APPENDIX 11

Greenhouse Gas Assessment

GREENHOUSE GAS & ENERGY ASSESSMENT

FOR

SOUTH PIT EXTENSION PROJECT

BY

SEE SUSTAINABILITY CONSULTING

DECEMBER 2006

ABN 55 392 517 718 | P.O. Box 736 | Toronto NSW 2283 | ph: 0401 159 277
dblyth@seesustainability.com.au | www.seesustainability.com.au

1. Introduction

Umwelt (Australia) Pty Limited (Umwelt) engaged SEE Sustainability Consulting to undertake an Greenhouse Gas (GHG) and Energy Assessment as part of the environmental assessment for the proposed Mt Arthur Coal South Pit Extension Project (Project). Mt Arthur Coal propose to extend the currently approved Mt Arthur North South Pit further south into the Bayswater No. 3 Mining Lease in order to maximise resource recovery, maximise productivity of their mining equipment and improve overburden handling efficiencies and rehabilitation outcomes. The proposed project will produce up to approximately 25 million tonnes of ROM coal over the project life of 21 years.

The main sources of greenhouse gases associated with the open cut mining operations are methane emitted from the exposed coal seams, direct emissions of CO_2 from the combustion of petroleum products, indirect emissions of CO_2 through the consumption of electricity and direct emissions of CO_2 from spontaneous combustion, explosives use and slow oxidation of exposed coal.

The Greenhouse Gas and Energy Assessment report for the project has four main sections:

1. An assessment of the energy and greenhouse gas emissions from the proposed South Pit Extension Project in accordance with recognised assessment guidelines;
2. Calculation of energy consumption and greenhouse gas emissions for the proposed South Pit Extension Project for various operational scenarios including maximum annual production, average annual production and the total project;
3. Calculation of the emissions from the burning of the coal produced by the project; and
4. Assessment and identification of where relevant management controls can be utilised to minimise energy use and greenhouse gas emissions and nomination of specific mitigation strategies to achieve this objective.

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) and
- the Australian Greenhouse Office (AGO) *Factors and Methods Workbook December 2005 (Workbook)*.

The Greenhouse Gas and Energy Assessment has also been prepared having regard to the NSW Greenhouse Plan produced by the NSW Greenhouse Office.

The Greenhouse Gas and Energy Assessment has been prepared using information provided by Mt Arthur Coal regarding the estimated project annual production schedules, annual electricity consumption, annual diesel consumption and annual explosives consumption for the proposed South Pit Extension Project.

2. Energy and Greenhouse Emissions for South Pit Extension Project

This section provides an assessment of the energy consumption and greenhouse gas emissions for the proposed South Pit Extension Project.

Scope of Emissions Inventory

The abovementioned 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 mining operation
- **Scope 2** covers *indirect* emissions from the mining operation's consumption of purchased electricity produced by another organisation.
- **Scope 3** includes other *indirect* emissions as a result of the mining operation's activities that are not from sources owned or controlled by the organisation (for example, product transport on the rail system).

Direct emissions are produced from sources within the boundary of an operating mine as a direct result of its activities e.g. combustion of diesel fuels for transportation of product and waste and fugitive emissions of methane.

Indirect emissions are produced outside the boundary of the mining operation by other organisations but are a direct result of the mining operation's activities. Indirect emissions mainly result from the generation of electricity consumed by the mining operation. It is usual industry practice that the emissions resulting from burning the Project's product coal at a power station are not included in this type of assessment as the emissions from the power station are assessed separately under the project assessment and approval process for that power station. Nevertheless, **Table 1.3** includes an assessment of the emissions resulting from the burning of the coal mined from the South Pit Extension Project.

The term "mining operation's activities" refers to the activities associated with the proposed South Pit Extension Project that occur within the Project Area.

Scope 3 emissions for diesel, electricity consumed by the operation and emissions from rail and conveyor transport of product coal have been included in the inventory calculation for the South Pit Extension Project. Emissions from sea transport have not been included in the inventory as the exact destination, shipping route and distance is not yet known for exported product coal. 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 South Pit Extension Project having no control over Scope 3 emissions such as those from product transport on the rail system, the assessment of Scope 3 emissions in **Tables 1.1** and **1.2** below have been included for completeness.

