pressure difference across the hole (Pa)

Hence, for a 14mm hole, the cross sectional area = $1.54x10^{-4}m^2$

Density of anhydrous ammonia = $682kg/m^3$

Pressure differential = 8.8 bar (or $8.8x10^5$ Pa)

$G_L = 0.6 \times 1.45x10^{-4} \times (2 \times 682 \times 8.8x10^5)^{0.5} = 3kg/s$

To calculate the adiabatic flash rate (i.e. the quantity of vapour formed from a liquid release), the following formula is used:

$V = (W.C_{p(mean)}.(T_1\text{-}T_2))/H_v$ (Ref.15)

Where: V = weight of the flash vapour produced (kg/s)

W = weight of liquid spilled (kg/s)

$C_{p(mean)}$ = geometric mean of the specific heats over a range between T_1 and T_2

T_1 = Temperature of the liquid in the process (^oC)

T_2= Atmospheric pressure boiling temperature of the liquid (^oC)

H_v = Latent Heat of Vaporisation (kJ/kg)

V = 3 x 1.37 x (21 – (-33))/287.84

Vapour Release Rate = 0.77 kg/s

A dispersion analysis was conducted using the gas release rate estimated above. When a gas is released, the downwind dispersion is a function of wind speed and weather conditions. In bright sunny conditions, with high wind, the gas disperses readily, but in light wind and overcast conditions the cloud tends to disperse slowly. To model such releases, dispersion analysis analyse weather conditions in 6 classes:

A – Bright sunny conditions, highly unstable air streams;

B – Bright sunny conditions, moderately stable air streams;

C – Partial cloud, moderately stable air streams;

D – Mostly cloudy, some patches of sun, moderately stable air;

E – Full cloud cover, very light to stable air streams;

F – Full cloud, virtually no wind, very stable air streams.

A wind speed is added to the values above to estimate the dispersion at the selected wind weather condition. For example, D5 represents partial cloud with moderate air stream and a wind speed of 5m per second. The selected values are input to a computer model that assesses the dispersion of the release and estimates the downwind concentration of the gas over a range of distances from the release source. The results are read in parts per million (ppm) of gas content in air.

The model used for the analysis was SLAB. This model was developed by the University of California (Lawrence Livermore Laboratories) for the US Department of Energy. This model is also used as the basis for the EFFECTS© consequence analysis program used by the TNO organisation in the Netherlands. The model was applied for each of the release scenario detailed above.

For ammonia, there are a number of organisations that publish toxicity impact data. The UK IChemE publish the following concentration levels of interest:

- Lowest reported lethal concentrations for any species for 30 minutes exposure (Ref.18) – 5000 ppm
- Injuriuos (50% of lowest reported lethal concentrations) – 2500 ppm

In Australia, the Emergency Response Planning Guideline (ERPG) values are used and are intended to provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects as described in the definitions for ERPG-1, ERPG-2, and ERPG-3 as a consequence of exposure to the specific substance.

- The **ERPG-1** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor. For ammonia this is 25 ppm.
- The **ERPG-2** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action. For ammonia this is 150 ppm.
- The **ERPG-3** is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects. For ammonia this is 750 ppm.

It is noted that the ERPG values listed above for ammonia are extremely conservative and many toxicity publications lists ammonia fatality impact concentrations much higher than the ERPG values. For this analysis, a value of 750 ppm has been used to determine whether fatality impact could occur at the site boundary, and a concentration of 150ppm has been used to determine whether injury could occur at the site boundary. Concentrations exceeding these values would warrant further review in the frequency and risk analysis.

For conservatism, the SLAB model was run using a concentration level of interest of 1000 ppm to determine the impact distance at the lower level of concentration. Model simulations were undertaken for time averaging periods of 1 second and 900 seconds to represent peak and typical short term (STEL) exposures. The source and meteorological parameters used in the model are presented in **Table 5-1** and **Table 5-2**.

Table 5-1: Source Parameters

Parameter	Ammonia
Spill source type	Stack
Source duration (seconds)	3600
Source height (metres)	0.3
Storage temperature (K)	288
Source Area (m^2)	0.000028
Averaging Time (seconds)	1, 900
Emission Rate (kg/s)	0.77
Analysis level of interest (ppm)	1000

Table 5-2: Meteorological Parameters

Parameter	Value
Surface Roughness (metres)	0.05
Temperature (K)	288
Relative Humidity (%)	40
Wind Speed and Stability Scenarios (PG stab, m/s)	B3, B5, D3, D5, D9, E1.5, F1

The result of the analysis is shown in **Table 5-3** and **Table 5-4**.

Table 5-3: Ammonia 750 PPM Maximum Distance form Source (Metres) – 1 Second Averaging Period

Met Condition	Height (m) Above Ground Level			
	0.01	1.5	1.8	2.5
B3	117	115	115	114
B5	99	98	98	97
D3	222	217	214	206
D5	197	193	191	185
D9	161	158	157	150
E1.5	297	283	279	265
F1	426	399	387	346

Table 5-4: Ammonia 750 PPM Maximum Distance From Source (Metres) – 900 Second Averaging Period

Met Condition	Height (m) Above Ground Level			
	0.01	1.5	1.8	2.5
B3	97	96	96	95
B5	76	75	73	72
D3	195	191	188	180
D5	160	156	153	147
D9	119	115	113	107
E1.5	283	275	269	255
F1	419	392	381	341

It can be seen from **Table 5-3** and **Table 5-4** that the maximum downwind distance for a concentration level of ammonia of 750 ppm is 426 m. This occurs using a 1 second averaging period, at 0.01 m above ground level, and under F class stability 1 m/s conditions (i.e. postulated worst case conditions).

The closest site boundary is located over 545 m (gas fired option) from the ammonia storage and hence there would be no impact offsite as a result of the postulated incidents at the ammonia storage, hence, this incident has not been carried forward for further analysis.

The same analysis as that above was performed for the 150 ppm concentration (i.e. injurious impact for ammonia concentrations). It was identified that the ammonia concentration at the site boundary was estimated to be 585 ppm, this exceeds the 150 ppm levels selected for injury potential. Hence, this incident was carried forward for further analysis to identify the injury risk at the site boundary.

It is noted that at 585 ppm, the concentration is well below the published criteria for fatality, which is 5,000 ppm (IChemE, Ref.18). To confirm the fatality potential at 585 ppm, a probit analysis was conducted. Probit analysis is a method of determining the probability of fatality as a result of an exposure to a hazardous event. The probit equation takes the form:

$$Y = k1 + k2 \ln (C^n t)$$

Where: k_1 = -35.9 (Ref.26);

$k2$ = 0.71 (Ref.26);

C = Concentration (ppm)
n = 2
t = time exposure in minutes (60 minutes as per ERPG)

The relationship between probit and probability of fatality is shown in **Figure 5-2** (Ref.15). The values calculated from the probit equation are compared to the graph and the probability of fatality estimated.

Hence, for 585 ppm:

$$Y = -35.9 + 1.85 \ln (585^2(60)) = -4.75$$

It can be seen from the value of -4.75 that there is zero ("0") risk of fatality as a result of exposure to 585 ppm of ammonia over a 1 hour period. Hence, the decision not to carry the incident forward is justified.

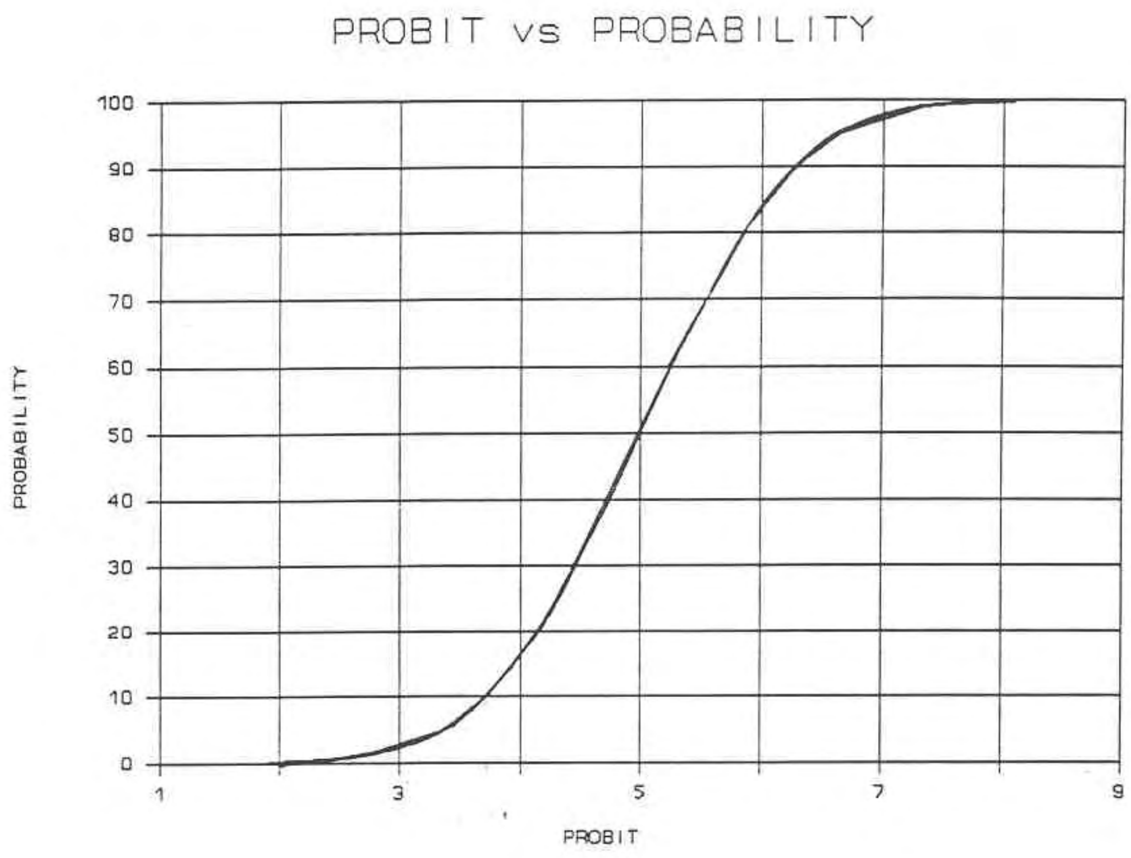


Figure 5-2: Probit Curve (Ref.15)

5.3 Transformer Explosion & Fire

In both power station options, each of the main transformers would be located in its own bunded area, with the capacity to contain the full contents of the transformer. In the event of a leak of transformer oil from a transformer, the oil level within the transformer will fall, exposing the windings. Exposed windings may result in sparking and ignition of the oil vapour in the casing causing a localised explosion and oil fire in the transformer and bund. The bund fire would radiate heat to the surrounding areas, potentially impacting offsite. A detailed pool fire analysis has been conducted below for a bund fire in the transformers at the coal fired facility and the gas fired facility.

Pool Fire Diameter

In the worst case scenario, a full fire in a transformer bund would act as a cylindrical fire as the updraft of the fire would draw the square corners of the fire into a cylindrical shape. The equilibrium pool diameter is calculated by equating the area of the bund into an equivalent pool diameter. The analysis below has been performed for the coal fired scenario. The analysis for the gas fired scenario has been conducted using the same approach with the results detailed in **Table 5-5** at the end of this section.

Area of the bund = 20 x 10 = $\pi/4(D^2)$

D = 16m

The flame burns in the shape of a cylinder tilted in the direction of the wind. **Figure 5-3** shows a diagram of a pool fire impacting a target as a distance from the flame.

