Appendix C8

Greenhouse Gas & Energy Assessment

Mangoola Coal Project

Scope 1, 2 & 3 Energy & Greenhouse Assessment

Prepared by SEE Sustainability Consulting

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Mangoola Coal Project

Scope 1, 2 & 3 Energy & Greenhouse Assessment

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1 Introduction

This report provides an assessment of the potential Greenhouse Gas and Energy impacts associated with Xstrata Mangoola's proposed modification to the approved Project (herein referred to as "the Project"). The Project will involve open cut mining within existing mining leases, using a modified approach in comparison to the approved Project as per Project Approval 06_0014 (PA 06_0014). Xstrata Mangoola Pty Limited (trading as Mangoola Coal) is seeking approval for the proposed Modification under section 75W of the *Environmental Planning and Assessment Act 1979* (EP & A Act). SEE Sustainability Consulting have been engaged by Umwelt (Australia) Pty Ltd (Umwelt) to assess and evaluate the potential Greenhouse Gas and Energy impacts associated with the Project, for comparison to the Anvil Hill Project Environmental Assessment (EA) (Umwelt, 2006). This assessment accompanies a broader EA for the Project being prepared by Umwelt.

The assessment has been prepared using information provided by Xstrata Mangoola regarding:

- estimated annual coal production schedules;
- predicted energy content of ROM and product coal;
- estimated annual on site diesel, electricity and explosives consumption; and
- estimated quantities of construction materials for the Project.

1.1 Description of the Approved and Proposed Projects

The key elements of the approved and proposed Projects are described in **Table 1** below:

Table 1: Comparison of the approved and proposed operations

Major Project Components/Aspects	Approved Operations	Proposed Operations
Limits on Extraction	• Up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal	• No change
Mine Life	• 21 years from 2007	• No change
Operating Hours	• 24 hours per day, 7 days per week	• No change
Mining Methods	• Open Cut mining operations to be undertaken using truck and shovel methods to handle overburden and coal	• No change to mining methods but change to the number and type of equipment to be used
Mining Areas	• Mining operations to be undertaken within the approved project disturbance area	• small extension to the approved project disturbance boundary of approximately 8 ha where drilling has established that the coal crop line extends beyond the approved project disturbance boundary
Infrastructure	• CPP and associated infrastructure; • Access road and Wybong Road intersection; • Rail infrastructure; • Administration and employee facilities; • Electrical and power reticulation • Telecommunication cables;	As provided for in the Project Approval but with the following changes: • operating the Raw Water Dam at its full supply level (following the change from tailings dam to Raw Water Dam as per Pipeline Modification); • construction of a noise wall in the rail loop area based on outcomes of noise modelling and as required by the original project's statement of commitments; • modification to the rail loop design

	• Water supply and sewage systems; • Tailings infrastructure; • Workshop and refuelling facilities; • Lighting; and • Explosives storage.	including drainage design which will have a minor affect on the overall footprint of the rail loop. Access road and intersections will remain unchanged.
Tailings Strategy	• In-pit management of tailings (PA 06_0014 MOD 2)	• No change
External Coal Transport	• Product coal will be loaded onto trains and transported to market via the Project rail loop connected to the Muswellbrook-Ulan railway. Expected average of four trains per day	• No change
Mine Staging	• Mine plan was based on the existing 500kV electricity transmission line (ETL) being in the current location, resulting in two or more pits operating at any one time throughout the mine life	• New mine staging/sequencing to allow for more efficient resource recovery (approval to relocate the existing ETL is currently being sought in conjunction with this Project).

1.2 Assessment Context

The greenhouse assessment is based upon the methodologies outlined in:

- the World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) Greenhouse Gas Protocol 2004 (GHG Protocol);
- the Australian Government Department of Climate Change (DoCC) National Greenhouse Accounts (NGA) Factors, June 2009; and
- the Xstrata Coal (XC) Scope 3 emissions reporting standard and calculator.

These guidelines define three “scopes” of emissions categories for a project:

- **Scope 1** covers direct emissions from the combustion of fuels (e.g. diesel) and industrial processes within the boundary of the operation;
- **Scope 2** covers indirect emissions from the operation’s consumption of purchased electricity produced by another organisation; and
- **Scope 3** includes other indirect emissions as a result of the operation’s activities that are not from sources owned or controlled by the organisation (for example, product transport).

Direct emissions are produced from sources within the boundary of an operation as a direct result of its activities e.g. combustion of diesel fuels in coal production.

Indirect emissions are produced outside the boundary of the operation by other organisations but are directly linked to the operation’s on-site activities. Indirect emissions mainly result from the generation of electricity consumed by the operation, and combustion of the product coal. **Table 2** below shows how the physical source of the emissions, i.e. direct or indirect, relates to the Scope of Emissions.

Table 2 Direct & Indirect Emissions versus Scope of Emissions

	Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
Direct (Within the boundary of the operation)	Diesel consumption by the Project		Upstream emissions due to the Project's consumption of diesel[c]
	Emissions of methane		
	Emissions from explosives		
	Emissions from Slow Oxidation and Spontaneous Combustion[a]		
Indirect (Outside the boundary of the operation)		Electricity consumption by the operation	Upstream emissions due to the operation's consumption of electricity[b]
			Downstream emissions from diesel consumed for product transport via rail and ship
			Downstream emissions from the combustion of product coal
			Embedded GHG in steel and concrete infrastructure

a Coal and other carbonaceous material will begin to slowly oxidise and release CO_2 when exposed to the atmosphere as a result of mining. If not effectively managed, the heat build up can result in spontaneous combustion and the release of both CO_2 and CH_4

b Indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

c Indirect emissions attributable to the extraction, production and transport of diesel.

(Energy Strategies, 2000; DoCC, National Greenhouse Accounts (NGA) Factors, November 2008, p57)

The World Business Council for Sustainable Development and World Resources Institute *Greenhouse Gas Protocol* 2004 considers the reporting of Scope 3 emissions to be optional. If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and 2. However, it should be noted that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

Despite the Project not controlling Scope 3 emissions from the use of coal, this assessment includes an assessment of the relevant Scope 3 emissions resulting from the Project.