Annual Greenhouse Gas Emissions for the Project

An assessment of the Scope 1, Scope 2 and Scope 3 energy and greenhouse gas emissions from the proposed South Pit Extension Project was undertaken over the life of the project from year 1 to year 21. A calculation of the energy consumption and greenhouse gas emissions for the project for various operational scenarios including maximum annual production, average annual production and the total project was also undertaken.

The estimated energy and greenhouse gas emissions for the proposed South Pit Extension Project based on the conceptual production schedule and operational scenarios are shown in **Table 1.1** and **1.2** below.

The Project seeks approval to extract a maximum of 25 Mt of ROM coal over the project life of 21 years. This results in approximately 20 Mt of product coal over the project life of 21 years. The amount of product coal generated per unit of ROM coal (the yield) has been estimated based on expected coal quality and the efficiency of the coal preparation plant and may vary during the life of the Project.

Scope 3 emissions from the combustion of coal produced from the Project have been calculate based on an average Project product coal energy content of 24.845 GJ/tonne. The standard emissions factors for coal combustion have been taken from the AGO Workbook for combustion of fuel. Assuming that all coal produced from the Project is consumed by and burned by the end users, the Full Fuel Cycle annual average GHG emissions from the combustion of product coal are estimated to be **2,311,768** tonnes of carbon dioxide equivalent (TCO_2e) per annum. The emission factors used in the above calculation is the Full Fuel Cycle Emission Factor for Black Coal – NSW Electricity Generation of 97.7 kg CO_2-e/GJ.

Slow Oxidation and Spontaneous Combustion

Coal and other carbonaceous material will begin to slowly oxidise and release CO_2 when exposed to the atmospheres 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. 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 2000*.

As discussed in the Energy Strategies Report the factors listed on page 13 of the Energy Strategies Report are thought to overestimate these emissions by a factor of four or more and so have been divided by four when used in calculating Scope 1 slow oxidation and spontaneous combustion emissions from the South Pit Extension Project.

Greenhouse Emissions from the Transport of Product Coal

The Scope 3 emissions from the diesel fuel consumed by rail transport of the Project's product coal and Scope 3 emissions from generation of the electricity consumed by conveyor transport of the Project's product coal have been included in the inventory calculations below. Emissions from sea transport of the Project's

export product coal have not been included in the inventory as the exact destination, shipping route and distance is not yet known. At this time, these emissions are highly speculative and for this reason have not been included in the calculations below.

In calculating the emissions from product coal transport it has been assumed that:

- approximately 12% or 114,000 tonnes of coal per annum will be transported to Macquarie Generation; and
- the remainder of the coal will be transported to the Newcastle Port for export.

The estimated energy and GHG emissions for the Project based on conceptual production schedule and operational scenarios are shown in **Tables 1.1** and **1.2** below.

Table 1.1 South Pit Extension Project Energy Usage Estimate Year 1 - Year 21 (Scope 1, 2 & 3)

