11 Greenhouse Gases

11 Greenhouse Gases

The Greenhouse Gas (GHG) assessment for the Caval Ridge Mine has considered the following:

- Annual global and national GHG emissions
- International and national policy in regards to GHG emissions
- Direct and indirect sources of greenhouse gas emissions for operation of the mine
- Proposed GHG reduction measures
- Risks to project from climate change impacts.

11.1 Background to Greenhouse Gases and Climate Change

11.1.1 Evidence and Causes of Climate Change

Climate change refers to long-term fluctuations in temperature, precipitation, wind, and other elements of the Earth's climate system. The Earth naturally absorbs and reflects incoming solar radiation and emits longer wavelength terrestrial (thermal) radiation back into space. A portion of this terrestrial radiation is absorbed by gases (known as greenhouse gases) in the atmosphere. Changes in the atmospheric concentrations of these greenhouse gases can alter the balance of energy transfers between the atmosphere, space, land, and the oceans. The major greenhouse gases which make the largest contribution to global warming are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 to provide an objective source of information about climate change. IPCC summarised the findings of The Fourth Assessment Report in Climate Change 2007: Synthesis Report (IPCC 2007). The key findings of this report were:

- Warming of the climate system is unequivocal as evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Global atmospheric concentrations of greenhouse gases have increased greatly as a result of human activities since 1750 and now far exceed pre-industrial values.
- Global greenhouse gas emissions due to human activities have grown since pre-industrial times with an increase of 70% between 1970 and 2004.
- Global atmospheric CO_2 concentration has risen 35% above its pre-industrial level (280 to 380 ppm) due primarily to increased fossil fuel use.
- Global atmospheric concentrations of CH_4 have increased from a pre-industrial value of 715 parts per billion (ppb) to 1,774 ppb in 2005 due to agriculture and fossil fuel use.
- Global atmospheric concentrations of N_2O have increased from a pre-industrial value of 270 ppb to 319 ppb in 2005 due to agriculture.

- Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas emissions.
- Continued greenhouse gas emissions at or above current levels would cause further warming and induce many changes in global climate system during the 21st century.

11.2 Legislative Framework

11.2.1 International Policy

The Kyoto Protocol to the United Nations Framework Convention on Climate Change was signed in 1997 and entered into force in 2005. Australia ratified the Kyoto Protocol in December 2007. Its aim is to limit greenhouse gas emissions of countries that ratified the protocol by setting individual mandatory greenhouse gas emission targets in relation to those countries' 1990 greenhouse gas emissions. Australia has committed to meeting its Kyoto Protocol target of 108% of 1990 emissions by 2008-2012.

The Kyoto Protocol sets out three flexibility mechanisms to allow greenhouse gas targets to be met:

- The Clean Development Mechanism
- Joint Implementation
- International Emissions Trading.

The definitions of the three mechanisms above are complex but effectively they allow greenhouse gas reductions to be made at the point where the marginal cost of that reduction is lowest. Essentially, an industrialised country sponsoring a greenhouse gas reduction project in a developing country can claim that reduction towards its Kyoto Protocol target and those greenhouse gas reductions can be traded.

11.2.2 Australia's Climate Change Policy

Australia's climate change policy is managed by the Department of Climate Change. The Australian policy on climate change was released in July 2007 (Australian Government, 2007) and sets out the Commonwealth Government's focus on reducing emissions, encouraging the development of low emissions and emission reduction technology, climate change adaptation, and setting Australia's policies and response to climate change within a global context.

11.2.2.1 Carbon Pollution Reduction Scheme

A 2007 report of the Prime Ministerial Task Group on Emissions Trading foreshadowed a national emissions trading scheme to help Australia address the global issues of climate change.

The Green Paper (Australian Government, 2008a) and subsequent White Paper (Australian Government, 2008b) on the Carbon Pollution Reduction Scheme (CPRS) were issued in 2008 and provide the government's outline of the CPRS. Key features of the CPRS will be:

Key features of the proposed scheme are:

- The CPRS is scheduled to commence on 1 July 2010.