Xstrata Coal (XC) have developed a standard methodology and calculator for estimating Scope 3 energy consumption and associated greenhouse gas emissions based on an analysis of all potential Scope 3 emissions from coal mines. This analysis determined that the only "material" sources of Scope 3 energy consumption and associated greenhouse gas emissions arise from (Xstrata Coal, 2008a):

- Emissions associated with infrastructure development;
- Emissions from product transport; and
- Emissions from the end use of the product.

The XC Scope 3 emissions methodology and calculator use factors from the DoCC *National Greenhouse Accounts (NGA) Factors, June 2009* and are consistent with the guidelines described above.

This assessment has been prepared on a comparative basis with that undertaken for the approved project, including the use of an emissions factor derived from site specific testing. Xstrata Coal is currently participating in a broader industry wide process to develop more robust geographically specific emissions factors and methodologies for open cut coal mining operations. To support this work, Xstrata Coal is currently collating test data to further refine site specific factors for the Mangoola Coal Project site. In the future, it is envisaged that this information will be used to support reporting processes required under legislation such as the *National Greenhouse and Energy Reporting Act 2007*.

2 Scope of Emissions Inventory

The assessment of Scope 1, 2 and 3 greenhouse emissions reviews the main sources of greenhouse gases from the Project including:

- direct emissions from the on-site combustion of diesel (Scope 1);
- direct emissions of methane from the exposed coal seams (Scope 1);
- direct emissions from spontaneous combustion and slow coal oxidation (Scope 1);
- direct emissions from the use of explosives (Scope 1);
- indirect emissions from the on-site consumption of electricity (Scope 2);
- indirect emissions associated with the embodied energy in new infrastructure (Scope 3);
- indirect 'upstream' emissions associated with the on-site consumption of diesel and electricity (Scope 3);
- indirect emissions from the consumption of diesel and fuel oil for saleable coal transport via rail and ship from the Project to domestic and overseas customers (Scope 3); and
- indirect emissions from the end use of the saleable coal produced by the Project (Scope 3). This is consistent with the requirements for assessing coal mining projects within NSW under State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007.

Consistent with the methodologies previously described, Scope 3 emissions not included in the greenhouse inventory for the assessment are:

- disposal of waste generated;
- disposal (end of life) of products sold;
- employee business travel;
- employees commuting to and from work;
- extraction, production and transport of other purchased materials and goods;
- out sourced activities; and
- transport of non-product materials and waste off site.

(DoCC, *National Greenhouse Accounts (NGA) Factors*, June 2009, p57)

3 Assessment of Scope 1 and 2 Energy Consumption

3.1 Introduction

An assessment of energy consumption associated with on-site activities (Scope 1 and 2 energy consumption) was undertaken for the ***total Project life*** from the proposed Year 1 to Year 21 of the Project, and the results are shown in **Table 3** below.

Also shown in **Table 3** are:

- Estimated ***average annual energy consumption*** over the operational 15 years of the 21 year life of the Project; and
- Estimated ***energy consumption for Years 3 to 14***, which correspond to the forecast maximum annual production from the Project (based on information provided by Xstrata Mangoola).

3.2 Assumptions

Estimated tonnes of Run of Mine (ROM) Coal were obtained from the forecast production schedules provided by Xstrata Mangoola.

ROM coal will be further processed at the Coal Handling and Preparation Plant (CHPP) for transport to export markets, and domestic use for power generation. Xstrata Mangoola have assumed a 73% yield from ROM to product coal.

Nineteen per cent of product coal is to be transported to Macquarie Generation power stations, with 81% allocated for transport to export markets. Predicted yields from coal processing provided by Xstrata Mangoola have been used to estimate saleable product coal production.

The predicted consumption of electricity and explosives for the Project shown in **Table 2** is based on data provided by Xstrata Mangoola, and based on existing similar operations.

Diesel consumption was estimated based on a list of the proposed mobile fleet equipment required for the Project, provided by Xstrata Mangoola. Fuel consumption figures for mining activities each year were provided by Xstrata Mangoola. Fuel consumption figures for clearing and rehabilitation work for each year were calculated from hours of operation provided by Xstrata Mangoola, and maximum fuel consumption rates obtained from the equipment manufacturer (Caterpillar Inc, 2001). The final predicted diesel consumption is 3.05 l/t ROM.

The figures for energy content per unit of each energy source were obtained from the DoCC *National Greenhouse Accounts (NGA) Factors*, June 2009.

The energy content of saleable coal was provided by Mangoola Coal after representative analysis of the coal seams, and calculation of energy content in the subsequent domestic and export grades of coal to be produced. The energy content of the coal was estimated by Xstrata Mangoola to be 23.8 GJ/t for export product coal and 21.2 GJ/t for domestic product coal.

Methane and slow oxidation and spontaneous combustion are included in **Table 3** for information purposes only. Since they contribute to Scope 1 greenhouse gas emissions for the Project, they are discussed in more detail in **Section 4**.

4 Assessment of Scope 1 and 2 Greenhouse Gas Emissions

4.1 Introduction

Scope 1 and 2 greenhouse gas emissions from the Project considered as part of this assessment include:

- Scope 1 emissions from:
  - Diesel consumed on-site;
  - Explosives;
  - Methane;
  - spontaneous combustion and slow oxidation of coal; and
- Scope 2 emissions from electricity consumption;

An assessment of the predicted scope 1 and 2 greenhouse gas emissions was undertaken for the ***total Project life***, and the results are shown in **Table 4**.

Also shown in **Table 4** are:

- Estimated ***average annual scope 1 and 2 greenhouse gas emissions*** over the estimated 15 year operational life of the Project.
- Estimated ***scope 1 and 2 greenhouse gas emissions for Years 3-14***, which correspond to the forecast maximum annual production from the Project (based on information provided by Xstrata Mangoola).

4.2 Assumptions

The emissions factors for diesel and electricity were obtained from the DoCC *National Greenhouse Accounts (NGA) Factors*, June 2009.