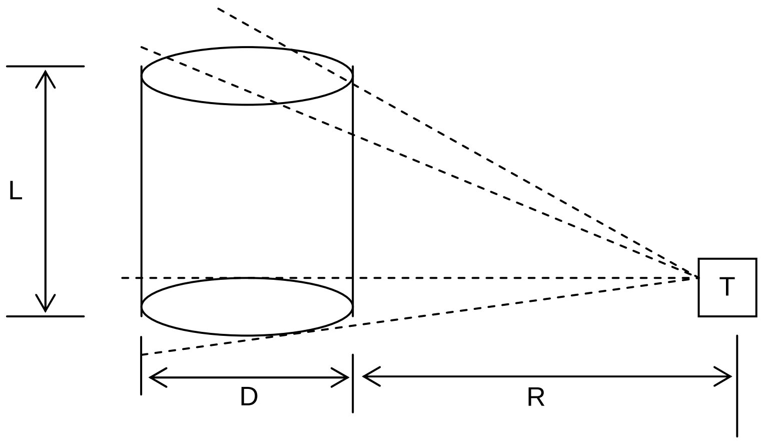


Figure 5-3: View Factor Method for Heat Radiation Calculations

Flame Height (L)

The flame height of a pool fire is given by the following correlation of Thomas (Ref.14):

$$L = 42D\left(\frac{m}{\rho_o\sqrt{gD}}\right)^{0.61} \qquad \text{-----------------}(\mathbf{1.1})$$

where: L= mean flame height (m)

D= pool diameter (m)

ρ_o= ambient air density (typically 1.2 kg/m^3)

m= mass burning rate (kg/m^{2}s) = 0.0667, based on 5mm/min burn down rate (Ref.15)

g= acceleration due to gravity (9.81 m/s^2)

Hence, flame height for the coal fired facility transformer bund fire is:

$L = 42 \times 16\ (0.0667/(1.2(9.81 \times 16)^{0.5}))^{0.61} = 24.7$m

Heat Radiation Impact - To estimate the heat radiation impact at specific distances, the view factor method has been applied, which uses the heat radiation from the surfaces of the flame and applies a correction factor for flame shape and target distance/location.

The heat radiation at a specific distance from the flame can be estimated from the formula:

$$Ir = Ie \times F \times \tau \qquad \text{-------}(\mathbf{1.2})$$

Where: I_r = Target Heat (kW/m^2).

I_e= Flame Heat (kW/m^2) or surface emissive power (SEP).

τ = Transmissivity.

F = View Factor

View Factor - The calculation of the view factor (F) in **Formula 1.2** depends upon the shape of the flame and the location of the flame to the receiver. F is calculated using an integral over the surface of the flame, S. The formula can be shown as:

$$F = \int\int_S \frac{\cos\beta_1 \cos\beta_2}{\pi d^2} \qquad \text{----------}\ (\mathbf{1.3})$$

The above Formula (1.3) may be solved using the double integral or using a numerical integration method in spread sheet form. A spreadsheet calculator (SSC)[1] has been developed to determine the radiation flux experienced at a “target” originating from a pool fire in a tank/transformer, bund or flammable liquid storage depot with fire walls. It is intended typically for fires of petroleum liquids though it can be used with any material so long as the “emissivity” of the flame is known. This is the heat flux at the surface of the flame and is given in kiloWatts per square metre (kW/m^2). The other parameters needed are: diameter of tank/bund, height of the tank/walls (if any), distance to target, height of flame, tilt of flame caused by wind. It is assumed that the tank/walls have some height although there is no reason not to use the calculator for pool fires at ground level by entering a zero height.

Transmissivity – is the reduction in heat radiation due to the presence of water vapour and carbon dioxide in the atmosphere between the radiation source and the target. This can be calculated using the following formula (Ref.16):

Transmissivity = $1.006 - 0.01171(\log10X(H_2O) - 0.02368(\log_{10}X(H_2O)))^2 - 0.03188(\log_{10}X(CO_2) + 0.001164(\log_{10}X(CO_2)))^2$

Where: $X(H_2O)$ = (RH x L x Smm x 2.88651 x 102)/T

$X(CO_2)$ = L x 273/T

RH = relative humidity

[1] The Spread Sheet Calculator was developed by Dr Wayne Davies of the Chemical Engineering Faculty, Sydney University and Mr. Steve Sylvester of AECOM.

L = path length in metres

Smm = saturated water vapour pressure in mm mercury (= 17.535 @ 293K)

T = temperature in degrees Kelvin (293K)

The distance from the fire to the boundary of the proposed coal fired facility (L) is 620m, relative humidity is selected as 70% (0.7). Using these values and the values listed above, the transmissivity parameter is calculated to be 0.54.

The following data was input to the spread sheet calculator:

- Pool diameter – 16m
- Flame height – 24.7m
- Transmissivity – 0.54
- SEP – 37.6 kW/m^2 (Ref.14)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7 kW/m^2 was 27.6 m from the fire. A summary of the heat radiation impact analysis at selected distances from the fire is shown in **Table 5-5**.

The distance from the fire to the boundary of the proposed gas fired facility (L) is 545 m, relative humidity is selected as 70% (0.7). Using these values and the values listed above, the transmissivity parameter is calculated to be 0.55.

An analysis was also conducted for a transformer fire in the gas fired option. The following results were input to the spread sheet calculator:

- Pool diameter – 12m
- Flame height – 20.2m
- Transmissivity – 0.8 (heat radiation impact dust of 4.7kW/m^2)
- SEP – 48.4 kW/m^2 (Ref.14)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7 kW/m^2 was 24.9 m from the fire. A summary of the heat radiation impact analysis at selected distances from the fire is shown in **Table 5-5**.

Table 5-5: Heat Radiation Impact from a Transformer Bund Fire (Gas Fired Option)

Heat Flux (kW/m^2)	Distance to Heat Flux (m)	
	Coal fired option	Gas fired option
35	10.8	9.6
23	12.9	11.6
15	15.7	14.2
12.5	17.1	15.5

	Distance to Heat Flux (m)	
10	19	17.2
8	21.2	19.2
6	24.5	22.1
4.7	27.6	24.9
2	42	37
1.2	54	48

From **Table 5-5** it can be seen that at distances in excess of 500 m there would be a negligible heat radiation impact (<1 kW/m^2).

The distance from the transformer bund closest to the main turbine hall building (coal fired option) would be about 20 m. From **Table 5-5**, the heat radiation impact at this distance would be around 10 kW/m^2. The adjacent turbine hall building would be constructed from steel sheet over steel framework and at a level of 15 kW/m^2 there is a potential for weakening of the structure over an extended period of time (Ref.5). However, at 10 kW/m^2, the potential for weakening of the structure in the turbine hall would be diminished and, although there may be signs of heat damage to the adjacent structure, there would be no potential for building collapse and incident escalation to the adjacent turbine hall.

The distance from the transformer bund to the gas turbine enclosure (gas fired option) would be about 15 m. From **Table 5-5** , the heat radiation impact at this distance would be around 12 kW/m^2. The adjacent turbine enclosure would be constructed from steel sheet over steel framework and at a level of 15 kW/m^2 there would be a potential for weakening of the structure over an extended period of time (Ref.5). However, at 12 kW/m^2, the potential for weakening of the structure in the turbine hall would be diminished and, although there may be signs of heat damage to the adjacent structure, there would be no potential for building collapse and incident escalation to the adjacent turbine hall.

As there is no potential for offsite impact or onsite incident growth, this incident has not been carried forward for further analysis.

5.4 Gasoline and Diesel Fuel Spill and Fire

5.4.1 Diesel Transfer to Underground Tank

In the event of a spill (Diesel/Gasoline) during transfer of fuel from the road tanker to the underground tanks, the fuel would be retained within the transfer area bund. Ignition of the fuel would result in a bund fire that could result in heat radiation impact offsite. The fuel transfer area bund is the same dimensions for both the coal fired and gas fired options.

Pool Fire Diameter

In the worst case scenario, a full fire in the fuel transfer area bund would act as a cylindrical fire as the updraft of the fire would draw the square corners of the fire into a cylindrical shape. The equilibrium pool diameter is calculated by equating the area of the bund into an equivalent pool diameter. The analysis below has been performed for the coal fired scenario. The analysis for the gas fired scenario has been conducted using the same approach with the results detailed in **Table 5-6** at the end of this section.

Area of the bund = 8 x 2 = $\pi/4(D^2)$ [Note: tanker transfer bund is a speed hum style containment of generally standard size]

D = 4.5 m

Using the same analysis technique as that described in **Section 5.3**, the input data to the spread sheet calculator is:

- Pool diameter – 4.5m
- Flame height – 10.2m
- Transmissivity – 0.83
- SEP – 89.94 kW/m^2 (Ref.14)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7 kW/m^2 was 15.5 m from the fire. A summary of the heat radiation impact analysis at selected distances from the fire is shown in **Table 5-6**.

Table 5-6: Heat Radiation Impact from a Diesel/Gasoline Transfer Area Bund Fire

Heat Flux (kW/m^2)	Distance to Heat Flux (m)
35	6
23	7.3
15	8.9
12.5	9.7
10	10.8
8	12
6	13.8
4.7	15.5
2.1	23.2
1.2	29.7

From **Table 5-6** it can be seen that at 545 m (location of the closest boundary, gas fired option) there would be a negligible heat radiation impact.

The distance from the fuel spill (fuel transfer area) to the adjacent closest buildings on site has not yet been finalised, hence, to ensure the heat radiation at the closest building to the fuel transfer area does not cause damage or fire growth potential to the buildings, **it is recommended that the fuel transfer area be no closer than 12 m to structures at the site**. This would ensure the heat radiation impact is below 10 kW/m^2, limiting the potential for impact to adjacent areas.

As there is no potential for offsite impact or onsite incident growth, this incident has not been carried forward for further analysis.

5.4.2 Start-Up Diesel Tank – Full Bund Fire

The start up diesel fuel tank stores 3,600 kL of fuel and has dimensions 20 m diameter x 12 m high. The tank is bunded with bund dimensions of 24.5 m long x 16.8 m wide x 2.3 m high. The worst case incident is a full bund fire with an equivalent fire diameter estimated as:

Area of bund = 24.5m x 16.8m = $\pi/4 \times D^2$

$D = (4/\pi \times 24.5 \times 16.8)^{0.5} = 22.9$m

Using the same analysis as that conducted in Section B1.1, the following dimensions are estimated for input to the SSC:

- Pool diameter – 22.9m
- Flame height – 31.6m
- Transmissivity – 0.78
- SEP – 27.7 kW/m^2 (Ref.14)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7 kW/m^2 was 31.3m from the fire. A summary of the heat radiation impact analysis at selected distances from the fire is shown in **Table 5-7**.

Table 5-7: Heat Radiation Impact from a Start-Up Diesel Tank Full Bund Fire

Heat Flux (kW/m^2)	Distance to Heat Flux (m)
35	12.4
23	14.7
15	17.8
12.5	19.4
10	21.5
8	24
6	27.6
4.7	31.3
2.1	47.5
1.2	61

From **Table 5-7** it can be seen that at 620 m (location of the closest boundary, coal fired option) there would be a negligible heat radiation impact.

The distance from the fuel spill (start up diesel tank bund) to the adjacent closest buildings on site has not yet been finalised, hence, to ensure the heat radiation at the closest building to the start-up diesel storage tank does not cause damage or fire growth potential to the buildings, **it is recommended that the fuel transfer area be no closer than 22 m to structures at the site**. This would ensure the heat radiation impact is below 10 kW/m^2, limiting the potential for impact to adjacent areas.

As there is no potential for offsite impact or onsite incident growth, this incident has not been carried forward for further analysis.