- CPRS will cover stationary energy, transport, fugitive emissions, industrial processes, waste and forestry sectors, and the six greenhouse gases counted under the Kyoto Protocol from the time the scheme begins.
- The scheme will be a cap-and-trade scheme, in which total emissions are capped, permits allocated up to the cap and emissions trading allowed, using the market to find the cheapest way to meet any necessary emissions reductions.
- A medium-term emissions abatement goal of between 5-15% of below 2000 levels will be set, to be achieved by the end of 2020. With current population growth forecasts, this is equivalent to a 34-41% reduction in per capita emissions.
- A long-term emissions abatement goal of 60% by 2050 (against 2000 levels) will be set to meet Kyoto Protocol requirements.
- Significant emitters (more than 25,000 tonnes CO_2 equivalent (or CO_2-e) per annum) of greenhouse gases need to acquire and surrender a carbon pollution permit for every tonne of greenhouse gas they emit per year.
- Firms will compete to purchase the number of carbon pollution permits that they require.
- Assistance will be given to emissions-intensive, trade-exposed industries and some power generators. This will exclude coal mines, with the exception of the most emissions-intensive mines which will be assisted under the Coal Sector Adjustment package.
- The government will support the National Low Emissions Coal Initiative through the National Low Emissions Coal Fund.

11.2.2.2 National Greenhouse and Energy Reporting Act 2007

The National Greenhouse and Energy Reporting National Greenhouse and Energy Reporting (NGER) Act establishes a national framework for Australian corporations to report Scope 1 and Scope 2 (see Section 11.3.3) greenhouse gas emissions, reductions, removals and offsets and energy consumption and production, from July 2008. It is designed to provide robust data as a foundation to the CPRS. From 1 July 2008, corporations will be required to register and report if:

- They control facilities that emit 25 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produce/consume 0.1 PJ or more of energy.
- Their corporate group emits 125 kilotonnes or more greenhouse gas (CO_2 equivalent), or produces/consumes 0.5 PJ or more of energy.

Lower thresholds for corporate groups will be phased in by 2010-2011. Companies must register by 31 August, and report by 31 October, following the financial year in which they meet a threshold.

11.2.2.3 Energy Efficiency Opportunities

The Energy Efficiency Opportunities (EEO) legislation came into effect in July 2006, and requires large energy users (over 0.5 PJ of energy consumption per annum) to participate in the program. The objective of this program is to drive ongoing improvements in energy consumption amongst large users, and businesses are required to identify, evaluate and report publicly on cost effective energy savings opportunities.

EEO legislation is designed to lead to:

- Improved identification and uptake of cost-effective energy efficiency opportunities.
- Improved productivity and reduced greenhouse gas emissions.
- Greater scrutiny of energy use by large energy consumers.

As a large energy user, BMA is a mandatory participant in EEO. Consequently, the minimum requirements of the scheme need to be met at the Caval Ridge Mine by looking at the many factors influencing energy use; the accuracy and quality of data and analysis; the skills and perspectives of a wide range of people; decision making and communicating outcomes.

The EEO will be incorporated into the National Framework for Energy Efficiency.

11.2.3 State Policy and Initiatives

The Queensland Government created the Office of Climate Change in October 2007 in order to lead an effective climate change response.

11.2.3.1 ClimateSmart 2050

ClimateSmart 2050 is the Queensland Climate Change Strategy, which was released in June 2007. It aims to reduce greenhouse emissions by 60% from 2000 levels by 2050 in line with the national target by building initiatives into the Queensland Government's 2000 Energy Policy (Queensland Government 2007). Its initiatives include:

- The introduction of a Smart Energy Savings Program, which targets large energy users and requires them to undertake energy efficiency audits and implement energy savings measures that have a three year or less payback period.
- The Queensland Future Growth Fund for development of clean coal technologies.
- Changes to the Queensland Gas Scheme which will oblige major industries to source 18% of all power from Queensland based gas-fired generation.