Methane emission calculations were done based on gas analysis of relevant coal seams from the site, provided by Xstrata Mangoola. This has allowed for the use of an empirical emissions factor for methane, and is considered appropriate for a greenhouse gas assessment. The emissions factor used for methane (0.0055 TCO_2-e per Tonne ROM) is the same as the emissions factor used for the original assessment and means that the methane emissions calculations from the approved and proposed projects are directly comparable. The empirical emissions factor is lower than the default factor provided for in the DoCC *National Greenhouse Accounts (NGA) Factors,* June 2009 version. However, as it is based on actual testing of methane presented within the coal seams on site, it is considered to provide a more accurate estimate of the actual methane emissions likely to be emitted as a result of open cut coal mining on this site.

The emissions factor for explosives was taken from the DoCC *National Greenhouse Accounts (NGA) Factors,* January 2008 as the June 2009 version does not include a factor for explosives. It is assumed that ammonium nitrate based explosives will be used in the Project.

Coal and other carbonaceous material will begin to slowly oxidise and release CO_2 when exposed to the atmosphere as a result of mining. If not effectively managed, the heat build up can result in spontaneous combustion and the release of both CO_2 and CH_4. At this point in time, without an accepted methodology for estimating these emissions, the emissions from both slow oxidation and spontaneous combustion are excluded from the National Greenhouse Gas Inventory. However, in an effort to include the potential emissions from slow oxidation and spontaneous combustion, emission factors for calculating these emissions were taken from the Energy Strategies report on fugitive greenhouse emissions prepared for the Australian Greenhouse Office (Energy Strategies, 2000). The report estimates that emissions from slow oxidation and spontaneous combustion are typically around 3.125 kgCO_2-e per Tonne of saleable coal from open cut mining.

Table 3 – Mangoola Coal Project Scope 1 & 2 Energy Consumption

Years	Estimated ROM Tonnes	Estimated Saleable Coal Tonnes	Energy Content of Saleable Coal (GJ)	Emissions Source	Scope 1 Usage (Direct)	Scope 2 Usage (Indirect)	Total Usage	Units	Energy Content / Unit	Total Energy (GJ)	% of Energy	GJ/T ROM	GJ/T Saleable	GJ/GJ
Total Project Life														
Yr 1 - 15 (Total)	140,187,957	102,337,209	2,389,004,770	On-site Diesel	427,244		427,244	kL	38.6	16,491,630	83.8%	0.118	0.161	0.0069
				Explosives	287,586		287,586	Tonnes	2.3	661,448	3.4%	0.005	0.006	0.0003
				Methane	36,416		36,416	Tonnes		-				
				Slow Ox & Spon	319,804		319,804	Tonnes		-				
				Electricity		700,940	700,940	MWh	3.6	2,523,383	12.8%	0.018	0.025	0.0011
				Total						**19,676,461**	**100%**	**0.140**	**0.192**	**0.0082**
Annual Avg over Project Life														
Yr 1 - 15 (Annual Avg)	9,345,864	6,822,481	159,266,985	On-site Diesel	28,483		28,483	kL	38.6	1,099,442	83.8%	0.118	0.161	0.0069
				Explosives	19,172		19,172	Tonnes	2.3	44,097	3.4%	0.005	0.006	0.0003
				Methane	2,428		2,428	Tonnes		-				
				Slow Ox & Spon	21,320		21,320	Tonnes		-				
				Electricity		46,729	46,729	MWh	3.6	168,226	12.8%	0.018	0.025	0.0011
				Total						**1,311,764**	**100%**	**0.140**	**0.192**	**0.0082**
Maximum Year														
Year 3-14	10,500,000	7,665,000	178,935,128	On-site Diesel	34,997		34,997	kL	38.6	1,350,894	84.4%	0.145	0.198	0.0085
				Explosives	26,526		26,526	Tonnes	2.3	61,010	3.8%	0.007	0.009	0.0004
				Methane	2,728		2,728	Tonnes		-				
				Slow Ox & Spon	23,953		23,953	Tonnes		-				
				Electricity		52,500	52,500	MWh	3.6	189,000	11.8%	0.018	0.025	0.0011
				Total						**1,600,904**	**100%**	**0.152**	**0.209**	**0.0089**

Methane generation and Slow Oxidation & Spontaneous Combustion from the Project have been included in the Energy Usage table above for information purposes only.

Table 4 – Mangoola Coal Project Scope 1 & 2 Greenhouse Gas Emissions

Years	Estimated ROM Tonnes	Estimated Saleable Coal Tonnes	Energy Content of Saleable Coal (GJ)	Emissions Source	Scope 1 Usage (Direct)	Scope 2 Usage (Indirect)	Total Usage	Units	Emissions Factor for Scope 1 (Direct)	Scope 1 Emissions TCO2e (Direct)	Emissions Factor for Scope 2 (Indirect)	Scope 2 Emissions TCO2e (Indirect)	Emissions Factor for Scope 3 (Indirect)	Scope 3 Emissions TCO2e (Indirect)	Total Scope 1 & 2 Emissions TCO2e	% of Total Emissions	TCO2e/ T ROM	TCO2e/T Saleable
Total Project Life																		
Yr 1 - 15 (Total)	140,187,957	102,337,209	2,389,004,770	On-site Diesel	427,244		427,244	kL	2.68	1,146,168			0.20	87,406	1,146,168	39.5%	0.008	0.011
				Explosives	287,586		287,586	Tonnes	0.17, 0.18	50,052					50,052	1.7%	0.000	0.000
				Methane *	36,416		36,416	Tonnes	21	764,727					764,727	26.3%	0.005	0.007
				Slow Ox & Spon	319,804		319,804	Tonnes	1	319,804					319,804	11.0%	0.002	0.003
				Electricity		700,940	700,940	MWh	-		0.89	623,836	0.18	126,169	623,836	21.5%	0.004	0.006
				Total						**2,280,751**		**623,836**		**213,575**	**2,904,588**	**100%**	**0.021**	**0.028**
Annual Avg over Project Life																		
Yr 1 - 15 (Annual Avg)	9,345,864	6,822,481	159,266,985	On-site Diesel	28,483		28,483	kL	2.68	76,411			0.20	5,827	76,411	39.5%	0.008	0.011
				Explosives	19,172		19,172	Tonnes	0.17, .18	3,128					3,128	1.6%	0.000	0.000
				Methane *	2,428		2,428	Tonnes	21	50,982					50,982	26.4%	0.005	0.007
				Slow Ox & Spon	21,320		21,320	Tonnes	1	21,320					21,320	11.0%	0.002	0.003
				Electricity		46,729	46,729	MWh	-		0.89	41,589	0.18	8,411	41,589	21.5%	0.004	0.006
				Total						**151,842**		**41,589**		**14,238**	**193,431**	**100%**	**0.021**	**0.028**
Maximum Year																		
Year 3-14	10,500,000	7,665,000	178,935,128	On-site Diesel	34,997		34,997	kL	2.68	93,887			0.20	7,160	93,887	41.5%	0.009	0.012
				Explosives	26,526		26,526	Tonnes	0.17, 0.18	4,621					4,621	2.0%	0.000	0.001
				Methane *	2,728		2,728	Tonnes	21	57,278					57,278	25.3%	0.005	0.007
				Slow Ox & Spon	23,953		23,953	Tonnes	1	23,953					23,953	10.6%	0.002	0.003
				Electricity		52,500	52,500	MWh	-		0.89	46,725	0.18	9,450	46,725	20.6%	0.004	0.006
				Total						**179,739**		**46,725**		**16,610**	**226,464**	**100%**	**0.022**	**0.030**