5.5 Chlorine Storage and Handling Incident Consequences

The hazard identification analysis indicated that chlorine releases could occur as a result of a manifold leak or failure of a pigtail line. Noting that the pigtail line is installed between the drum and the manifold, holes in the manifold, larger than the pigtail diameter would be limited by the flow restriction down the pigtail line. Hence, the governing factor in the chlorine release is the pigtail line diameter.

The worst case incident is therefore a pigtail line failure releasing into the storage building and escaping through the vents in the building. Pigtail lines are nominally 6 mm NB, hence, this diameter has been used to estimate the chlorine release rate for this scenario. The release rate calculation is as follows.

Liquid Release rate $G_L = C_d A(2.\rho.\delta P)^{0.5}$ (Ref.15)

Where: C_d = Co-efficient of discharge (0.6)

A = cross sectional area of the release hole (m^2)

ρ = density of the liquid (kg/m^3)

δP= pressure difference across the hole (Pa)

Hence, for a 6mm hole, the cross sectional area = $1.54x10^{-4}m^2$

Density of chlorine = $1.56kg/m^3$

Pressure differential = 6.95 bar (or $6.95x10^5$ Pa)

$G_L = 0.6 \times 2.83x10^{-5} \times (2 \times 1560 \times 6.95x10^5)^{0.5} = 0.79kg/s$

To calculate the adiabatic flash rate (i.e. the quantity of vapour formed from a liquid release, the following formula is used:

$V = (W.C_{p(mean)}.(T_1-T_2))/H_v$

Where: V = weight of the flash vapour produced (

W = weight of liquid spilled (kg/s)

$C_{p(mean)}$ = geometric mean of the specific heats over a range between T_1 and T_2

T_1 = Temperature of the liquid in the process (^oC)

T_2= Atmospheric pressure boiling temperature of the liquid (^oC)

H_v = Latent Heat of Vaporisation (kj/kg)

V = 0.79 x 1.3 x (21 –(-34.6))/1370.84

Vapour Release Rate = 0.041kg/s

The model used for the analysis was SLAB (see details listed in **Section B2.1.4**). This model was developed by the University of California (Lawrence Livermore Laboratories) for the US Department of Energy. The model was applied for the release scenarios detailed above.

For chlorine, the concentration levels of interest are:

- Fatality potential (Ref.9) – 20 ppm
- Injuriuos (50% of lowest reported lethal concentrations) – 5 ppm

The SLAB model was run using the two concentration levels above (20 and 5 ppm) to determine the impact distance at these levels of concentration. Model simulations were undertaken for time averaging periods of 1 second and 900 seconds to represent peak and typical short term (STEL) exposures. The source and meteorological parameters used in the model are presented in **Table 5-8** and **Table 5-9]**.

Table 5-8: Source Parameters

Parameter	Chlorine
Spill source type	Stack
Source duration (seconds)	3600
Source height (metres)	0.3
Storage temperature (K)	288
Source Area (m^2)	0.000028
Averaging Time (seconds)	1s, 900s
Emission Rate (kg/s)	0.041
Analysis level of interest (ppm)	5, 20

Table 5-9: Meteorological Parameters

Parameter	Value
Surface Roughness (metres)	0.05
Temperature (K)	288
Relative Humidity (%)	40
Wind Speed and Stability Scenarios (PG stab, m/s)	B3, B5, D3, D5, D9, E1.5, F1

The result of the analysis is shown in **Table 5-10** and **Table 5-11**, for 5 ppm for averaging periods of 1 second and 900 seconds.

Table 5-10: Chlorine 5 PPM Maximum Distance Form Source (Metres) – 1 Second Averaging Period

Met Condition	Height (m)			
	0.01	1.5	1.8	2.5
B3	175	175	175	174
B5	136	136	136	135
D3	402	401	400	389
D5	308	307	307	305
D9	225	225	224	223

Met Condition	Height (m)			
	0.01	1.5	1.8	2.5
E1.5	786	783	782	778
F1	1570	1561	1558	1546

Table 5-11: Chlorine 5 Ppm Maximum Distance Form Source (Metres) – 900 Second Averaging Period

Met Condition	Height (m)			
	0.01	1.5	1.8	2.5
B3	115	114	114	113
B5	90	90	89	89
D3	261	260	259	258
D5	197	196	195	192
D9	143	141	140	137
E1.5	536	533	531	526
F1	1135	1127	1124	1111

It can be seen from **Table 5-10** and **Table 5-11** that the maximum downwind distance for a concentration level of chlorine of 5 ppm is 1,558 m. This occurs using a 1 second averaging period, at 1.8 m above ground level, and under F class stability 1 m/s conditions.

The result of the analysis is shown in **Table 5-12** and **Table 5-13**, for 20 ppm for averaging periods of 1 second and 900 seconds.

Table 5-12: Chlorine 20 PPM Maximum Distance Form Source (Metres) – 1 Second Averaging Period

Met Condition	Height (m)			
	0.01	1.5	1.8	2.5
B3	84	83	83	83
B5	68	67	67	66
D3	182	180	179	176
D5	142	140	138	136
D9	106	104	103	100
E1.5	326	321	319	313
F1	576	563	558	540

Table 5-13: Chlorine 20 PPM Maximum Distance Form Source (Metres) – 900 Second Averaging Period

Met Condition	Height (m)			
	0.01	1.5	1.8	2.5
B3	58	57	57	56
B5	46	45	45	43
D3	124	121	120	117
D5	94	92	91	87
D9	69	66	65	61
E1.5	243	239	237	230
F1	464	453	446	432

It can be seen from **Table 5-12** and **Table 5-13** that the maximum downwind distance for a concentration level of chlorine of 20 ppm is 558 m. This occurs using a 1 second averaging period, at 1.8m above ground level, and under F class stability 1 m/s conditions.

The results of this analysis show that the maximum downwind distance for a concentration level of 20 ppm of chlorine is 558 m and for a concentration level of 5 ppm of chlorine is 1,558ppm.

The site boundary is located over 545 m from the likely site of ammonia storage and hence only within about 10 m of the site boundary would there be a fatality potential. However, there is a higher potential for injury, as the impact distance extends considerably further than the fatality risk. The potential for fatality and injury risk has been carried forward for frequency and risk analysis. It is noted that there are no population centres within the impact zone of the proposed power station, hence nuisance impact have not been assessed in this study.

5.6 Gas Pipeline Leak

A review of the hazard identification section indicates that the only gas pipeline incidents carried forward for further analysis are related to external impact and the potential for pipeline breach from an excavator, auger or other digging equipment striking the pipeline. It is noted that the pipeline would be manufactured from X42 grade steel and that the pressure is about 5,000 kPa or 50 bar. Hence, propagation of a breach (i.e. hole created by an external impact) would occur (Ref.20) at this pressure using “X” grade steel pipe.

The pipeline will be installed in an easement, about 20m wide. The easement will be dedicated to the gas pipeline alone and will be fitted with signposting along the full length of the easement denoting a high pressure gas pipeline installation in the easement. The location of the easement (i.e. in open countryside, will limit access for general excavation equipment normally used on suburban areas, (e.g. backhoe, front end loader, auger, etc.), hence, the potential for excavation machinery to access the pipeline route is limited.

Based on the above information, an external excavating device impacting a steel pipeline, with diameter 355 mm and wall thickness 9.4 mm, would cause pipeline rupture. Hence, to determine the leak rate from a 355 mm hole in the pipeline (i.e. rupture), the EFFECTS© model was used. EFFECTS© is a series of loss estimation programs developed by the TNO Organisation in the Netherlands (Ref.21). In the event of a rupture in the pipeline, the release would commence with a significant surge of gas, reducing with time as the flow in the pipeline was restricted as a result of flow friction, etc. The depressuring flow from a 5 km pipeline is shown in **Figure 5-4**. It cab be seen from this graph that the flow commences with a high flow rate diminishing to a relatively low rate after 10 minutes.

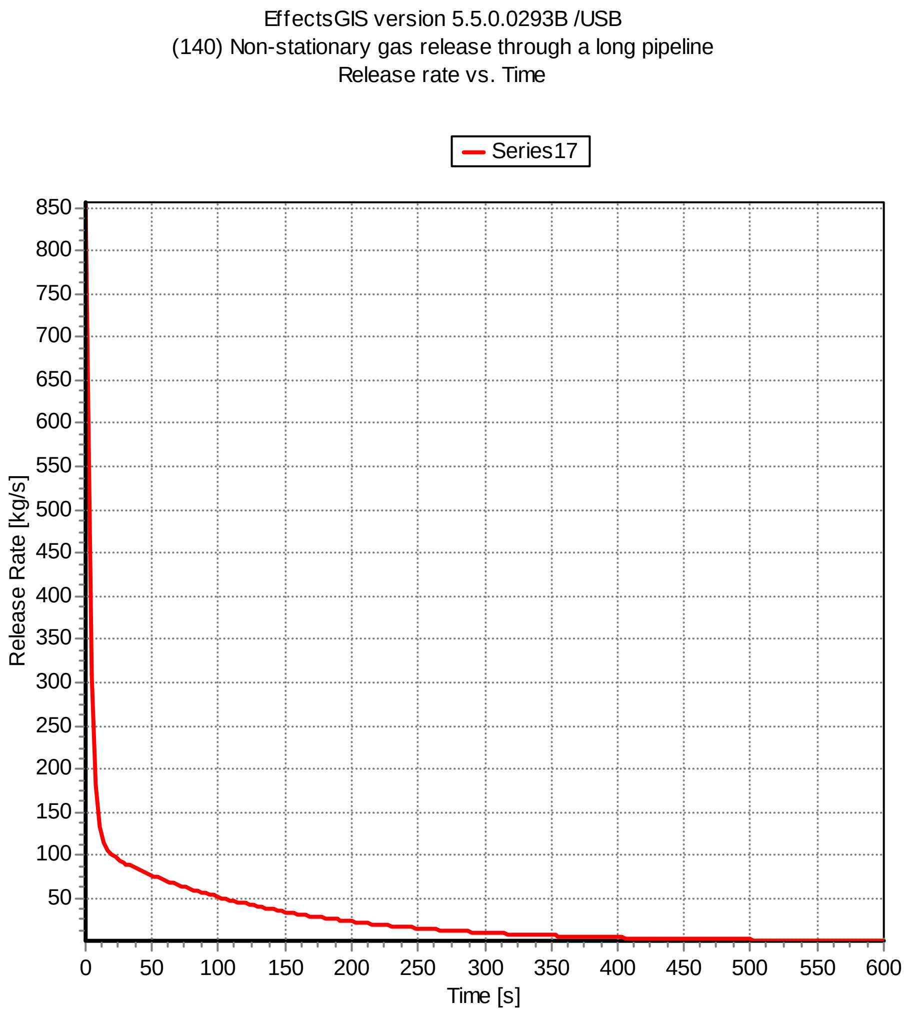


Figure 5-4: Depressuring flow rate from a guillotene fracture of Gas Supply Pipeline to the Gas Turbine Power Station

In the event of immediate ignition, the release would burn as a jet fire in the form shown in **Figure 5-4**. Much research has been conducted on the shape of jet fires, the most appropriate modelling shape being the frustum of a cone (Ref.14). An analysis of the fire shape and impact was performed using the EFFECTS© model, the results of the analysis are summarised in **Table 5-14**. It is noted that the pipeline is buried and, hence, releases will occur below ground level. A horizontal release will commence to scour the ground and be directed upwards at an angle of about 45°. The EFFECTS© model has therefore used an angle of 45° for assessment of impacts to the surrounding areas.

Noting that the flow rate is constantly changing, due to depressuring, the flow rate used in the analysis of the jet fire has been selected based on the impact criteria published in HIPAP No.4 (Ref.4). HIPAP No.4 indicates that people impacted by more than 4.7kW/m^2 for over 30 seconds would feel pain and therefore need to move from the area. At 60 seconds there would be significant burning of skin, hence, a release value at time 60 seconds has been selected for this analysis. The release value at 60 seconds is 71.2kg/s.