11.2.4 BMA's Greenhouse Gas Policy

BMA acknowledges the risks posed by climate change associated with increasing greenhouse gas concentrations in the atmosphere. BMA has a corporate climate change approach (Appendix S) with actions focused in the following areas:

- Working collaboratively with government, industry, communities and employees to reduce emissions, including:
  - contributing approximately $130 million over ten years to the $1 billion COAL21 Fund established by the Australian coal industry to support the research and demonstration of low emissions coal utilisation technologies; and
  - raising awareness within the BMA workforce and neighbouring communities and providing support to greenhouse abatement projects.
- Improving the management of energy and greenhouse gas emissions from coal production, in particular:
  - adopting energy and greenhouse gas intensity reduction targets of 0.3 % and 5.6 % respectively by 2012.
  - employing the company's Energy Excellence Program to identify and implement opportunities for improved energy efficiency in mining operations.
  - investigating the potential recovery and utilisation of coal seam methane at several BMA sites.
- Transparent reporting of BMA's emissions profile.

11.3 Inventory Methodology

11.3.1 Accounting and Reporting Principles

The GHG inventory for the Caval Ridge Mine is based on the accounting and reporting principles detailed within the Greenhouse Gas Protocol (2004). The Protocol was first established in 1998 to develop internationally accepted accounting and reporting standards for greenhouse gas emissions from companies. The main principles are as follows:

- Relevance: The inventory must contain the information that both internal and external users need for their decision making.
- Completeness: All relevant emissions sources within the inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is complied.
- Consistency: The consistent application of accounting approaches, inventory boundary and calculation methodologies is essential to producing comparable GHG emissions over time.
- Transparency: Information needs to be archived in a way that enables reviewers and verifiers to attest to its credibility. All parameter, values and methodologies used are accessible and presented within the inventory.
- Accuracy: Data should be sufficiently precise to enable intended users to make decisions with reasonable assurance that the reported information is credible.

11.3.2 Inventory Organisational Boundaries

The organisational boundary of the project is defined as the Caval Ridge Mine and associated infrastructure within ML 1775 and MLA 70403 and includes all the greenhouse gas emissions controlled or influenced by the project.

11.3.2.1 Inventory Operational Boundaries

The Coordinator-General's ToR for the BBCGP EIS specifies that both direct and indirect emissions from the project should be assessed.

The Greenhouse Gas Protocol further defines direct and indirect emissions through the concept of emission scopes.

- Scope 1: Direct greenhouse gas emissions. Direct greenhouse gas emissions occur from sources that are owned or controlled by a company. For example:
  - Emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.
  - Emissions from on-site power generators
  - Coal seam gas.
- Scope 2: Electricity indirect greenhouse gas emissions. This accounts for greenhouse gas emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated but they are allocated to the organisation that owns or controls the plant or equipment where the electricity is consumed. Scope 2 emissions also capture the importing of energy (such as chilled water or steam) into a site.
- Scope 3: Other Indirect greenhouse gas emissions. This is an optional reporting class that accounts for all other indirect greenhouse gas emissions resulting from a company's activities, but occurring from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation of product by contractors; use of sold products and services; and employee business travel and commuting. These are not routinely reported by companies as the emissions are difficult to estimate accurately, the company does not have control of the emissions sources and these emissions are reported by other companies as their Scope 1 emissions.

11.3.3 Calculation Approach

The greenhouse gas emission inventory for the project is based on the methodology detailed in the Greenhouse Gas Protocol (the Protocol) (World Business Council 2004) and the relevant emission factors in the National Greenhouse Accounts (NGA) Factors (Department of Climate Change 2008b).

A spreadsheet model has been specifically developed for the project and uses the data sources and emission factors detailed below in order to calculate project emissions for every year of construction and operation, according to the protocol and using methodology detailed in the NGA Factors.

There are several greenhouse gases including CO_2, CH_4, and N_2O, however, to simplify inventory accounting, a unit called carbon dioxide equivalents (CO_2-e) is used. This accounts for the various global warming potentials of non-CO_2 gases as specified in NGA factors. The global warming potential is a measure of the amount of infrared radiation captured by a gas in comparison to an equivalent mass of CO_2, over a fixed lifetime. GHG inventories in this report are expressed as mass of CO_2-e released, following this convention.