Note: * as noted in Section 4.2 above, an empirical emissions factor of 0.0055 TCO_2-e per Tonne ROM has been used to calculate methane emissions. The factor of 21 given here is a conversion factor that recognizes the increased global warming potential of methane compared to carbon dioxide.

5 Assessment of Scope 3 Greenhouse Gas Emissions

An assessment of the Scope 3 greenhouse gas emissions associated with the Project is provided below and summarised in **Figure 1** and **Table 9**, and includes the outputs from the XC Scope 3 emissions calculator.

5.1 Greenhouse Gas Emissions associated with infrastructure development

Scope 3 emissions associated with the embodied energy in the mine infrastructure are estimated at 180,229 TCO_2-e, representing only 0.06% of the Scope 3 emissions over the life of the Project. This is based on the following estimates of steel and concrete to be used for infrastructure development associated with the Project in part provided by Xstrata Mangoola, with an assumption made where the quantities are yet to be defined:

- Concrete =56 160 Tonnes;
- Steel = 13,570 Tonnes.

Table 5 – Greenhouse Emissions Associated with Infrastructure Development

Emissions Source	Usage (Tonnes)	Scope 3 Emissions Factor (TCO_2-e/tonne)	Scope 3 Emissions (TCO_2e)
Concrete	56 160	0.36	20,217
Steel	13,570	12.88	174,782
Total			**194,999**

5.2 Scope 3 Emissions Associated with Scope 1 and 2 Energy Use

Scope 3 emissions associated with scope 1 and 2 energy use are:

- For diesel use – indirect emissions attributable to the extraction, production and transport of diesel used by the Project; and
- For electricity use – indirect emissions from the extraction, production and transport of fuel burned to generate electricity used for the Project and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

Although these emissions represent only 0.09% of the total scope 3 emissions from the Project, they are included in **Table 6** to provide an assessment of the 'full fuel cycle' emissions associated with the Project.

Table 6 – Scope 3 Emissions Associated with Scope 1 and 2 Energy Use

	Emissions Source	Usage	Scope 3 Emissions Factor	Scope 3 Emissions (TCO_2e)
Total Project Life	Diesel	427,244 kL	0.20	87,406
	Electricity	700,940 MWh	0.18	126,169
	Total			**213,575**
Annual Average	Diesel	28,483 kL	0.20	5,827
	Electricity	46,729 MWh	0.18	8,411
	Total			**14,238**

5.3 Greenhouse Emissions from the Transport of Saleable Domestic Coal

Saleable domestic coal is to be transported to Bayswater and Liddell Power Stations by rail. The rail distance is approximately 45 km. Note there will be a rail loop adjacent to the coal handling area of the mine.

Scope 3 emissions from the transport of saleable domestic coal via rail are estimated to be 0.002% of the Scope 3 emissions from the Project.

Table 7 – Greenhouse Emissions from the Transport of Saleable Domestic Product Coal

	Total Saleable Export Product Coal Transported (T)	Transport Mode	Transport distance (km)	Emissions Factor (kg CO_2e/tonne-km)	Scope 3 Emissions (TCO_2e)
Total Project Life	19,486,126	Rail	45	0.0054	4,735
Annual Average	1,299,075	Rail	45	0.0054	316

5.4 Greenhouse Emissions from the Transport of Saleable Product Coal for Export

The greenhouse gas emissions from the Scope 3 consumption of diesel fuel and fuel oil for rail and sea transport of saleable product coal to export markets have been included in the inventory provided in **Table 8**. In calculating emissions for coal transport it has been assumed that:

- Rail distance from the Project to the Port of Newcastle is approximately 145 km;
- The average weighted shipping distance for the export coal is 8,308 km, based on the following distribution percentages and distances (Port Waratah Coal Services, 2009):

Table 8 – Greenhouse Emissions from the Transport of Saleable Product Coal for Export

	Total Saleable Export Product Coal Transported (T)	Transport Mode	Transport distance (km)	Emissions Factor (kg CO_2e/tonne-km)	Scope 3 Emissions (TCO_2e)
Total Project Life	82,851,083	Rail	145	0.0054	64,872
		Ship	8,308	0.0126	8,672,918
		Total			**8,737,790**
Annual Average	5,523,406	Rail	145	0.0054	4,325
		Ship	8,308	0.0126	578,195
		Total			**582,519**

Table 9 – Destination, Percentage and Transport Distance of Saleable Product Coal for Export