Year	Production ROM Tonnes	Production Saleable Tonnes	Energy Content of Saleable Tonnes (GJ)	Emissions Source	Scope 1 Usage	Scope 2 Usage	Scope 3 Usage	Total Usage	Units	Energy Content / Unit	Total Energy in GJ	% of Energy	GJ/T ROM	GJ/T Saleable	GJ/GJ
1	638,000	510,400	12,680,888	Diesel	2,272		638	2,911	kL	38.6	112,345	89.9%	0.176	0.220	0.009
				Explosives	108			108	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	647,889			647,889	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		3,318,373	173,294	3,491,667	kWh	0.0036	12,570	10.1%	0.020	0.025	0.001
				Total							**124,915**	100.0%	**0.196**	**0.245**	**0.010**
5	1,275,000	1,020,000	25,341,900	Diesel	4,499		1,275	5,774	kL	38.6	222,884	89.9%	0.175	0.219	0.009
				Explosives	215			215	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	1,294,763			1,294,763	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		6,631,545	346,315	6,977,860	kWh	0.0036	25,120	10.1%	0.020	0.025	0.001
				Total							**248,004**	100.0%	**0.195**	**0.243**	**0.010**
10	1,490,000	1,192,000	29,615,240	Diesel	4,927		1,490	6,417	kL	38.6	247,693	89.4%	0.166	0.208	0.008
				Explosives	251			251	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	1,513,095			1,513,095	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		7,749,805	404,714	8,154,519	kWh	0.0036	29,356	10.6%	0.020	0.025	0.001
				Total							**277,050**	100.0%	**0.186**	**0.232**	**0.009**
15	1,275,000	1,020,000	25,341,900	Diesel	4,496		1,275	5,771	kL	38.6	222,752	89.9%	0.175	0.218	0.009
				Explosives	215			215	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	1,294,763			1,294,763	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		6,631,545	346,315	6,977,860	kWh	0.0036	25,120	10.1%	0.020	0.025	0.001
				Total							**247,873**	100.0%	**0.194**	**0.243**	**0.010**
21	213,000	170,400	4,233,588	Diesel	734		213	947	kL	38.6	36,559	89.7%	0.172	0.215	0.009
				Explosives	36			36	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	216,302			216,302	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		1,107,858	57,855	1,165,713	kWh	0.0036	4,197	10.3%	0.020	0.025	0.001
				Total							**40,756**	100.0%	**0.191**	**0.239**	**0.010**

AGO Factors &Methods Workbook 2005, Table 3, p. 10 and Table 26, p. 38

Table 1.1 South Pit Extension Project Energy Usage Estimate Year 1 - Year 21 (Scope 1, 2 & 3) continued

Year	Production ROM Tonnes	Production Saleable Tonnes	Energy Content of Saleable Tonnes (GJ)	Emissions Source	Scope 1 Usage	Scope 2 Usage	Scope 3 Usage	Total Usage	Units	Energy Content / Unit	Total Energy in GJ	% of Energy	GJ/T ROM	GJ/T Saleable	GJ/GJ
Maximum Annual	2,915,000	2,332,000	57,938,540	Diesel	10,089		2,916	13,004	kL	38.6	501,965	89.7%	0.172	0.215	0.009
maximum annual production				Explosives	491			491	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	2,960,183			2,960,183	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		15,161,532	791,772	15,953,304	kWh	0.0036	57,432	10.3%	0.020	0.025	0.001
				Total							**559,397**	100.0%	**0.192**	**0.240**	**0.010**
Project Total	25,000,000	20,000,000	496,900,000	Diesel	86,524		25,005	111,529	kL	38.6	4,305,019	89.7%	0.172	0.215	0.009
Over 21 Years				Explosives	4,213			4,213	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	25,387,500			25,387,500	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		130,030,291	6,790,499	136,820,790	kWh	0.0036	492,555	10.3%	0.020	0.025	0.001
				Total							**4,797,574**	100.0%	**0.192**	**0.240**	**0.010**
Average Annual	1,190,476	952,381	23,661,905	Diesel	4,120		1,191	5,311	kL	38.6	205,001	89.7%	0.172	0.215	0.009
Project Total divided by 21				Explosives	201			201	tonnes		-	0.0%	0.000	0.000	0.000
				Methane	1,208,929			1,208,929	kg		-	0.0%	0.000	0.000	0.000
				Slow Oxidation				-			-	0%	0.000	0.000	0.000
				Spontaneous Combustion				-			-	0%	0.000	0.000	0.000
				Electricity		6,191,919	323,357	6,515,276	kWh	0.0036	23,455	10.3%	0.020	0.025	0.001
				Total							**228,456**	100.0%	**0.192**	**0.240**	**0.010**

AGO Factors &Methods Workbook 2005, Table 3, p. 10 and Table 26, p. 38

Table 1.2 South Pit Extension Project Greenhouse Gas Emissions Estimate Year 1 - Year 21 (Scope 1 & 2)