11.3.4 Emission Factors

Direct measurement of greenhouse gases at the emission source can give the most accurate and precise assessment of greenhouse gas emissions. This is typically not feasible at a mine because of the cost involved, the disruption to production involved and the typically large number of trucks and plant equipment involved. Emission factors remove the need for site specific testing of emissions. They are a factor expressed as the amount of greenhouse gas emissions per unit of activity, which can be used to determine inventories for a site. This is much more feasible than testing each source individually, and it is one of the few ways that inventories for proposed sites can be calculated.

Emission factors can be sourced from various sources, for example, the Department of Climate Change, from site-specific information or from operational details obtained from similar emission sources. The majority of the emission factors used in this report has been sourced from the Department of Climate Change NGA Factors Workbook, 2008 as indicated in Table 11.1 below.

Table 11.1 Emission Factors used in the project GHG Inventory

Emission Source	Units	Emission Factor	Source
Scope 1 Emissions			
Fugitive open cut coal mine emissions	kg CO_2-e/t ROM	17.1	NGA Factors. Table 6 (production of coal, fugitive emissions)
Combustion emission factor diesel	t CO_2-e/kL	2.7	NGA Factors. Table 3, (fuel combustion for transport) column C
Explosives - ANFO	t CO_2 / t product	0.17	NGA Factors. Table 4 (explosive use)
Explosives - Emulsion	t CO_2 / t product	0.17	NGA Factors. Table 4 (explosive use)
Scope 2 Emissions			
Electricity Consumption (QLD)	kg CO_2-e/kWh	0.91	NGA Factors. Table 5 (consumption of purchased electricity) Column A
Scope 3 Emissions			
Coking Coal	kg CO_2-e/GJ	90.2	NGA Factors. Table 1 (fuel combustion factors, stationary energy) column B
Coking coal energy content factor	GJ/t	30	NGA Factors. Table 1 (fuel combustion factors, stationary energy) column A
Rail transport of coal	g CO2-e/net tonne km travelled	25.0	Queensland Rail Greenhouse Challenge Cooperative Agreement, 2000
Coal terminal handling	t CO2-e/Mt coal handled	1616.3	Hay Point Coal Terminal Expansion 3 EIS, 2006
Coal bulk carrier diesel consumption	kL/ Mt coal	65.7	Information provided by BMA

11.3.5 Materiality

Materiality is a concept used in accounting and auditing to minimise time spent verifying amounts and figures that do not impact a company's accounts or inventory in a material way. The exact materiality threshold that is used in greenhouse gas emissions accounting and auditing is subjective and dependant on the context of the site and the features of the inventory. Depending on the context, the materiality threshold can be expressed as a percentage of a company's total inventory, a specific amount of GHG emissions, or a combination of both.

All emissions that are found within the boundary are included in the inventory unless they are excluded on materiality grounds. Information is considered to be material if, by its inclusion or exclusion it can be seen to influence any decisions or actions taken by users. A material discrepancy is an error (for example, from an oversight, omission or miscalculation) that results in a reported quantity or statement being significantly different to the true value or meaning.

Emissions are assumed to be immaterial if they are likely to account for less than 5% of the overall emissions profile. This materiality threshold has been chosen on the basis of the author's experience of open-cut coal mine greenhouse gas inventories. The following emissions are not included in the inventory on the basis of materiality:

- Consumption of unleaded petrol (ULP) or LPG in site vehicles. Most site vehicles run on diesel fuel, which is included in the inventory. Only small vehicles such as cars belonging to site personnel will consume unleaded fuel and are typically immaterial.
- The inventory does not consider emissions or sequestration arising from land use, land use change and forestry such as rehabilitation and clearing. These are small surface areas that are not highly forested, so the GHG emissions from land clearing or sequestration from forestry are immaterial.

11.3.6 Aggregation

Aggregation refers to the combining of several inventories, typically of different sites or operations, into an overall inventory. This is not applicable to the Project as it is a single-site inventory and operation.

11.4 Emissions Summary

Greenhouse gas emissions have been estimated for the operation of the project, which has a project life of 30 years beginning in 2012. The Scope 1 emission sources from the project included in this inventory are:

- Fugitive emissions of coal seam gas (CSG) from the open cut mining of coal
- Diesel consumption in vehicles
- Use of explosives.