Destination	%	Distance (km)
Japan (Osaka)	54.77%	8,065
Korea (Busan)	17.38%	8,197
Taiwan (Kaohsiung)	9.99%	7,821
China (Shanghai)	7.20%	8,469
Mexico (Mazatlan)	3.76%	10,884
Malaysia (Penang)	0.97%	8,488
Vietnam (Da Nang)	0.34%	7,717
Spain (Valencia)	0.33%	18,681
Thailand (Bangkok)	0.28%	8,436
Singapore	0.27%	7,423
India (Chennai)	0.22%	10,230
Hong Kong	0.17%	7,808
Pakistan (Karachi)	0.12%	12,160
Other	4.20%	9,568 (average of above distances)
Weighted Average		**8,308**

Diesel consumption factors for rail and shipping transport were obtained from the Australian Greenhouse Office, *National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Indicators (1990 to 2005*) (AGO, 2007):

- Rail transport diesel consumption factor is 0.0054 kg CO_2-e / tonne-km; and
- Shipping transport diesel consumption factor is 0.0126 kg CO_2-e / tonne-km.

Annual average scope 3 emissions from the diesel fuel consumed for transport of saleable product coal are estimated to be approximately 3.92% of the total Scope 3 emissions from the Project.

5.5 Greenhouse Gas Emissions from the End Use of the Coal

The estimated greenhouse gas emissions associated with the end use of the coal produced by the Project are shown in **Table 10**. It is assumed that:

- All saleable domestic coal is consumed as thermal coal in power stations;
- All saleable export coal is consumed as thermal coal in overseas power stations; and
- Emissions of CO_2-e/GJ from the end use of the coal are calculated using the coal composition and energy content of the coal, within the XC Scope 3 Emissions Calculator.

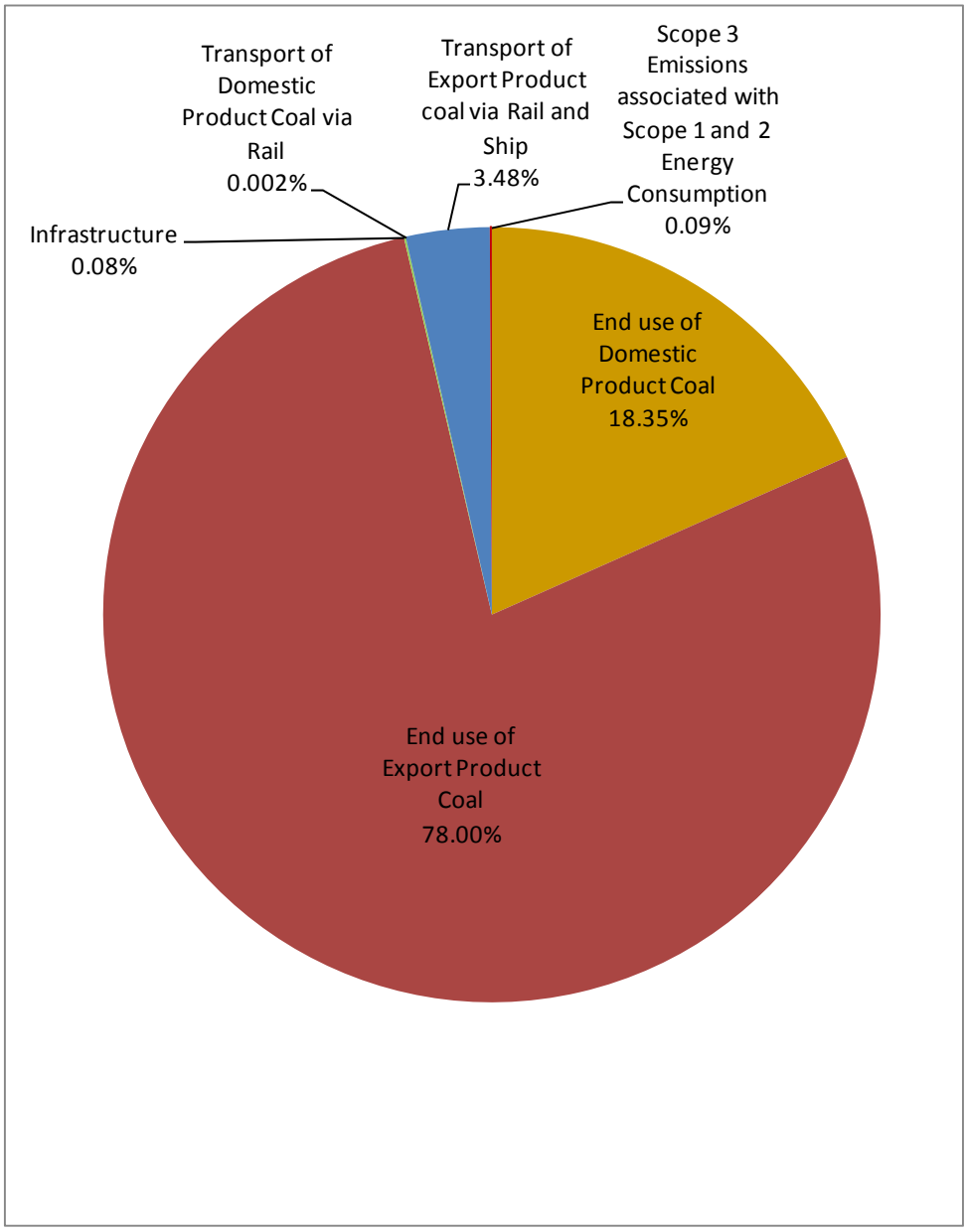
The greenhouse gas emissions from the end use of the saleable coal produced by the Project are estimated to be 16,110,151 TCO_2-e on an annual average. This consists of 3,067,549 TCO_2-e per annum from the end use of saleable domestic product coal and 13,042,602 TCO_2-e per annum from the end use of saleable export product coal.

The combustion of this thermal coal would generate an average 56,867,928 MWh per annum at an average efficiency of 34.3% for Bayswater and Liddell power stations (Macquarie Generation, 2008) and 36% overseas (the average power station efficiency in OECD countries is estimated at 36% - IEA, 2004).