Year	Production ROM Tonnes	Production Saleable Tonnes	Emissions Source	Scope 1 Usage	Scope 2 Usage	Scope 3 Usage	Total Usage	Units	Emissions Factor for Scope 1	Scope 1 Emissions in TCO2e	Emissions Factor for Scope 2	Scope 2 Emissions in TCO2e	Emissions Factor for Scope 3	Scope 3 Emissions in TCO2e	Total Emissions in TCO2e	% of Emissions	TCO2e/T ROM	TCO2e/T Saleable
1	638,000	510,400	Diesel	2,272		638	2,911	kL	2.7	6,135			0.3	2,405	8,540	31.2%	0.013	0.017
			Explosives	108			108	tonnes	0.1659 to 0.177	218					218	0.8%	0.000	0.000
			Methane	647,889			647,889	kg	21	13,606					13,606	49.7%	0.021	0.027
			Slow Oxidation				-		0.125	64					64	0.2%	0.000	0.000
			Spontaneous Combustion				-		3	1,531					1,531	5.6%	0.002	0.003
			Electricity		3,318,373	173,294	3,491,667	kWh			0.835	2,771	0.15	642	3,413	12.5%	0.005	0.007
			Total							**21,554**		**2,771**			**27,372**	100.0%	**0.043**	**0.054**
5	1,275,000	1,020,000	Diesel	4,499		1,275	5,774	kL	2.7	12,147			0.3	4,793	16,940	31.0%	0.013	0.017
			Explosives	215			215	tonnes	0.1659 to 0.177	436					436	0.8%	0.000	0.000
			Methane	1,294,763			1,294,763	kg	21	27,190					27,190	49.8%	0.021	0.027
			Slow Oxidation				-		0.125	128					128	0.2%	0.000	0.000
			Spontaneous Combustion				-		3	3,060					3,060	5.6%	0.002	0.003
			Electricity		6,631,545	346,315	6,977,860	kWh			0.835	5,537	0.15	1,284	6,821	12.5%	0.005	0.007
			Total							**42,960**		**5,537**			**54,574**	100.0%	**0.043**	**0.054**
10	1,490,000	1,192,000	Diesel	4,927		1,490	6,417	kL	2.7	13,302			0.3	5,502	18,804	30.0%	0.013	0.016
			Explosives	251			251	tonnes	0.1659 to 0.177	508					508	0.8%	0.000	0.000
			Methane	1,513,095			1,513,095	kg	21	31,775					31,775	50.6%	0.021	0.027
			Slow Oxidation				-		0.125	149					149	0.2%	0.000	0.000
			Spontaneous Combustion				-		3	3,576					3,576	5.7%	0.002	0.003
			Electricity		7,749,805	404,714	8,154,519	kWh			0.835	6,471	0.15	1,500	7,971	12.7%	0.005	0.007
			Total							**49,310**		**6,471**			**62,784**	100.0%	**0.042**	**0.053**
15	1,275,000	1,020,000	Diesel	4,496		1,275	5,771	kL	2.7	12,138			0.3	4,792	16,930	31.0%	0.013	0.017
			Explosives	215			215	tonnes	0.1659 to 0.177	436					436	0.8%	0.000	0.000
			Methane	1,294,763			1,294,763	kg	21	27,190					27,190	49.8%	0.021	0.027
			Slow Oxidation				-		0.125	128					128	0.2%	0.000	0.000
			Spontaneous Combustion				-		3	3,060					3,060	5.6%	0.002	0.003
			Electricity		6,631,545	346,315	6,977,860	kWh			0.835	5,537	0.15	1,284	6,821	12.5%	0.005	0.007
			Total							**42,951**		**5,537**			**54,564**	100.0%	**0.043**	**0.053**
21	213,000	170,400	Diesel	734		213	947	kL	2.7	1,982			0.3	795	2,777	30.6%	0.013	0.016
			Explosives	36			36	tonnes	0.1659 to 0.177	73					73	0.8%	0.000	0.000
			Methane	216,302			216,302	kg	21	4,542					4,542	50.1%	0.021	0.027
			Slow Oxidation				-		0.125	21					21	0.2%	0.000	0.000
			Spontaneous Combustion				-		3	511					511	5.6%	0.002	0.003
			Electricity		1,107,858	57,855	1,165,713	kWh			0.835	925	0.15	214	1,140	12.6%	0.005	0.007
			Total							**7,129**		**925**			**9,064**	100.0%	**0.043**	**0.053**

AGO Factors &Methods Workbook 2005, Table 3, p. 10, Table 5, p. 12; Table 12, p. 19 and Table 23, p. 36 and Table 26, p. 38; Energy Strategies 2000, p. 13-14