Table 5-14: Heat Radiation Impacts From Pipeline Incidents as a Result of Jet Fire From an External Impact Breach

Hole Diameter (m)	Rupture (355mm)
Jet Fire Length-Total (m)	100.5m
Width of Flame at End (m)	19.37
Width of Flame at Base (m)	3.76m
Flame Lift Off (m)	13.26m
Angle of Flame from Horizontal	45^o

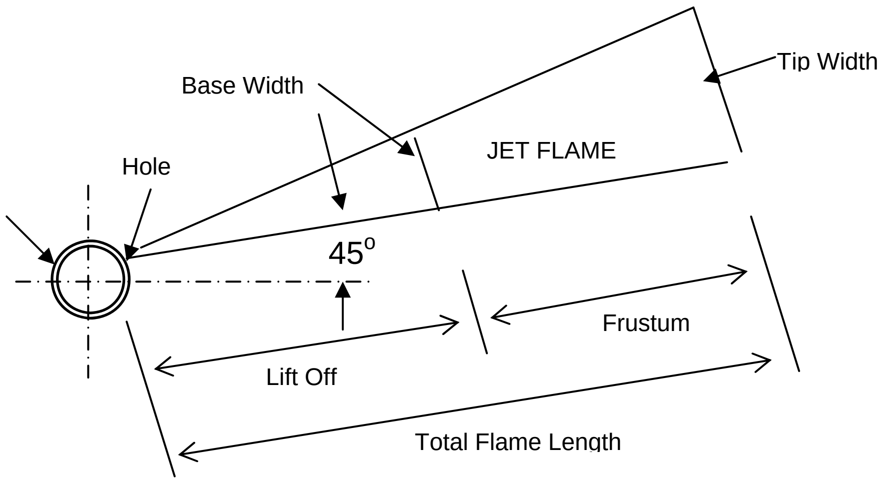


Figure 5-5: Jet flame schematic

In the event a gas release from a hole does not immediately ignite, the gas will escape from the pipeline and be released as a gas jet, dispersing in the area surrounding the pipeline. It is noted that the pipeline will be installed in an easement, well clear of surrounding areas. The easement will not contain any structures that could confine the gas and, hence, explosion is not likely in this area (Ref.14). The more likely scenario is a flash fire, whereby the gas cloud developed as a result of the release will burn rapidly but without deflagration (explosion).

A rupture of the pipeline in the easement will see a significant quantity of gas released, resulting a gas cloud of many tonnes. This will extend well beyond the easement boundary. Hence, ignition of the cloud would result in flash fire outside the confines of the pipeline easement. This incident has therefore been carried forward for further analysis (frequency & risk).

5.7 Gas Leak into the Turbine Enclosure

The five gas turbines will be installed within a Gas Turbine Hall and each unit enclosed in an acoustic enclosure.

In the event a gas leak occurs within the gas turbine enclosure, under normal circumstances the enclosure ventilation fan would extract the gas and disperse it externally. However, in the event the ventilation fan is shut down or in a failed condition, the gas would build up in the enclosure to a point where the gas detectors, installed within the turbine enclosure, would identify the gas accumulation and shut down gas supply at the turbine hall entry valves. In the event this system fails, along with the fan failure, the gas will eventually reach the lower flammable limit and if ignited a gas explosion would occur within the turbine enclosure. This explosion would result in destruction of the gas turbine enclosure and blast impact towards the site boundary.

To estimate the magnitude of the blast wave the TNT equivalence method was used. This method estimated the quantity of gas within an explosive cloud and equates the mass of gas to an equivalent mass of TNT. Empirical analysis can then be performed to estimate the blast pressure at specific distances from the blast centre.

To estimate the quantity of gas at LEL in the gas turbine enclosure, the volume of the enclosure is first calculated. The gas turbine enclosure has dimensions: 20m long x 4.2m wide x 4.4m high. Whilst the volume of the enclosure can be calculated as: 20x4.2x4.4 = 369.6m^3, the enclosure is fitted with equipment and the gas turbine unit itself. This reduces the free volume in the enclosure to below 50%. However, for this analysis a free volume of 50% has been assumed. Hence, the volume of gas (at LEL) that would explode if ignited is 369.6/2 = 184.8m^3.

The mass of methane, at LEL, within 184.8m^3 of gas is calculated as follows:

1 mole of gas is contained within each 22.4 L of volume. Hence, for 184,800 L of gas the number of moles = 184,800/22.4 = 8,250 mole

At LEL there is a 5% mixture of methane gas in air. Hence, the total number of mole of methane = 8,400 x 0.05 = 412.5 mole. The molecular weight of methane is 16. Hence, the total mass of methane in the enclosure is 6,600kg.

The equivalent mass of TNT is calculated by:

$$W_{TNT} = \alpha\left(\frac{W.H_c}{H_{TNT}}\right)$$

Where: W = mass of fuel in the cloud (1,850 kg in the turbine enclosure)

H_c = heat of combustion of the fuel (38,000 kJ/kg for methane)

H_{TNT} = TNT blast energy (5420 kJ/kg)

α = explosion efficiency (0.04 for methane, Ref.15)

Hence,

W_{TNT} = 0.04 (6600x38000/5420) = 1,850kg TNT

Overpressure is now calculated using a scaled distance curve, based on actual distance from the blast and the TNT equivalent, this is given by:

$$z = \frac{R}{(W_{TNT})^{1/3}}$$

Where: R = distance from the blast (m)

W_{TNT} = kg equivalent of TNT

The closest gas turbine to the site boundary is Turbine No. 6, which is 45m from the western boundary. Hence, for a value of R= 46 and W_{TNT} = 1,850 kg

$Z = 46/(1850)^{0.333} = 46/12.3 = 3.74$

Z is now used to estimate the peak overpressure which can be read from a curve for scaled overpressure plots (see **Figure 5-6**). From **Figure 5-6** for a value of z = 3.74, the peak overpressure is read as 110kPa or 1.1 bar.

The same analysis as that above was conducted for various distances from the explosion centre. **Table 5-15** summarises the results of the analysis.

Table 5-15: Explosion Overpressure Versus Distance for Explosion in the Gas Turbine Enclosure

Explosion Overpressure (kPa)	Distance (m)
70	78
35	130
14	210
7	390

The distance from the closest gas turbine enclosure to the site boundary (west) would be 545m. Based on the explosion analysis summarised in **Table 5-15**, the explosion overpressure at the site boundary would be <7 kPa. HIPAP No.4 (Ref. 5) indicates that explosion overpressure in the order of 7 kPa would not result in any fatalities or significant damage to buildings. Therefore this incident has not been carried forward for further analysis.

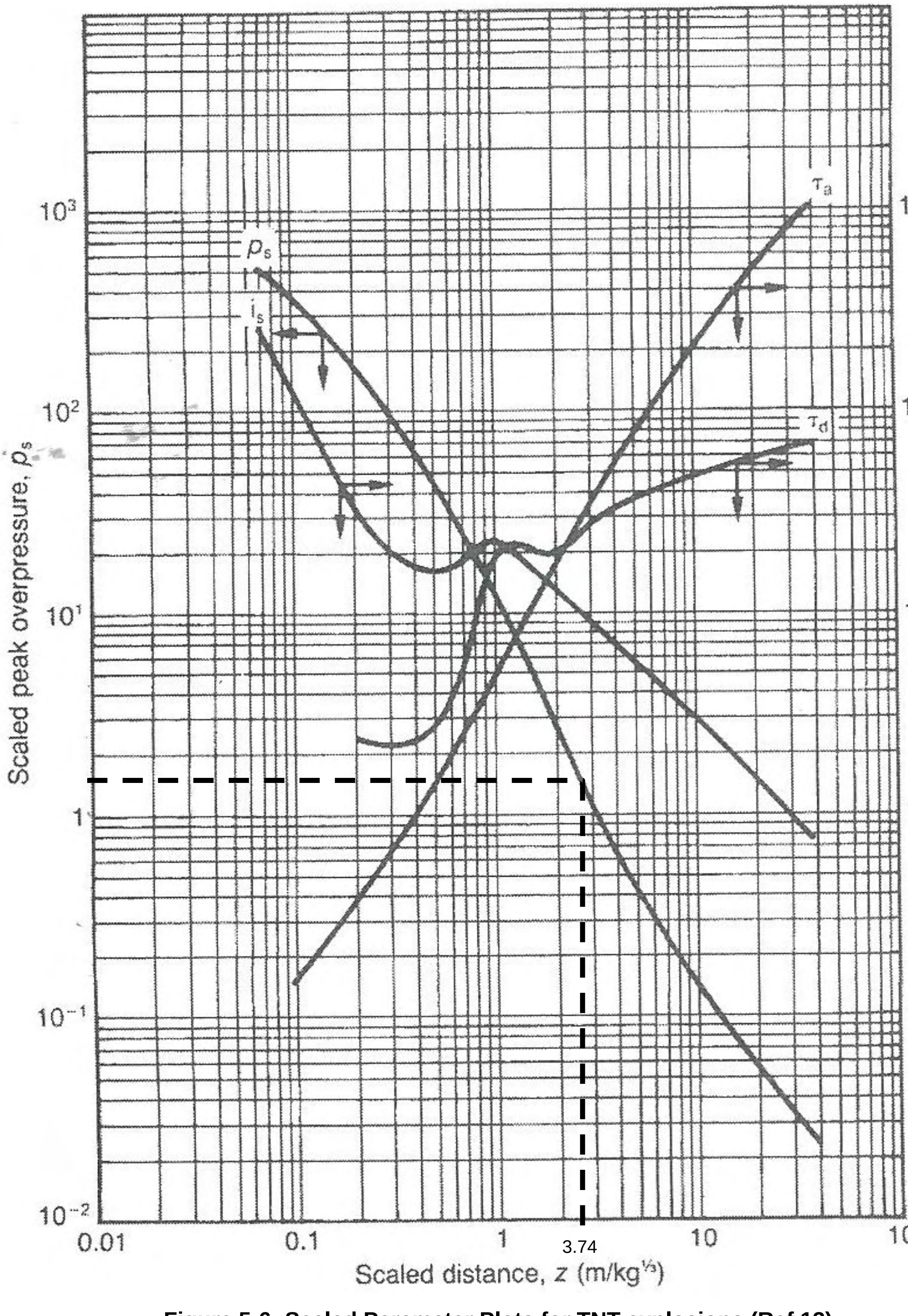


Figure 5-6: Scaled Parameter Plots for TNT explosions (Ref.13)

6.0 Frequency Analysis

6.1 Incidents Carried Forward Frequency Analysis

The consequence analysis indicates that three incidents have the potential to impact offsite areas with severity levels exceeding the criteria published in HIPAP No.4 (Ref.5). Hence, those incidents carried forward for frequency analysis are:

- Gas pipeline incident leading to gas leak as a result of external interference (i.e. excavation impact);
- Chlorine cylinder connection failure leading to chlorine release; and
- Ammonia release from pipework, flanges & fittings.

6.2 Gas Pipeline Incident Frequency Analysis

Gas pipeline incidents occur both in Australia and Overseas. However, the number of incidents that occur in Australia involving high pressure (HP) gas pipelines is limited and is a function of the number of lines in the country. A higher density of high pressure gas pipelines is found in Europe and hence the results of the data gathered by the European Gas Pipeline Incident Data Base (EGPIDG – Ref.12) has been used as the basis for this study. The use of this data would be conservative as the density of gas pipelines is less in Australia and hence there are generally less incidents per km of pipeline than in Europe (Ref.10).