The Scope 2 emissions from the project result from the purchasing of electricity for drag lines, coal handling and preparation plants, lighting and facilities.

The Scope 3 emissions from the project considered in this assessment are the following:

- End use of the coal in metallurgical uses as coking coal.
- Transport of the coal via rail to Hay Point Terminal, an estimated distance of 220 km.
- Handling of coal at Hay Point Terminal and an overseas terminal (assumed to be equivalent emissions to Hay Point).
- Shipping of the coal, based on average ship diesel consumption rate.

11.4.1 Scope 1, 2 and 3 emissions

Table 11.2 shows a summary of the Project's Scope 1, Scope 2 and Scope 3 emissions. The life of mine emissions represent the total GHG emissions over the projected operating life of 30 years.

Table 11.2 GHG emissions for the Project

Scope	Source	Minimum Emissions (t CO_2-e / yr)	Maximum Emissions (t CO_2-e / yr)	Average Emissions (t CO_2-e / yr)	Life of Mine Emissions (t CO_2-e)
1	Fugitive emissions	120,129	196,359	161,647	4,849,404
1	Diesel combustion	72,450	131,595	105,818	3,174,554
1	Explosives	3,348	5,011	4,430	132,886
2	Purchased electricity	56,315	105,572	99,305	2,979,160
3	Coal railing and terminal handling	35,370	48,634	48,192	1,445,754
3	Coal shipping	70,956	97,565	96,678	2,900,327
3	Coal End Use	10,824,000	14,883,000	14,747,700	442,431,000
Total Scope 1		**233,872**	**319,480**	**271,895**	**8,156,843**
Total Scope 1 and Scope 2		**300,583**	**420,522**	**371,200**	**11,136,003**
Total Scope 3		**10,930,326**	**15,029,198**	**14,892,569**	**446,777,081**

Fugitive CSG emissions are on average approximately 43% of the Sum of Scope 1 and Scope 2 emissions. Combustion of diesel represents approximately 29%, and purchased electricity approximately 27%. This is shown in Figure 11.1. This is consistent with open cut coal mines in Queensland where emissions of CSG have been estimated with the default emission factors rather than from direct measurements.

Figure 11.1 shows the Scope 1 and Scope 2 emissions for every year of the mine's operation. Emissions from purchased electricity (Scope 2) are approximately constant after the first year. This is consistent with the mine plan which shows less than a 5% standard deviation in ROM coal production after the first year of operation. The electricity consumption relates mainly to the dragline and CHPP operation.

By comparison, Scope 1 emissions show a steady increase as a function of time. This is consistent with the mine plan which shows a steady increase in diesel consumption as a function of time, reflecting the increasing fuel required by haul trucks to move overburden and extract coal as the depth of the open cut pits increases.