Table 10– Proposed Project Scope 3 Greenhouse Gas Emissions

	Scope 3 Emissions over Total Project Life (TCO2e)	**Annual Average Scope 3 Emissions (TCO2e)**	% of total
End use of Domestic Product Coal	**46,013,239**	**3,067,549**	18.35%
End use of Export Product Coal	**195,639,023**	**13,042,602**	78.00%
Infrastructure	**195,233**	**13,016**	0.08%
Transport of Domestic Product Coal via Rail	**4,735**	**316**	0.002%
Transport of Export Product coal via Rail and Ship	**8,737,790**	**582,519**	3.484%
Scope 3 Emissions associated with Scope 1 and 2 Energy Consumption	**213,575**	**14,238**	0.09%
Total Scope 3 emissions	**250,803,595**	**16,720,240**	100.0%

Figure 1 – Mangoola Coal Mine Project Scope 3 Greenhouse Gas Emissions by Source



6 Summary of Greenhouse Gas and Energy Assessment

The Scope 1, 2 and 3 Greenhouse Gas and Energy Assessment for the Project has found that:

6.1 Energy Consumption

The Project's estimated on-site energy consumption is dominated by onsite diesel use at an average of 1,099,442 GJ (28,483 kL) per annum or 83.8% of the total. Electricity consumption is the next largest on-site energy use with an average of 168,226 GJ (46,729 MWh) per annum or 12.8% of the total;

- The predicted average annual energy index for the Project is 0.192 GJ/tonne of saleable coal, which is lower than the Australian open cut black coal mining industry average of 0.29 GJ/tonne (AGSO, 2000);
- Net energy consumption over the life of the Project (GJ of energy consumed divided by the energy content of the saleable coal) is predicted to be 0.0082 GJ/GJ. This implies that on a GJ/GJ basis (excluding Scope 3), the Project is expected to consume only 0.82% of the energy it produces as saleable coal. This is slightly lower than the Australian open cut black coal mining industry average of 0.010 GJ/GJ (AGSO, 2000); and
- The low energy consumption indices associated with the Project when compared to the industry average is due to the simplified mining plan and high production rate for the Project.

6.2 Greenhouse Gas Emissions

The Scope 1 and 2 greenhouse emissions from the Project have been estimated at an annual average of 193,431 TCO_2-e per annum. This represents approximately 0.034% of Australia's total greenhouse emissions of approximately 553 million TCO_2-e pa (National Greenhouse Gas Inventory - accounting for the Kyoto target May 2009);

- The main source of greenhouse emissions from on-site mining activities is diesel consumption, making up 39.5% of the predicted total emissions at an average of 76,411 TCO_2-e per annum;
- Emissions of methane from the coal seam account for 26.3% or an average of 50,982 TCO_2-e per annum;
- Emissions from electricity use account for 21.5% or an average of 41,589 TCO_2-e per annum.
- Emissions from explosives and slow oxidation and spontaneous combustion make up the remaining 12.7% of the Project's emissions;
- The predicted average annual greenhouse index for on-site activities of the Project is 0.028 TCO_2-e/tonne of saleable coal. This is lower than the Australian open cut black coal mining industry average of 0.050 TCO_2-e/tonne of product coal (AGSO, 2000);
- The low greenhouse index associated with the Project when compared to the Australian industry average is due to the low methane emissions from the coal. The default emissions factor for NSW open cut coal mines is 0.045 TCO_2-e per Tonne ROM, compared with 0.0055 TCO_2-e per Tonne ROM measured in samples from the Mangoola seams, as provided by Xstrata Coal.

The Scope 3 greenhouse emissions from the end use of the coal produced by the Project would produce an annual average of approximately 16,708,629 TCO_2.e per annum. This is equivalent to 0.038% of annual global greenhouse gas emissions (Total annual global emissions in 2005 have been estimated at approximately 44,000,000,000 TCO_2-e [IEA, 2008, p.11]).

7 Comparison of Assessment of Proposed Project to Approved Project Assessment

A comparison of the proposed Project and the approved Project energy and greenhouse assessments is provided in **Tables 11** and **12** below. The comparison shows that the proposed project has lower energy consumption and greenhouse gas emissions over the life of the project than the approved Project. However, due to the shorter project life (and therefore higher annual coal production), the proposed project has higher annual energy consumption and greenhouse gas emissions than the approved Project.

The different assessment outcomes are due to the following differences in the assessments:

Production & Product Changes:

- Over the life of the Project, the proposed Project has a slightly lower total ROM coal production It also has a lower assumed yield through the Coal Handling and Preparation Plant (73% compared with 76% for the approved project), resulting in the proposed project having a lower total saleable coal production;
- The average energy content of the saleable coal from the proposed project is lower, as it is assumed to be 81% export coal at 23.8 GJ/T and 19% domestic coal at 21.2 GJ/T. In comparison, the approved project assumed 100% of saleable coal would be export coal at 23.8 GJ/T.

Energy Consumption:

- The diesel consumption per tonne of ROM coal for the proposed Project is lower than for the approved Project, due to a more efficient mining sequence;
- The electricity consumption per tonne of ROM coal for the proposed Project is lower than for the approved Project, due to the higher throughput rate at the CHPP;
- The predicted average annual energy index for the proposed Project is therefore lower than for the approved Project (0.192 GJ/tonne of saleable coal for the proposed Project compared with 0.226 GJ/ tonne of saleable coal for the approved Project);
- The net energy consumption index for the proposed Project is also lower than for the approved Project (0.008 GJ of energy consumed per GJ of saleable coal for Mangoola compared with 0.009 GJ/GJ for the approved Project).

Greenhouse Gas Emissions:

- Due to the lower energy consumption indices, the proposed Project has lower Scope 1 & 2 emissions over the life of the Project and a lower predicted average annual greenhouse index for on-site activities (0.028 TCO_2-e/Tonne of saleable coal for the proposed Project compared with 0.031 TCO_2-e/T for the approved Project);
- However, due to the higher annual coal production rate (which is equal or less than the approved maximum production rate) and the higher annual energy consumption, the proposed project has higher annual Scope 1 & 2 emissions compared with the approved project;
- Similarly, annual Scope 3 emissions are higher for the proposed Project, but the total lifetime Scope 3 emissions are lower.