The EGPIDG (Ref. 12) has collected HP gas pipeline incident data for over 30 years, hence the data set is considerable. However, it is noted that over the 30 years that the data has been collected there has been a decided trend downwards in the incident frequency rate, particularly in the past 5 years. This is attributed to the design, construction and protection techniques afforded by modern pipeline standards.

As the proposed pipeline would be constructed in accordance with a modern pipeline code (AS2885-Ref.13), the frequency of pipeline failure due to external interference over the past 5 years has been selected as the frequency most representative for this analysis. The EGPIDG (Ref. 12) indicates that the failure frequency due to external interference over the past 5 years is 0.1 failures per 1000km/yrs. To calculate the failure frequency for the postulated incident at the gas turbine pipeline, the incident consequence for the assessed jet fire (**Section 5.6**) was reviewed. It is noted that the impact distance extends well beyond the easement boundary and that should the fire occur parallel to the pipeline, the distance over which the jet fire would occur is about 100m. Hence, the length of pipeline over which an individual incident can have impact has been selected as 100m (i.e. impact distance up and down the pipeline from the impact source). Hence, the failure frequency as calculated as:

$\lambda_p = 100 \times 0.1/(1 \times 10^6) = 1 \times 10^{-5}$ per section per year.

This frequency has been carried forward for risk analysis.

6.3 Chlorine Release Frequency

The postulated chlorine release occurs as a result of a pigtail failure in the line from the cylinder to the manifold. In the event of a chlorine release, the chlorine room would be fitted with a gas detector system which activates a chlorine shut down system (chlorguard) attached to the chlorine cylinder valve.

The frequency of failure of the chlorine pigtail has been estimated to be 0.01 per annum. This is based on the frequency of pigtail failure of at least one in the plants life. This is conservative as the pigtails would be replaced regularly (once every 6 months) to minimise the potential for premature failure.

The probability of failure of the gas detector system is estimated below:

Gas detector Failure Rate = 0.22 per 10^6 hours (Ref.22)

Fail Rate per annum (p.a.) = (0.22 x 8760 hrs/yr)/10^6 = $2x10^{-3}$

Fractional Dead Time (FDT) = $\frac{1}{2} \lambda t$

where λ = failure rate p.a. and t = test interval (1/tests p.a.)

Four tests of the gas detector system would be conducted p.a. (i.e. once every three months), FDT is estimated as:

FDT = 0.5 x $2x10^{-3}$ x ¼ = $2.5x10^{-4}$

Hence, the probability that a gas detector will fail to detect the chlorine gas when it is released is

$2.5x10^{-4}$.

The probability of failure of the emergency shut down system (chlorguard) is estimated below:

Emergency Valve Failure Rate = 2.88 per 10^6 hours (Ref.22)

Fail Rate per annum (p.a.) = (2.88 x 8760 hrs/yr)/10^6 = $2.5x10^{-2}$

Fractional Dead Time (FDT) = $\frac{1}{2} \lambda t$

where λ = failure rate p.a. and t = test interval (1/tests p.a.)

Assuming the chlorguard system would be tested when the cylinders are replaced (once every two weeks), FDT is estimated as:

FDT = 0.5 x $2x10^{-3}$ x 1/26 = $4.8x10^{-4}$

Hence, the probability that the Chlorguard system will fail isolate a chlorine leak when activated from a chlorine gas detection is $4.8x10^{-4}$.

A fault tree has been developed to determine the failure of the chlorguard system and, hence, the failure to shut down the gas release. The fault tree is shown in **Figure 6-1**.

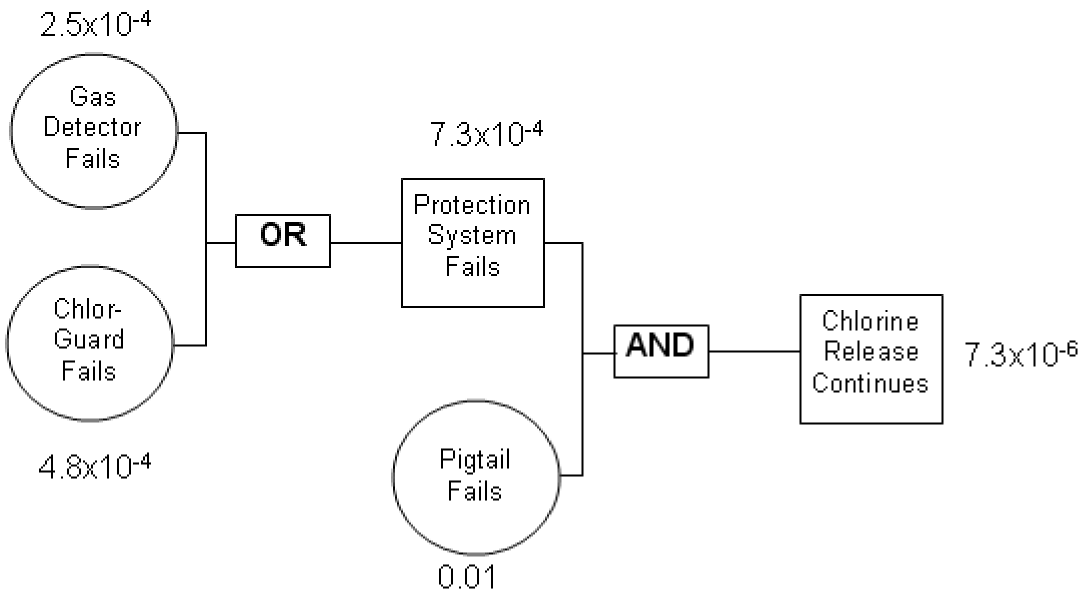


Figure 6-1: Fault Tree – Chlorine Release

The fault tree analysis shows that the frequency of chlorine release is in the order of $1x10^{-5}$ per annum (p.a.), which is conservative as the analysis has not taken account of the potential for manual isolation of the chlorine cylinders using breathing apparatus to access the leak area.

The chlorine release frequency has been carried forward for risk analysis.

6.4 Ammonia Release Frequency

Ammonia releases from storage and transfer systems may occur from a number of sources, as described in the hazard analysis section of the report. Leaks can occur from hoses, flange gaskets and pipework. The failure frequency for each component has been assessed in detail below.

6.4.1 Transfer Hose Failure Frequency

Leaks from transfer hoses may occur, however, the delivery of ammonia will only occur 2 -3 times per annum, with the tanker located on site for about 2 hours. Hence, the exposure from incidents involving transfers is extremely low and the exposure probability can be estimated by dividing the time on site by the total time in 1 year = 6hrs/8760hrs p.a. = $7x10^{-4}$. Hose failure frequency may be estimated from the failure rate data base information. CCPS (Ref.22, Taxonomy 3.2.5) provides a hose failure rate of 0.005p.a. Hence, the failure frequency for hose leak can be estimated by multiplying the leak frequency by the period on site = 0.005 x $7x10^{-4}$ = $3.5x10^{-6}$ p.a.

6.4.2 Gasket Failure Frequency

Leaks from gaskets may occur as detailed in the hazard analysis section of the study (**Section 4**). However, leaks only occur on pressurised flanges, flanges that are unpressurised (e.g. on the downstream side of a closed valve), will not leak. The leak only has the potential to occur on the upstream, pressurised side of the valve. A review of an ammonia tank installation indicates that there would be around 6 flanges exposed to the pressurised side of the tank, with a further 6 flanges located on the valves and fittings associated with the ammonia delivery line to the plant. It is noted that the ammonia delivery line would be fully welded along its length, with flanges and valves only located at the either end of the line.

The failure frequency of a flange may be estimated from the failure frequency data literature. A flange leak frequency has been estimated to be $4x10^{-5}$ p.a. (Ref.15). Based on the total exposed flanges, the total failure frequency is estimated to be 12 x $4x10^{-5}$ = $4.8x10^{-4}$ p.a.

6.4.3 Pipeline Leaks

Leaks from pipework may occur due to corrosion, leading to minor pinhole leaks that could grow to larger releases. The pipeline failure frequency may be estimated from the failure rate literature, the estimated pipeline leak rate for the ammonia pipework is $3x10^{-7}$ x Length/Diameter p.a. The pipeline length is estimated to be 50m and the diameter 50mm. Hence, the failure frequency is estimated to be $3x10^{-7}$ x 50/0.05 = 3x10-4 p.a.

6.4.4 Total Ammonia Leak Frequency

The total frequency for ammonia leaks is the summation of the frequency for all leak incidents. The total leak frequency is therefore:

Ammonia Leak Frequency (Total) = 3.5x10-6 + $4.8x10^{-4}$ + $3x10^{-4}$ = **$7.8x10^{-4}$ leaks p.a.**

6.4.5 Ammonia Continued Release Frequency

In the event of a release of ammonia, there is a potential for injury to occur at the site boundary (see **Section 5**). However, to minimise the potential for continuous release, the ammonia tank and associates pipwork will be fitted with gas detectors and a permanent fire water fog nozzle. In the event of leak, the gas detection system will identify the release and alarms will initiate emergency response (start the fog nozzle). The fog system that will absorb the ammonia, preventing continued release of ammonia from the storage area. It is noted that ammonia is a highly hygroscopic gas (i.e. dissolves in readily in water), hence, fog systems are extremely effective in controlling ammonia releases. In the event the automatic system fails, operator can initiate the fog system manually, however, for conservatism, this has not been included in the assessment.

The gas monitoring and fire main/fog system consists of a number of elements, these are:

- Gas detector System – the failure rate for the gas detection system is estimated from the OREDA data base (Ref.27, Taxonomy 4.1) – $2x10^{-3}$ p.a. The probability that the system is in a failed state when required (FDT) is ½λt. Assuming a test period of twice per year, FDT=0.5x0.002x1/2 = $5x10^{-4}$.
- Fire main system – the fire main system will consists of supply from two pumps; one diesel and one electric. The failure of the system is the multiple of the failure rates of the two pumps. Failure of a centrifugal fire water pump to start can be estimated from the OREDA Data base (Ref.27, Taxonomy) – 0.022 failures p.a. Hence, the FDT, based on a weekly test is FDT = 0.5 x 0.022 x 1/52 = $2x10^{-4}$. The probability of failure of the diesel pump to start can be estimated from the CCPS data base (Ref.22, Taxonomy 4.2.3.3) – 0.018.

Hence the failure probability of the gas detector and fog system (fire main) is assessed using a fault tree (see **Figure 6-2**).

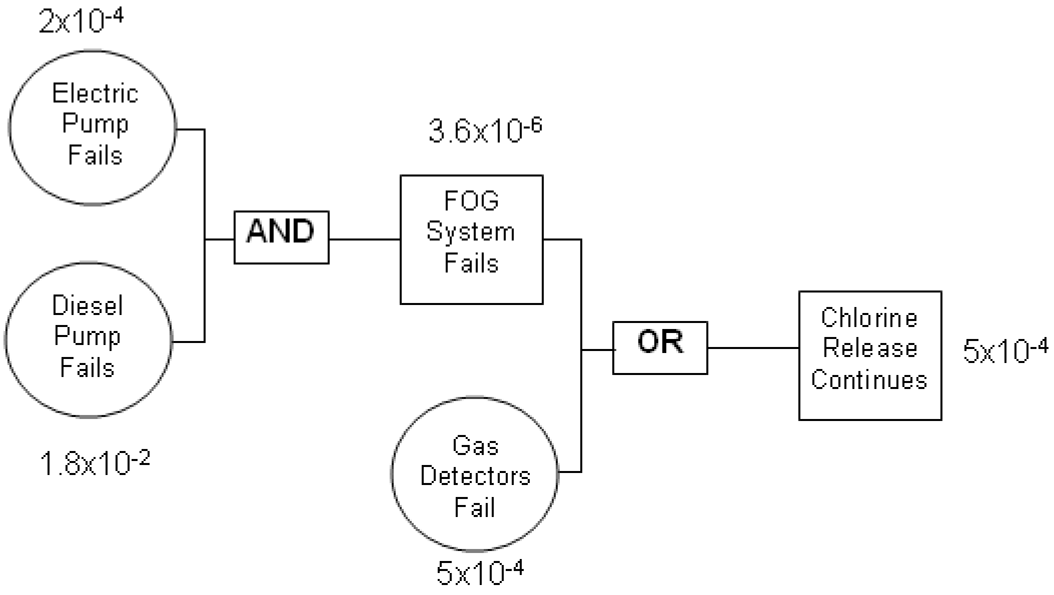


Figure 6-2: Fault Tree –Ammonia Protection System

Hence, the frequency of continued releases at the ammonia storage is the multiple of the release frequency by the failure of the protection system = $7.8x10^{-4}$ p.a. x $5x10^{-4}$ = **$3.9x10^{-7}$ p.a**.