Table 1.2 South Pit Extension Project Greenhouse Gas Emissions Estimate Year 1 - Year 21 (Scope 1, 2 & 3) continued

Year	Production ROM Tonnes	Production Saleable Tonnes	Emissions Source	Scope 1 Usage	Scope 2 Usage	Scope 3 Usage	Total Usage	Units	Emissions Factor for Scope 1	Scope 1 Emissions in TCO2e	Emissions Factor for Scope 2	Scope 2 Emissions in TCO2e	Emissions Factor for Scope 3	Scope 3 Emissions in TCO2e	Total Emissions in TCO2e	% of Emissions	TCO2e/T ROM	TCO2e/T Saleable
Maximum Annual	2,915,000	2,332,000	Diesel	10,089		2,916	13,004	kL	2.7	27,239			0.3	10,899	38,138	30.7%	0.013	0.016
maximum annual production			Explosives	491			491	tonnes	0.1659 to 0.1778	995					995	0.8%	0.000	0.000
			Methane	2,960,183			2,960,183	kg	21	62,164					62,164	50.1%	0.021	0.027
			Slow Oxidation				-		0.125	292					292	0.2%	0.001	0.002
			Spontaneous Combustion				-		3	6,996					6,996	5.6%	0.033	0.041
			Electricity		15,161,532	791,772	15,953,304	kWh			0.835	12,660	0.15	2,935	15,595	12.6%	0.005	0.007
			Total							**97,686**		**12,660**			**124,180**	100.0%	**0.043**	**0.053**
Project Total	25,000,000	20,000,000	Diesel	86,524		25,005	111,529	kL	2.7	233,614			0.3	93,471	327,085	30.7%	0.013	0.016
Over 21 Years			Explosives	4,213			4,213	tonnes	0.1659 to 0.1778	8,537					8,537	0.8%	0.000	0.000
			Methane	25,387,500			25,387,500	kg	21	533,138					533,138	50.1%	0.021	0.027
			Slow Oxidation				-		0.125	2,500					2,500	0.2%	0.012	0.015
			Spontaneous Combustion				-		3	60,000					60,000	5.6%	0.282	0.352
			Electricity		130,030,291	6,790,499	136,820,790	kWh			0.835	108,575	0.15	25,175	133,750	12.6%	0.005	0.007
			Total							**837,789**		**108,575**			**1,065,010**	100.0%	**0.043**	**0.053**
Average Annual	1,190,476	952,381	Diesel	4,120		1,191	5,311	kL	2.7	11,124			0.3	4,451	15,575	30.7%	0.013	0.016
Project Total divided by 21			Explosives	201			201	tonnes	0.1659 to 0.1778	407					407	0.8%	0.000	0.000
			Methane	1,208,929			1,208,929	kg	21	25,388					25,388	50.1%	0.021	0.027
			Slow Oxidation				-		0.125	119					119	0.2%	0.001	0.001
			Spontaneous Combustion				-		3	2,857					2,857	5.6%	0.013	0.017
			Electricity		6,191,919	323,357	6,515,276	kWh			0.835	5,170	0.15	1,199	6,369	12.6%	0.005	0.007
			Total							**39,895**		**5,170**			**50,715**	100.0%	**0.043**	**0.053**

AGO Factors &Methods Workbook 2005, Table 3, p. 10, Table 5, p. 12; Table 12, p. 19 and Table 23, p. 36 and Table 26, p. 38; Energy Strategies 2000, p. 13-14

3. Energy Consumption

Table 1.1 above shows that proposed Project estimated energy usage is dominated by diesel usage at 90% with the remaining 10% consisting of electrical energy. This is due to the dominance of diesel powered mining equipment. The Scope 1 and 3 diesel fuel consumption figure is an estimate of the diesel use at the mining operation. The Scope 2 and 3 electricity consumption figure is an estimate of the electricity consumed by the mining operation.