Table 11 – Differences in Energy Consumption of Proposed Project vs the Approved Project

	Proposed Total	Approved Total	Difference	Proposed Annual Avg	Approved Annual Avg	Difference Annual Avg
ROM Production T	140,187,957	140,116,795	71,162	9,345,864	7,005,840	2,340,024
Saleable Production T	102,337,209	106,488,764	-4,151,555	6,822,481	5,324,438	1,498,043
Energy Content Saleable GJ	2,389,004,770	2,541,328,800	-152,324,030	159,266,985	127,066,440	32,200,545
Total GJ Consumed	19,676,461	24,079,882	-4,403,421	1,311,764	1,203,994	107,770
GJ/T ROM	0.140	0.172	-0.031	0.140	0.172	-0.031
GJ/T Saleable	0.192	0.226	-0.034	0.192	0.226	-0.034
GJ Energy Consumed / GJ Energy Sold	0.008	0.009	-0.001	0.008	0.009	-0.001

Table 12 – Differences in GHG Emissions of Proposed Project vs Approved Project

	Proposed Total	Approved Total	Difference	Prposed Annual Avg	Approved Annual Avg	Difference Annual Avg
ROM Production T	140,187,957	140,116,795	71,162	9,345,864	7,005,840	2,340,024
Saleable Production T	102,337,209	106,488,764	-4,151,555	6,822,481	5,324,438	1,498,043
Scope 1& 2 Emissions TCO_2-e	2,904,588	3,351,478	-446,890	193,431	167,574	25,857
Scope 3 Emissions TCO_2-e	250,803,595	261,499,252	-10,695,658	16,720,240	13,074,963	3,645,277
Total Emissions TCO_2-e	253,708,183	264,850,730	-11,142,548	16,913,670	13,242,537	3,671,134
Scope 1& 2 Emissions TCO_2-e/T Saleable	0.028	0.031	-0.003	0.028	0.031	-0.003
Scope3 Emissions TCO_2-e/T Saleable	2.451	2.456	-0.005	2.451	2.456	-0.005
Total Emissions TCO_2-e/T Saleable	2.479	2.487	-0.008	2.479	2.487	-0.008

8 Greenhouse Mitigation Strategies

8.1 Energy Management and Energy Efficiency

The Project will develop and implement an Energy Management System that will address all aspects of energy management for the Project including:

- Leadership;
- Planning;
- People;
- Financial management;
- Supply management;
- Operations management and maintenance;
- Setting energy use and greenhouse emissions reduction targets;
- Using energy monitoring and reporting as a management tool;
- Plant and equipment; and
- Providing training on energy management to site personnel.

The Energy Management System will provide the basis for identifying and implementing energy efficiency opportunities for the Project. This will include energy efficiency opportunities in:

- Mining fleet;
- Stationary equipment; and
- Mining methods.

Energy efficiency opportunities in the mining fleet will focus on minimising diesel use by vehicles via:

- Considering the energy efficiency of new equipment when making purchasing decisions;
- Monitoring the fuel efficiency of diesel equipment;
- Optimising the conditions under which the mining fleet operates.

Energy efficiency opportunities for stationary equipment will include an assessment of:

- Considering the energy efficiency of new equipment when making purchasing decisions;
- Implementing a computerised energy management system (SCADA system);
- The use of high efficiency electric motors;
- The use of Variable Speed Drives for ventilation fans;
- A review of drive belts and coupling systems;
- Efficient lighting systems;
- Compressed air system monitoring and management; and
- A review of alternatives for bath house heating systems including air compressor heat recovery, electric boosted solar hot water or heat pump hot water.

Energy efficiency opportunities for mining methods will include an assessment of:

- Monitoring of blast management to ensure greenhouse emissions from blasting and mobile equipment is minimised.

The Project will also assess the viability of small scale tree planting for carbon sequestration. Whilst a small scale plantation would provide only limited benefit in terms of carbon sequestration it can also provide other benefits in terms of habitat restoration and improved land management.

8.2 Xstrata Coal Commitments

As an Xstrata Coal operation, Mangoola Coal is committed to the Xstrata Coal Climate Change Position Statement (Xstrata Coal, 2008a). Xstrata Coal also participates in the Energy Efficiency Opportunities (EEO) Program. Xstrata Coal is committed to playing its part in the international collaborative effort to implement solutions to the challenge of climate change.

Xstrata recognises the future will be a carbon constrained world and is working with governments, researchers and industry around the world to develop a portfolio of options for reducing greenhouse gas emissions from the extraction and use of coal in power generation.

Xstrata Coal's climate change strategy is focused on five key areas

1. Policy – Actively engaging with governments and other key stakeholders in the countries we operate in and contribute to broader sectoral initiatives at a national and international level.
2. Managing Our Footprint – Understanding our major direct emissions and energy (indirect emissions) sources and actively implementing measures to reduce these in an innovative and cost effective way.
3. Carbon Markets – Accounting for the cost of carbon in everything we do and interacting in international and national carbon markets as a way to maintain and add value to our business.
4. Technology – continuing to support research, development and demonstration across a range of emerging mining and low emission technologies (including carbon, capture and storage and renewable energy).
5. Communication – Transparent reporting and engagement with stakeholders to address climate change and energy issues via mutual cooperation and understanding.

Through its approach to climate change, Xstrata Coal:

- is a major contributor to the A$1 billion COAL 21 Fund, through the imposition of a voluntary levy on its production. The Fund will financially support the research, development and deployment of low emission power generation technologies in Australia;
- collaborates in research and development programs and provides both technical and financial support to dedicated Cooperative Research Centres focused on near zero emission technologies;
- supports additional research into CO_2 capture and storage to enable this technology to be commercialised worldwide as rapidly as possible;
- works continually for the more efficient use of energy and reduction of greenhouse gas emissions through a dedicated energy efficiency program at all operations;
- looks to collaborate with its customers, both domestic and international, towards the sustainable use of coal through new power generation technologies;
- seeks to effectively reduce fugitive emissions from its operations through the capture and use of methane wherever possible from coal seams to generate electricity; and
- contributes to the development of effective climate change policy (Xstrata Coal, 2008b).