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7.0 Risk Analysis

7.1 Incidents Carried Forward for Risk Analysis

Two incidents were carried forward for risk analysis, these were:

- Gas pipeline incident leading to gas leak as a result of external interference (i.e. excavation impact);
- Chlorine cylinder connection failure leading to chlorine release;
- Ammonia leak from transfer hose, flanges, and pipes.

The risk associated with each operation is assessed in **Sections 7.3** and **7.4**.

7.2 Risk Criteria

The land zoning for the proposed gas pipeline route will be Rural 1(a). The risk criteria published in HIPAP No.4 (Ref.5) is summarised in **Table 7-1**. It can be seen from this table that the criteria does not contain a fatality risk criterion for rural land. Rural land is not heavily populated and hence the selection of criteria for sensitive land use (e.g. hospitals, schools residential areas, etc.) would not be commensurate with the location of the proposed pipeline on rural land. Conversely, the selection of industrial risk criterion would not reflect the nature of the land upon which the pipeline would be located, considering the potential for some public access to the land adjacent to the pipeline route, albeit low frequency. Based on this analysis, it is proposed to use the criteria for sporting complexes and active open space as a representative risk criterion for the rural land. This would be a conservative criterion, as it would be expected that considerably more people would access sporting complex and active open spaces than would access the proposed gas pipeline route. Hence, based on this the selected fatality risk criteria for the pipeline route is 10 chances of fatality per million per year (10pmpy).

Table 7-1: Fatality Risk Criteria for Land Use Safety Planning (Ref. 5)

Land Use	Suggested Criteria (risk in a million per year)
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

(Ref.5)

7.3 Pipeline Easement Fatality Risks

A jet fire in the pipeline easement would extend beyond the easement boundary directly impacting areas where people may be located, however, it is noted that the majority of the pipeline would be within remote areas and the general public would not be exposed to the hazards and risks associated with the pipeline. The results of people being exposed to fire or heat radiation can be fatalities or injuries, depending on the magnitude of the heat radiation impact. However, as the jet fire itself has the potential to project beyond the easement boundary, any ignited release (immediate or delayed) will result in fatality if people are present in the area where the release occurs. However, if the release fails to ignite, there will be no impact to people (fatalities) and the consequences will be avoided.

Hence, the fatality probability at the pipeline easement boundary is 1 and the fatality risk is equal to the release frequency multiplied by the probability of ignition. Ignition probability is available from a number of data sources. For this study, the ignition probability has been selected as 0.3 (Ref.23) for massive leaks (>50kg/s) and therefore the fatality risk is:

Fatality Risk = 0.3 x 1×10^{-5} p.a. = 3 chances in a million per year (pmpy)

A review of the selected criteria for the pipeline route indicates that the estimated fatality risk is below the selected risk criteria. Hence, the pipeline would only be classified as potentially hazardous. It is noted that the assessment conducted above does not incorporate any risk reduction measures that may be employed, such as pipeline marker tape, pipeline patrols, etc. Notwithstanding this, it is noted that in the event of a fire or flash fire incident there will be an immediate impact outside the pipeline easement. Hence, **it is recommended that:**

- **The pipeline be located no closer than 100m to any property residence.**
- **The depth of cover over the pipeline where the pipeline crosses roads or where property residences are at 100m from the pipeline, be increased in open land areas from the proposed depth of 900mm to 1200mm (the length of the increased depth should be 100m either side of the road and 100m in either direction from the perpendicular to the property residence).**
- **Installation of pipeline marker tape 300mm below the ground surface where the pipeline crosses roads (the marker tape should be installed for 50m either side of the road).**
- **The distance between the signs located along the pipeline route be decreased such that signs are no more than 50m apart, notwithstanding any clear visibility along a straight flat section of the pipe route.**
- **A safety management system element be developed specifically for the pipeline, this element should include regular pipeline route and equipment inspections, line pigging with intelligent pigs on a regular basis (every 5 years), inspection and checking of the impressed current corrosion protection system.**

7.4 Chlorine Release Risks

The consequence analysis, as a result of a chlorine leak, indicated that fatality and injury could occur at the site boundary.

The frequency of chlorine release was estimated to be $7.3x10^{-6}$p.a. Hence, the risk of fatality or injury can be no greater than 7.3 pmpy. The area where the chlorine has the potential to impact would be towards the Drayton mine, an industrial site. Hence, the industrial risk criterion has been selected for this component of the analysis. **Table 7-1** indicates that the industrial fatality risk criterion is 50 pmpy. Hence, the operation of the proposed chlorine facility will not exceed this criterion. A review of HIPAP No.4 (Ref.5) indicates that injury risk as the site boundary should not exceed 10 pmpy for residential areas, however, there is no criterion published for industrial areas. Based on the relationship between other residential and industrial criteria in the HIPAP No. 4 (Ref.5), it would be expected that the industrial injury criterion would be less stringent than that for residential areas. Hence, industrial injury criterion is expected to be >10 pmpy. The risk of injury at the closest site boundary is <10 pmpy and therefore the criterion would not exceeded.

7.5 Ammonia Injury Risk

The consequence analysis identified that ammonia releases could result in concentrations at the site boundary that could be injurious for continued exposure. The frequency analysis identified that the continued release frequency for incidents at the ammonia storage was $3.9x10^{-7}$ p.a. or 0.39 chances of injury per million per year.

HIPAP No.4 (Ref.5) indicates that the maximum permissible injury risk at the site boundary is 50 chances in a million per year. Hence, the assessed risk is over two orders of magnitude less than the permissible risk and therefore the published risk criterion would not be exceeded.

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8.0 References

1. The Australian Code for the Transport of Dangerous Goods by Road and Rail (known as the Australian Dangerous Goods Code or ADG), 7th ed., 2007, Federal Office of Road Safety, Canberra, ACT.
2. Hazardous Industry Planning Advisory Paper No.6 (1992) – Guidelines for Hazard Analysis, NSW Department of Planning.
3. Multi-Level Risk Assessment (1997), NSW Department of Planning.
4. Applying SEPP 33 (1994), “Hazardous and Offensive Development Application Guidelines”, NSW Department Planning.
5. Hazardous Industry Planning Advisory Paper No.4 (1992) – Risk Criteria for Land Use Safety Planning, NSW Department of Planning.
6. AS2419-2005, “Fire hydrant installations – System design, installation and commissioning”, Standards Association of Australia, Sydney.
7. AS3780-2008, “The storage and handling of flammable and combustible liquids”, Standards Association of Australia, Sydney.
8. AS4332-2005, “The storage and handling of gases in cylinders”, Standards Association of Australia, Sydney.
9. AS1940-2004, “The storage and handling of flammable and combustible liquids”, Standards Association of Australia, Sydney.
10. AS2927-2001, “The storage and handling of liquefied chlorine gas”, Standards Association of Australia, Sydney.
11. AS1894-1997, “The storage and handling of non-flammable cryogenic and refrigerated liquids, Standards Association of Australia, Sydney.
12. Bolt, R. and Horalek, V. (2004), “EGPIDG* Pipeline Incident Database”, 13th Colloquium Reliability of HP Steel Pipes”, Prague. Czech Republic. (*European Gas Pipeline Incident Data Group)
13. AS2885.1-2007, “Pipelines: Gas and liquid petroleum – design and construction”, Standards Association of Australia, Sydney.
14. Lees, F.P. (2005), “Loss Prevention in the Process Industries”, Butterworth-Heinemann, London.
15. Tweeddale, H.M. (1993), “Hazard Analysis and Reduction”, University of Sydney, School of Chemical Engineering.
16. AS1210-1997, ”Pressure Vessels”, Standards Association of Australia, Sydney.
17. Townsend, N.A and Fearnehough, G.D (1986), Control of Risks from UK Gas Transmission Pipelines, proceedings 7th symposium on line pipe research, American Gas Association, Oct.1986, Houston, USA.
18. Withers, J. et.al. (1988), Ammonia Toxicity Monograph”, IChemE, Rugby UK.
19. Private Communication – S.Sylvester (SKM)/C.Gent(Orica Chloralkali Manager, Botany).
20. SKM-Agility Communication – Sylvester,S(SKM)/Cheng, M(Agility), July 2005
21. TNO Safety Software (Sept 2003), “EFFECTS Version 5.5”, TNO Environment, Energy and Process Innovation, Department of Industrial Safety, The Netherlands

22. CCPS (1989), "Process Equipment Reliability Data", Centre for Chemical and Process Safety, AIChemE, New York.

23. Cox, A.W. Lees, GF.P. and Ang, M.L. (1991), "Classification of Hazardous Locations", A report of the Inter-Institutional Group on the Classification of Hazardous Locations (IIGCHL), IChemE, Rugby, UK

24. Kletz, T, et.al., (1988), "Chlorine Toxicity Monograph", IChemE, Rugby UK.

25. AS2022-2003, ":Anhydrous ammonia – storage and handling", Standards Association of Australia, Sydney

26. Cameron, I & Raman R (2005), "Process Systems Risk Management - Process Systems Engineering", Vol.6, Elsevier Academic Press ISBN: 0-12-156932-2

27. OREDA (2003) – Offshore Reliability Data (4th ed), prepared by Sintef Industrial Management and published by the OREDA Participants including BP Exploration, ExxonMobil, Norsk Hydro, Phillips Petroleum, Statoil, Shell Exploration, TotalFina

28. AS2444-2001, "Portable Fire Extinguishers and Fire Blankets – Selection and Location", Standards Association of Australia.

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Plume Rise Assessment Report

Bayswater B Power Station

AECOM

4 September 2009

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Plume Rise Assessment Report
Bayswater B Power Station

4 September 2009

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"This page has been left blank intentionally"

Contents

List of Tables

Body Report

List of Figures

Body Report

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1.0 Introduction

Macquarie Generation (MacGen) is seeking Concept Plan Approval for activities to provide an additional 2,000 MW of electricity, on land within its ownership adjacent to the existing Bayswater Power Station. The proposed project is known as the Bayswater B Power Station which will generate electricity from the combustion of either coal or gas. The Civil Aviation Safety Authority (CASA) has established that exhaust plumes may upset low flying aircraft or cause damage to aircraft airframes when vertical gusts exceed 4.3 m/s. In order to manage or reduce this risk, pilots require information about potentially hazardous plumes so they can avoid the area of likely air disturbance.