The Scope 3 diesel consumption estimate also includes consideration of rail transport of the product coal to the Port of Newcastle (120km). Typically, electricity consumption for ancillary activities is dominated by the Coal Preparation Plant (CPP), followed by electric shovels with a minor contribution from the workshop, bath house and administration office. The Scope 3 electricity consumption estimate also includes consideration of conveyor transport of the product coal to Macquarie Generation (14km)

The energy indices for the mining operation are 0.192 GJ per tonne of ROM coal mined and 0.240 GJ per tonne of saleable coal. The index for GJ/tonne of saleable coal of 0.240 is less than the Australian open cut black coal mining industry average of 0.29 GJ/tonne (AGSO, 2000). The AGSO Benchmarking study excluded diesel use for product transport but energy use from product transport has been included in the data in **Table 1.1** above. The net energy consumption figures of 0.010 GJ/GJ for the proposed Project is equal to the Australian open cut black coal mining industry average of 0.010 GJ/GJ (AGSO, 2000).

The energy use estimates contained in **Table 1.1** are based on estimated consumption of diesel fuel (kL) and electricity (kWh) by Mt Arthur Coal for the Project. The calculations are detailed below:

- the diesel consumption figure was multiplied by 38.6 GJ/kL to arrive at the total GJ of diesel consumed; and

- the electricity consumption figure was multiplied by 0.0036 to convert it from kWh to GJ.

The diesel GJ and electricity GJ were added together to arrive at the total GJ of energy consumed by the Project. This figure was then divided by either ROM or saleable coal production to arrive at the energy use indices. The net energy consumption figure compares the total GJ of energy consumed by the Project to the total GJ of energy contained in the product coal. The indices were compared to industry averages for the open cut black coal mining industry.

4. Greenhouse Emissions

Table 1.2 above shows the Project estimated GHG emissions associated with energy consumption plus methane emissions from the coal seam and CO_2 emissions from explosives use and the slow oxidation and spontaneous combustion of mined coal and waste materials.

The Scope 1, 2 and 3 annual average GHG emissions for the mining operation are dominated by methane at 50.1%. Energy use emissions from diesel make up 30.7%

and electricity at 12.6%. Emissions from spontaneous combustion make up 5.6%, explosive use 0.8% and slow oxidation 0.2% of the inventory.

The average annual GHG emissions for the mining operation are estimated at **50,715** TCO_2e.

The greenhouse indices for the mining operation are 0.043 TCO_2e/tonne of ROM coal mined and 0.053 TCO_2e/tonne of saleable coal. The greenhouse index of 0.053 TCO_2e/tonne of saleable coal is comparable to the Australian open cut black coal mining industry average of 0.05 TCO_2e/tonne of saleable coal (AGSO, 2000).

The levels of methane contained in the coal seams to be mined by the South Pit Extension Project were estimated using the IPCC 2000 default figure for open cut coal mines 1.5m^3 of methane per tonne of ROM coal. Overburden depths vary from less than to greater than 50 metres during the life of the operation and so a conservative figure of 1.5 m^3 of methane per tonne of ROM coal has been used as per the IPCC 2000 guideline.

The GHG emissions estimates contained in **Table 1.2** are based on estimated consumption of diesel fuel (kL), explosives (T), emissions of methane (kg), CO_2 emissions from slow oxidation and spontaneous combustion and electricity consumption (kWh) by Mt Arthur Coal for the Project. The calculations are detailed below:

- the diesel consumption figure was multiplied by 3.0 T CO_2-e/kL to arrive at the total tonnes of CO_2-e from diesel consumption; and
- the explosives consumption figure was multiplied by 0.1659, 0.1673 or 0.1778 T CO_2-e/T (depending on the type of explosive) to arrive at the total tonnes of CO_2-e from explosives consumption.
- The methane emissions figure was multiplied by 21 T CO_2-e/T to arrive at the total tonnes of CO_2-e from methane emissions.
- The emissions from slow oxidation were arrived at by multiplying the saleable production figure by 0.125 kg CO_2-e/T to arrive at the total tonnes of CO_2-e from slow oxidation.
- The emissions from spontaneous combustion were calculated by multiplying the saleable production figure by 3.0 kg CO_2-e/T to estimate the total tonnes of CO_2-e from spontaneous combustion.
- The electricity consumption figure was multiplied by 0.985 kg CO_2-e/kWh t to arrive at the total tonnes of CO_2-e from electricity consumption.