Mangoola Coal has a number of greenhouse gas and energy management systems in place. Mangoola Coal will continue to implement these systems, reporting commitments and greenhouse/energy reduction objectives. Mangoola Coal, as part of Xstrata Coal, also

acknowledges that climate change is a major challenge and that accelerated action is required to stabilise greenhouse gas concentrations in the atmosphere at levels guided by the research of the United Nations Intergovernmental Panel on Climate Change.

Xstrata Coal was a member of the Greenhouse Challenge Plus program since its inception and Mangoola Coal has provided information and data as part of Xstrata Coal's Greenhouse Challenge Plus reporting requirements, including the last report required under the program for the final reporting year 2008/2009. The Xstrata Coal Climate Change Position Statement (Xstrata Coal, 2008a) also applies to the Mangoola Coal greenhouse and energy management objectives. As a major producer of thermal coal, Xstrata has committed to taking a leadership role in working together with government, other industries, the scientific community, environmental groups and other stakeholders to develop technological solutions to reduce or eliminate the greenhouse gas emissions from burning coal.

A key challenge for Xstrata is to improve energy efficiency while recognising that other sustainability objectives, such as increasing recycling, require increased energy input. Xstrata continues to participate in the Carbon Disclosure Project, publicly reporting on its actions to reduce its greenhouse footprint, its performance and the potential impacts of climate change on its business. The Carbon Disclosure Project is a global initiative that aims at encouraging private and public sector organisations to measure, manage and reduce emissions and climate change impacts of their business. Annual reports are published which detail members GHG footprints and give awards for reductions.

The Project will seek to provide for maximum resource extraction with maximum efficiency. Mangoola Coal will also assess and consider implementation, where feasible, of GHG and energy management and mitigation initiatives during the design, operation and decommissioning of the Project.

As part of Xstrata Coal, the Project will also participate in Xstrata Coal's response to the following programs:

- The National Greenhouse and Energy Reporting System (NGERS);
- The Energy Efficiency Opportunities (EEO) Program; and
- The proposed Carbon Pollution Reduction System (CPRS).

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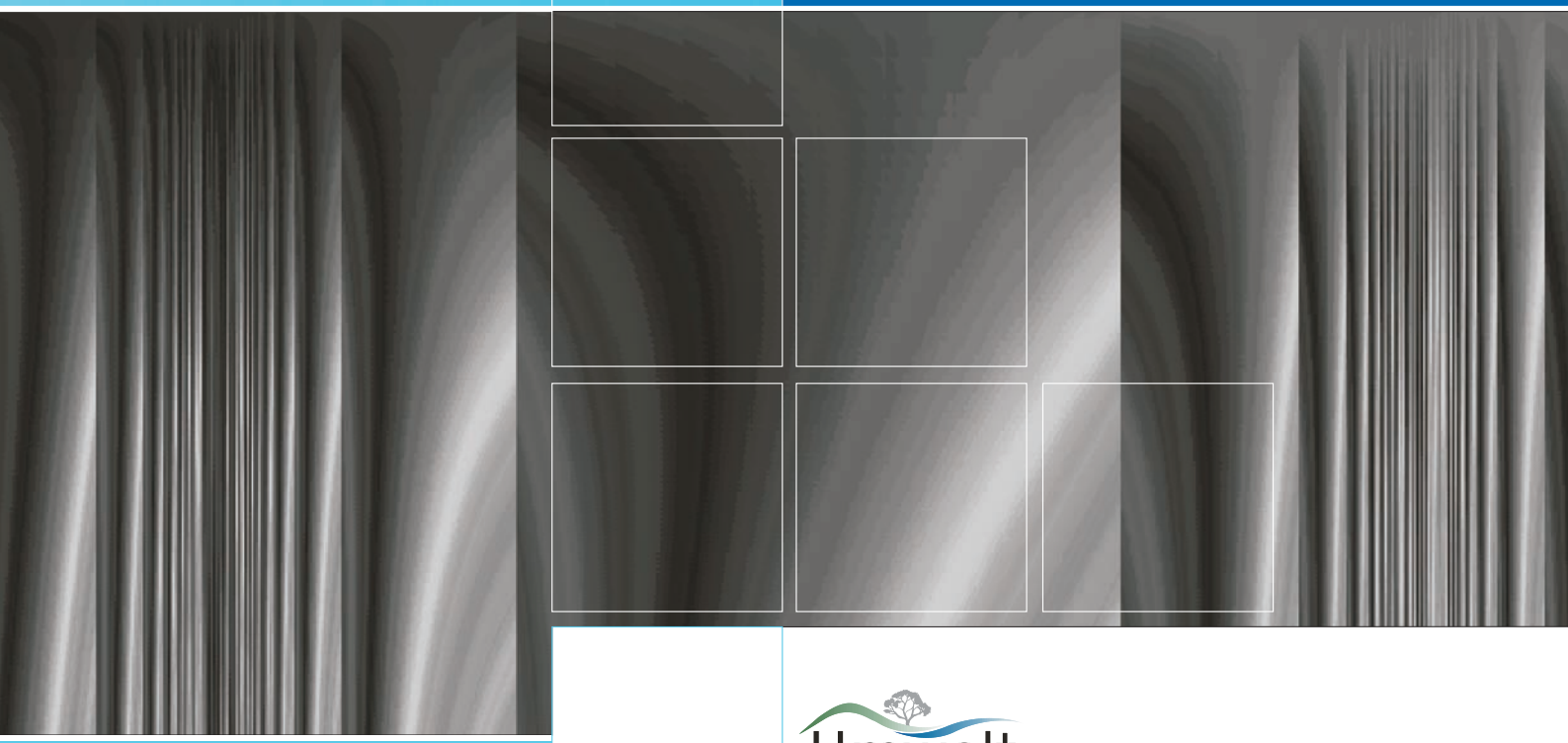

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