As such, facilities with exhaust plumes that have an average vertical velocity that exceeds 4.3 m/s at the Obstacle Limitation Surface (OLS) at an aerodrome, or at 110 m above ground level in other areas, are required to conduct a hazard assessment. As the stack of the proposed coal-fired plant will be taller than 110 m, MacGen is required to apply to CASA for an “Operational Assessment of a Proposed Plume Rise”. That application requires an Impact Assessment Report to be submitted that provides the data upon which CASA will base its hazard assessment, and determine whether the plume should be classified as a ‘hazardous object’ under Civil Aviation Safety Regulation (CASR) Part 139. This report provides that information, and was prepared in accordance with the Guidelines for Conducting Plume Rise Assessments (June 2004) issued by CASA, with data generated using the plume rise assessment module of The Air Pollution Model (TAPM) version 4.

As required by the CASA guidelines, the assessment was conducted using five continuous years of hourly meteorological data generated by TAPM. The assessment includes analysis of plume rise dynamics and upper level winds, and determines:

- The maximum height at which the critical vertical velocity (4.3 m/s) of the plume is reached; and
- The vertical and horizontal limits of the exhaust plume at which the average vertical velocity reduces to a value of 4.3 m/s.

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2.0 Project Description

2.1 Location

Bayswater B would be located on Lot 322 DP 625513 within the existing Bayswater Power Station site, adjacent to Plashett Dam, which is used to manage water supplies to the Bayswater Power Station and Lake Liddell. The site is within the Singleton local government area.

The Bayswater B site is approximately 4.5 km WSW of the existing Bayswater Power Station.

2.1.1 Nearby Airfields

There are a number of small airfields in the general area as shown in **Figure 1**. The closest airstrip is at Warkworth, approximately 11 km from the Bayswater B site. The closest major airport is located at Williamtown, approximately 100 km southeast of the site, which caters for both civilian and Defence Force facilities.

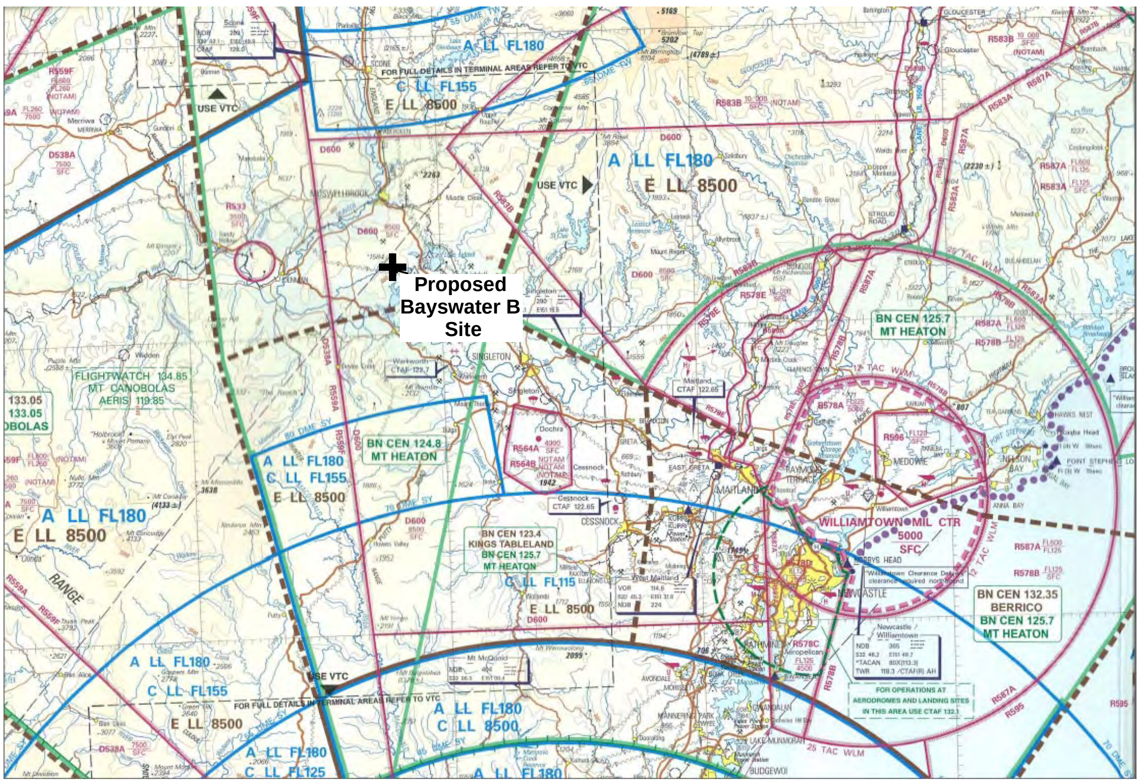

Figure 1: Location of Airfields

2.2 Proposed Plant

Coal Fired

The Bayswater B coal-fired option will use Ultra Supercritical Pulverised Coal Fired Technology. Exhaust gases would be emitted from a single 300 metre tall wake-free, twin flue stack (one flue per boiler unit).

Gas-fired

The Bayswater B gas-fired option would comprise five F class gas turbines, which would emit exhaust gases from five wake-free, 55 metre tall, single flue stacks (one stack per gas turbine unit). These turbines would consist of combined cycle gas turbines incorporating heat recovery steam generators.

Stack characteristics have been further defined in **Section 3** of this document.

3.0 Modelling Methodology

The analysis performed in this report was conducted using CSIRO's TAPM version 4. The model was set to produce an output of the plume rise from the exhaust stacks. This output consists of plume averaged vertical velocity, plume centreline elevation and radius of the plume (both in the vertical and horizontal planes). The plume elevation and radius are measured from the plume's point of release and the plume characteristics calculated until it stabilises in the atmosphere. TAPM produces this output in intervals ranging from 1 to 5 seconds, for each source and every hour of the modelling period. This allows interpolation of the plume elevation, at the point at which the plume vertical velocity reduces to 4.3 m/s.

Modelling data used in this plume rise assessment were the same as those used by Katestone in the Air Quality Impact Assessment prepared for the Bayswater B project to ensure consistency.

3.1 Dispersion Model Configuration

The configuration of the TAPM model was based on the requirements outlined in the CASA Advisory Circular "Guidelines for Conducting Plume Rise Assessment". Aspects of the assessment and their relative compliance with the CASA circular have been listed in **Table 1**. The latest version of TAPM (v4) was used for this assessment.

Table 1: TAPM Parameters

Parameter	Model Data	Compliant with CASA Guidelines (Y/N)
Modelling period	1 Jan 1999 – 31 Dec 2003*	Y
Grid centre coordinates	-32 deg -23 min; 150 deg 55.5 min	Y
Local values	304807, 6415180	N/A
Grid points	25 x 25	Y
Outer grid spacing	30 km x 30 km	Y
Vertical levels	25	Y
Domains	30 km, 10 km, 3 km, 1 km	Y
Terrain	AUSLIG 9 second DEM	Y

* This period was selected to ensure data used for the air quality impact assessment corresponded as close as practical to this assessment. Data used for the AQIA was March 1999 – February 2000, March 2000 – February 2001 and March 2007 – February 2008.

The source parameters for each of the proposed plants are shown in **Table 2**. As indicated, the proposed coal plant would be equipped with significantly higher stacks, a hotter gas stream and faster exit velocity than the gas plant; as such, the plume from the coal plant would be expected to be higher than that of the gas plant.

The plumes from the five stacks associated with the gas plant would be expected to merge due to their proximity to each other, which may increase the buoyancy of the plume, and was accounted for in the dispersion modelling through the application of a buoyancy enhancement factor to the emissions from each gas stack. The value for this buoyancy enhancement factor was obtained from Manins, Carras and Williams (1992) and entered into the TAPM model.

Table 2: Source Parameters

Parameter	Coal	Gas
Number of stacks	1	5
Location	302821, 641652	302741, 6412727 302787, 6412705 302838, 6412682 302889, 6412660 302940, 6412637
Stack height (m)	300	55
Stack radius (m)	5.78	3.4
Temperature (K)	415.45	375.55
Exit velocity (m/s)	24.8	20.4
Buoyancy enhancement factor	1	2.91*

* From Manins et al., 1992

Only one operational scenario was investigated for the coal and gas fired power plants. The operational scenario assumed constant operation for the full 5 years of meteorological data. In practice it is likely that there would be periods when the power station would not be operating or would be operating at less than full capacity. However as the aim of this assessment was to examine the plume rise for each hour of the 5 year of meteorological data, a constant operational scenario is considered appropriate.

The TAPM output files were investigated to determine the height at which the vertical velocity of the plume decreased to 4.3 m/s for each hour over the five year meteorological data period assessed. For periods where the modelled value did not equal exactly 4.3 m/s, the height for the vertical velocity immediately less than 4.3 m/s was assumed to be the critical height in order to provide a conservative assessment.

4.0 Results

4.1 Local Meteorology

Meteorological data for the area surrounding the Bayswater B Power Station shows that the region experiences light to moderate wind predominantly from the northwest and southeast with an average wind speed of 3.01 m/s and 2.4% calms over the 5 years of data analysed. A detailed analysis of the meteorology around Bayswater B has been provided in the Air Quality Impact Assessment prepared by Katestone Environmental for the Environmental Assessment for the Bayswater B Project undertaken by AECOM. A wind rose showing the prevailing wind directions and wind speed has been shown in **Figure 2**.

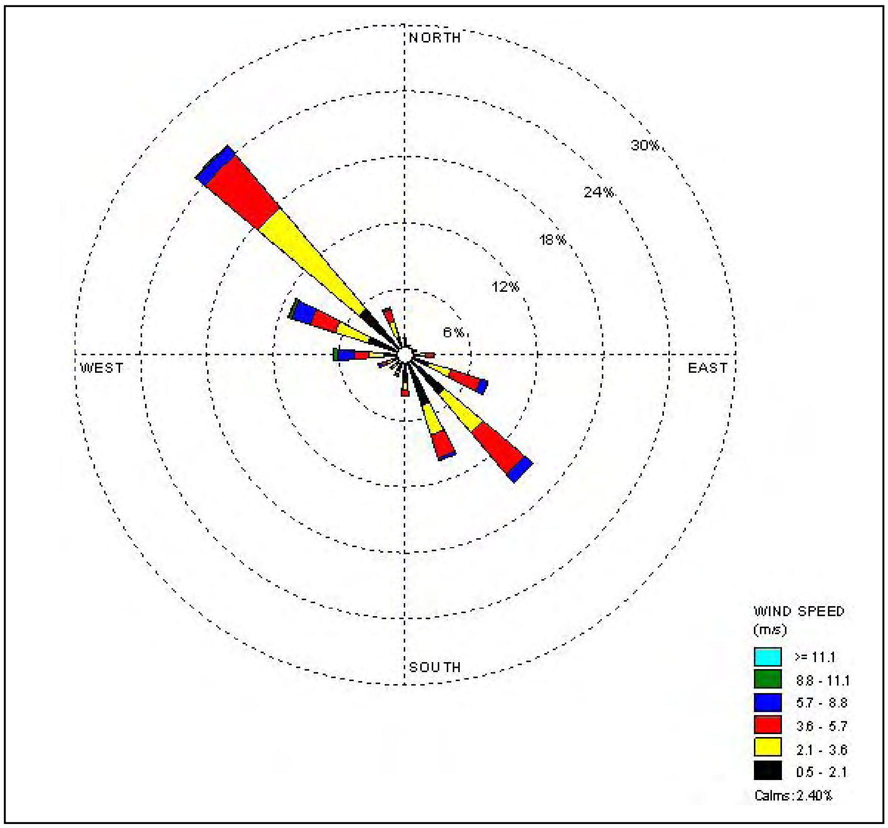

Figure 2: TAPM Generated wind rose for 1999-2003

The frequency of low wind speeds occurring between the source and the critical height were investigated at nine well-spaced levels. The data for levels 900 and 1100 m were linearly interpolated from the data extracted from TAPM for 750 m, 1000 m and 1250 m. As shown in **Table 3**, low wind speed conditions are expected to occur infrequently at the heights investigated. The implication of the wind speed frequencies is that the vertical plume velocities will not reach maximum heights as frequently due to the plume interaction with stronger more frequent winds at higher elevations.