The emissions from these sources were then added together to estimate the total tonnes of CO_2-e emitted by the Project. This figure was then divided by either ROM or saleable coal production to arrive at the energy use indices. The indices were compared to industry averages for the open cut black coal mining industry.

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 materials and waste off site (and sea transport of product coal).

Emissions from land clearing have been excluded from the inventory as the land to be disturbed by the proposed mine will be progressively rehabilitated with native vegetation, with a resultant net increase in native vegetation.

5. Emissions from Coal Combustion

Table 1.3 below shows the estimated GHG emissions associated with the combustion of the product coal produced by the Project, assuming that all product coal is burnt (whether in Australia or offshore).

The emissions from combustion have been calculated based on an average Project product coal energy content of 24.845 GJ/tonne. The standard emissions factors for coal combustion have been taken from the AGO Workbook for combustion of fuel.

The Full Fuel Cycle annual average greenhouse emissions from the combustion of product coal are estimated to be **2,311,768** TCO_2e per annum.

The combustion of the product coal would generate an average 2,368,803 MWh per annum at an average power station efficiency of 36%. The average power station efficiency in OECD countries is estimated at 36% (IEA, 2005). By way of comparison, the efficiency of the Bayswater and Liddell power stations operated by Macquarie Generation is 36% and 35% respectively (Macquarie Generation, 2006).

In terms of GHG emissions it is estimated that:

(a) the Project has been estimated to produce on average approximately **50,715** TCO_2e per annum. This represents in total about 0.009% of the Australian annual GHG emission rate; and

(b) the burning of product coal from the project would produce on average approximately **2,311,768** TCO_2e per annum. This is equivalent to:

  (i) 0.409% of Australia's total annual GHG emissions in 2004 which were 564,700,000; and

  (ii) 0.006% of annual global GHG emissions. The annual global emissions have been estimated based on the assumption that Australia's GHG emissions represent 1.4% of the total global emissions. Total global emissions are then estimated as 40,335,714,286 T CO_2-e.

The emission factors used in **Table 1.3** below is the Full Fuel Cycle Emission Factor for Black Coal – NSW Electricity Generation of 97.7 kg CO_2-e/GJ.

Table 1.3 South Pit Extension Project Product Coal Combustion Greenhouse Gas Emissions Estimate Year 1 - Year 21 (Full Fuel Cycle)

Year	Product Coal	Energy Content GJ/t	EF for Scope 1 kg CO2e/GJ	EF for Scope 3 kg CO2e/GJ	Full Fuel Cycle EF kg CO2e/GJ	Scope 1 kg CO2e/T	Scope 3 kg CO2e/T	Full Fuel Cycle EF kg CO2e/T	Annual Scope 1 T CO2e	Annual Scope 3 T CO2e	Annual Full Fuel Cycle EF T CO2e	MWh Generated
Year 1	510,400	24.845	89.8	7.8	97.7	2,231	194	2,427	1,138,744	98,911	1,238,923	1,269,103
Year 5	1,020,000	24.845	89.8	7.8	97.7	2,231	194	2,427	2,275,703	197,667	2,475,904	2,536,217
Year 10	1,192,000	24.845	89.8	7.8	97.7	2,231	194	2,427	2,659,449	230,999	2,893,409	2,963,893
Year 15	1,020,000	24.845	89.8	7.8	97.7	2,231	194	2,427	2,275,703	197,667	2,475,904	2,536,217
Year 21	170,400	24.845	89.8	7.8	97.7	2,231	194	2,427	380,176	33,022	413,622	423,697
Maximum Annual	2,332,000	24.845	89.8	7.8	97.7	2,231	194	2,427	5,202,881	451,921	5,660,595	5,798,489
Project Total	20,000,000	24.845	89.8	7.8	97.7	2,231	194	2,427	44,621,620	3,875,820	48,547,130	49,729,752
Annual Average	952,381	24.845	89.8	7.8	97.7	2,231	194	2,427	2,124,839	184,563	2,311,768	2,368,083

Note: Emission Factors taken from Table 1 AGO Factors & Methods Workbook 2005; Assumes average energy content of Mt Arthur product coal of 24.845 GJ/tonne; and OECD Average power station efficiency (IEA 2005)

6. Greenhouse Mitigation Strategies

Mt Arthur Coal will assess and implement where possible energy and greenhouse management initiatives during the project design, operation and decommissioning. Some of the opportunities for improving energy efficiency and reducing greenhouse emissions from the South Pit Extension Project are discussed below.

Due to the nature of open cut coal mining, geology and the low levels of methane contained in the coal seams to be mined, the South Pit Extension Project has no means of capturing and combusting coal seam methane. Therefore, greenhouse mitigation measures are largely focused upon energy management and energy efficiency.

Mt Arthur Coal is therefore assessing the viability of the following energy and greenhouse mitigation measures for the South Pit Extension Project:

- Energy management
- Energy efficiency in the mining fleet
- Energy efficiency in stationary equipment and
- Energy efficiency in mining processes and coal preparation

As part of its commitment to energy management and consistent with BHP Billiton requirements, Mt Arthur Coal will develop and maintain internal energy conservation plans with specific targets. Mt Arthur Coal will also develop and maintain internal greenhouse gas management programs. Measures that may be included in these management plans and programs are outlined briefly below.

Energy efficiency opportunities in the mining fleet focus on minimising diesel use by vehicles via equipment selection, monitoring of fuel use and optimising the conditions under which the mining fleet operates. This is consistent with current practice at Mt Arthur Coal and will be continued for the South Pit Extension Project.

Additional measures include continually reviewing processes and activities for which there is moderate to high energy demand with a view to reducing energy consumption or wastage and lowering greenhouse gas emissions. In recent years, projects have been completed in Mt Arthur Coal's coal handling and preparation plant and production areas that have led to improvements in process efficiencies and so contributed to reductions in energy consumed by these activities. These review processes will be continued in future.

As part of the South Pit Extension Project Mt Arthur Coal intend to plant significant new areas to native trees and shrubs in both mine rehabilitation and buffer lands over the life of the mine. This will result in a net increase in native vegetation and whilst this would provide only limited benefit in terms of carbon sequestration it will provide other benefits in terms of habitat restoration and improved land management.

7. References

ACIRL, *South Pit Extension Project Coal Seam Gas Analysis*, 2005 (unpublished).
Australian Coal Association Research Program, Monitoring and Reporting Greenhouse Gas Emissions, C8061, May 2001.

Australian Geological Survey Organisation (AGSO), *Energy/Greenhouse Benchmarking Study of Coal Mining Industry*, 2000, Canberra.

Australian Greenhouse Office, *Factors and Methods Workbook*, December 2005, Canberra.

Australian Greenhouse Office, *National Greenhouse Inventory 2004*, May 2006, Canberra.

Campbell, I, *Greenhouse Accounts show Australia is still on target for 108 per cent*, Media Release by Australian Minister for Environment and Heritage, 23 May 2006, Canberra.

Energy Strategies, George Wilkenfeld and Associates Pty Ltd and Dr Lawrence Leung, *Projection of Fugitive Greenhouse Gas Emissions to 2020*, 2000, Canberra.

Environment Australia, *Best Practice Environmental Management in Mining: Energy Efficiency*, July 2002, Canberra.

Intergovernmental Panel on Climate Change, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, Cambridge University Press, Cambridge UK, 2000.

International Energy Agency, *Key World Energy Statistics 2006*, 2006, France.

International Energy Agency, *World Energy Outlook 2004*, 2004, France.

International Energy Agency/Coal Industry Advisory Board, *Reducing Greenhouse Gas Emissions: The Potential of Coal*, 2005, France

Macquarie Generation, www.macgen.com.au , 2006

NSW Greenhouse Office, *NSW Greenhouse Plan*, 2005 Sydney

URS, *the Mt Arthur North Coal Project Environmental Impact Statement*, 2000.

World Business Council for Sustainable Development and World Resources Institute, *Greenhouse Gas Protocol*, 2004, Washington DC.

Umwelt (Australia) Pty Limited
2/20 The Boulevarde
PO Box 838
Toronto NSW 2283

Ph. 02 4950 5322
Fax 02 4950 5737

www.umwelt.com.au