Table 3: Low Wind Speed Occurrence between Source and Critical Height

Height (m)	Wind Speed (m/s)				
	< 0.1	< 0.2	< 0.3	< 0.4	< 0.5
300	0.01%	0.09%	0.18%	0.31%	0.55%
400	0.01%	0.07%	0.17%	0.31%	0.50%
500	0.02%	0.06%	0.14%	0.26%	0.42%
600	0.02%	0.05%	0.15%	0.25%	0.38%
750	0.01%	0.05%	0.12%	0.25%	0.37%
900	0.02%	0.08%	0.15%	0.27%	0.42%
1000	0.02%	0.08%	0.15%	0.27%	0.42%
1100	0.02%	0.08%	0.17%	0.27%	0.42%
1250	0.02%	0.08%	0.17%	0.27%	0.42%

4.2 Plume Rise Statistics

A summary of the plume characteristics for the coal and gas fired plants is provided in **Table 4** and **Table 5**, which shows the maximum, minimum and average heights below which the plume vertical velocity exceeded 4.3 m/s (critical height). Also shown are the maximum, minimum and average spreads of the plume in the horizontal and vertical directions.

Table 4: Critical Plume Extents – Coal-Fired Power Station

Statistic	Critical Height (m)	Horizontal Spread (m)	Vertical Spread (m)
Maximum	1127	132	66
Minimum	306	11	6
Average	355	29	10

The maximum critical plume extent was reached during the 2001 meteorological data period. On this basis the analysis of the critical plume extent was limited to one years data for the gas fired option. This is considered to be a conservative option and no additional data assessment is considered necessary for this option.

Table 5: Critical Plume Extents – Gas-Fired Power Station (worst case year, 2001)

Statistic	Critical Height (m)	Horizontal Spread (m)	Vertical Spread (m)
Maximum	642	90	45
Minimum	65	9	4
Average	102	20	10

Given the comparison between the two plants i.e. same location, similar stack characteristics (with exception of height), a detailed analysis of the plume spread data was undertaken on the coal fired option only (option which resulted in the largest critical height and plume spread characteristics). From this point on the assessment analysis relates to the coal fired option only.

The existing Bayswater Power Station is located approximately 4.5 km from the site; as such, the plume of the proposed coal fired plant is not expected to merge with the plumes from Bayswater Power Station prior to the plume velocity decaying below the critical threshold. The maximum horizontal spread of the plume supports this statement given that it was estimated to be 132 m.

A visual representation of the extent of the modelled plume height and width within the critical velocity parameters is provided in **Figure 3**. This plot indicates that the greatest critical heights correspond to the largest plume radii.

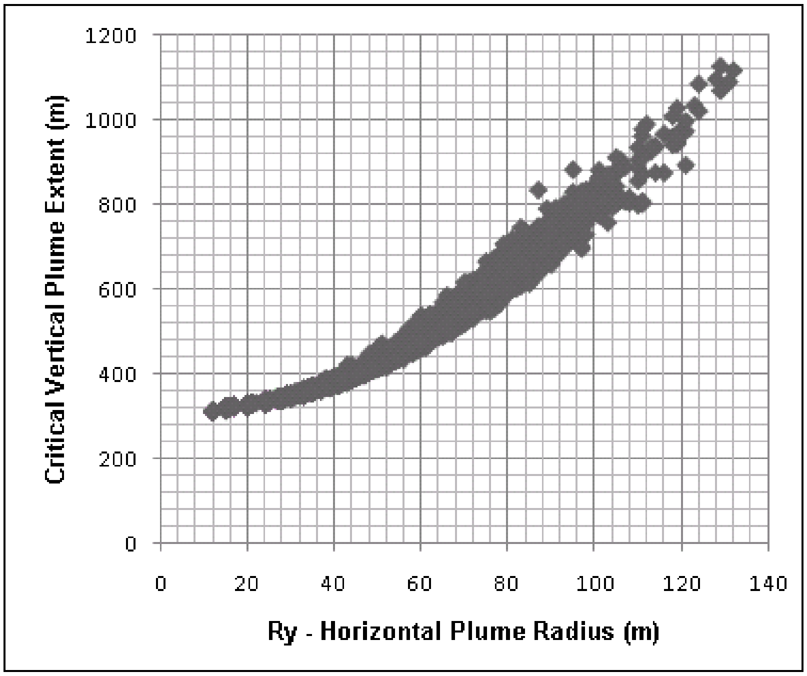

Figure 3: Plume height vs horizontal radius

Table 6 shows the proportion of time for which the plume velocity exceeds 4.3 m/s. As expected, the plume exiting the stacks has a critical velocity greater than 4.3 m/s. The proportion of the plume with a velocity exceeding the 4.3m/s decreases rapidly. At 641m above ground level the plume velocity would be expected to fall below 4.3 m/s for 99% of the time and at a height of 962 m the plume would be expected to fall below the 4.3 m/s velocity for 99.95% of the time.

Table 6: Proportional Exceedence of Critical Vertical Velocity – Coal Fired Power Station

Percentile Exceedence of 4.3 m/s	Height (m)
100%	306
90%	322
80%	327
70%	328
60%	329
50%	335
40%	341
30%	348
20%	362
10%	403
9%	410
8%	418
7%	429
6%	441
5%	458
4%	480
3%	511
2%	559
1%	641
0.50%	732
0.30%	796
0.20%	828
0.10%	901
0.05%	962

In addition to the plume statistics presented in **Tables 4 - 6**, the CASA guidelines require the preparation of a probability distribution for the height and lateral limit of the critical plume vertical velocity (4.3 m/s). This data is presented in **Figure 4**.

The lines drawn on **Figure 4** represent the fraction of time over the 5 years of modelled data that the vertical plume velocity exceeds 4.3 m/s and also details the corresponding plume extent at that height. For example, the area between the “0.1” and the “0.01” line represents a point above the stacks where the 4.3 m/s velocity would be exceeded for up to 438 hours over the five years of modelled data.

The area of primary concern to aircraft as outlined by **Figure 4** is the area located close to the source in both the horizontal and vertical directions i.e. as the lines increase in value, the potential for experiencing vertical velocities greater than 4.3 m/s increases until the “1” line is reached (which represents the heights at which all plume velocities will be greater than 4.3 m/s).

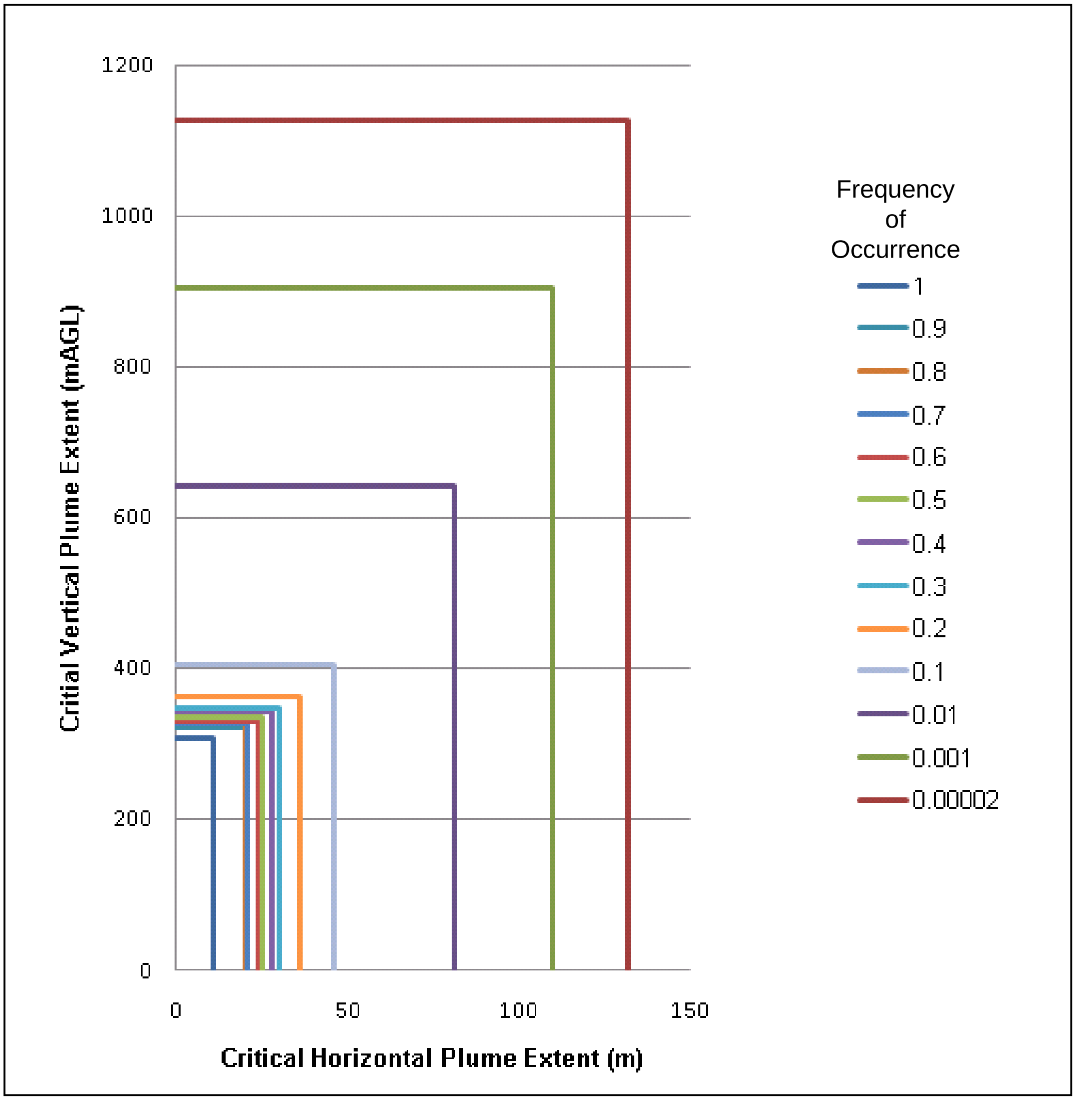

Figure 4: Probability Distribution - Height and Lateral Limit of Critical Vertical Plume Velocity

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5.0 Conclusion

The coal and gas fired options for the proposed Bayswater B Power Station have been assessed to determine the potential impact on aviation safety. The assessment has been performed using the CSIRO's TAPM model to allow the prediction of upper air meteorology and plume rise statistics for five years commencing in 1999.

Results of the plume rise analysis demonstrated that both proposed options (coal-fired and gas fired) plant stack plumes will exceed the 4.3 m/s above the 110 m criteria applicable to this facility. On the basis of these findings, the proponent is required to apply to CASA for an "Operational Assessment of a Proposed Plume Rise". This report provides sufficient information to allow the CASA assessment to be undertaken.

In addition to the application for an Operational Assessment to Proposed Plume Rise, it is recommended that CASA be notified of the final stack height (depending on whether the coal of gas option is selected) for inclusion in the RAAF Aeronautical Information Service tall structure database.

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6.0 References

CASA (2004). Advisory Circular AC 139-05(0): Guidelines for Conducting Plume Rise Assessments. Civil Aviation Safety Authority.

CASA (2004), Draft Advisory Circular AC 139-08(0): Reporting Tall Structures. Civil Aviation Safety Authority

Manins, P.C. (1992). Plume rise from multiple stacks. Clean Air, 1992, 26(2), pp 65 – 68.

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