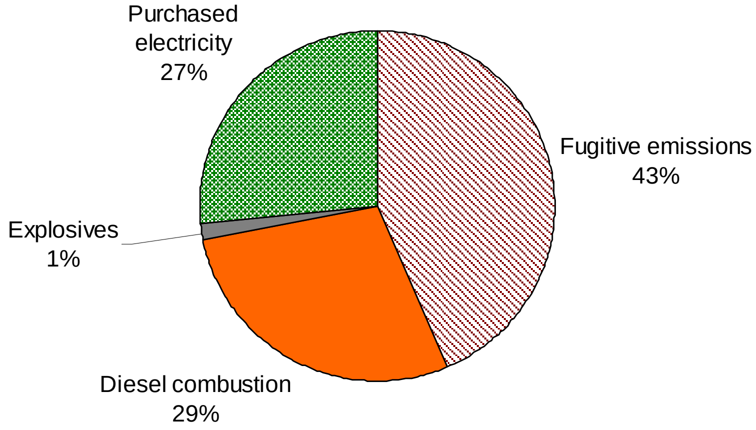

Figure 11.1 **Average Scope 1 and Scope 2 emissions by emission source (%)**

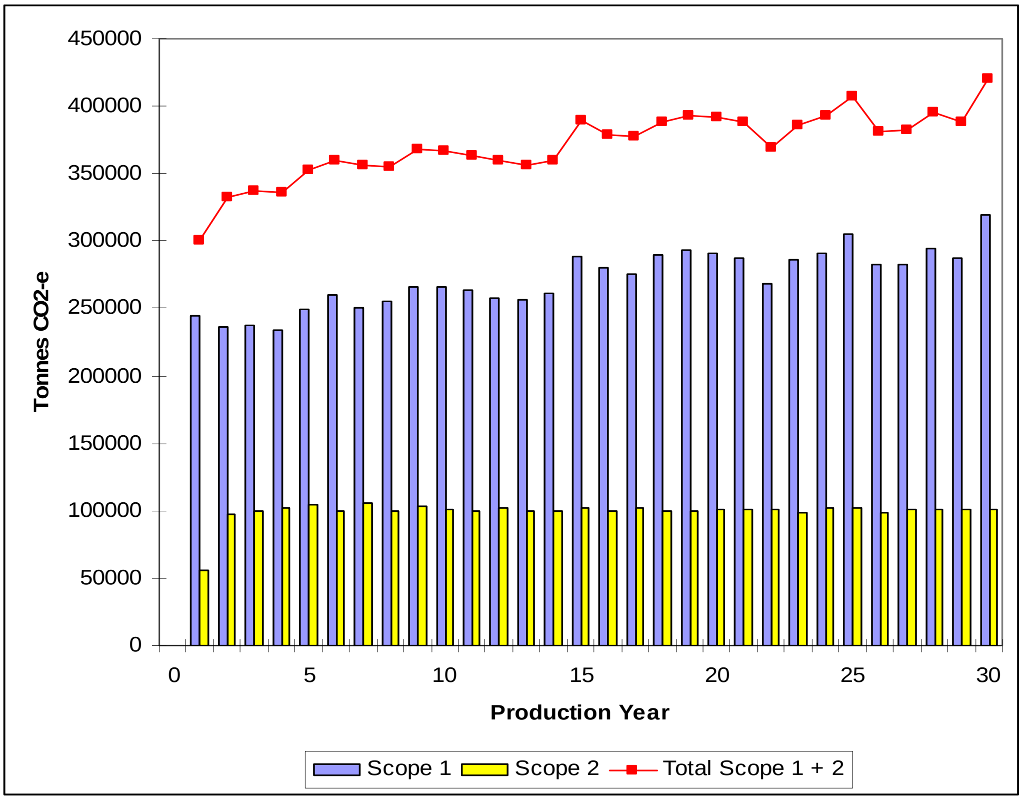

Figure 11.2 **Scope 1 and Scope 2 emissions for each production year of the Project (t CO_2-e)**

Scope 3 emissions are not directly attributable to the project's operation, and are not routinely reported by companies. The overwhelming majority of Scope 3 emissions from the project are due to the end use of the coal in metallurgical operations such as steel making. The end use accounts for 99% of the Scope 3 emission sources that have been considered in this assessment. Other Scope 3 emissions from the project that have not been assessed include:

- Emissions from transport of materials for the construction of the CHPP.
- Emissions from extraction and processing of diesel consumed by the project.
- Emissions from the transportation of coal from end ports to clients' facilities.
- Emissions associated with waste to landfill.
- Emissions from employee travel.

These remaining Scope 3 emission sources are expected to contribute less than 1% to the total Scope 3 inventory.

11.4.2 Performance Measures

The performance of the greenhouse gas emissions efficiency is measured as emissions intensity, as defined by the Greenhouse Gas Protocol. Emissions intensity is defined as tonnes CO_2-e/ tonnes product coal, based on total Scope 1 and Scope 2 emissions. The project's GHG performance intensity varies from 0.036 t CO_2-e/t ROM to 0.043 t CO_2-e/t ROM throughout the life of the mine. This is broadly consistent with other open cut coal mines.

11.5 Comparison to National and State emissions

11.5.1 Australian Emissions

The 2006 National Greenhouse Gas Inventory is the latest available national account of Australia's GHG emissions (Australian Government 2008b). The National Greenhouse Gas Inventory has been prepared in accordance with the Revised 1996 and 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The IPCC guidance defines six sectors for reporting greenhouse gas emissions:

- Energy (including coal mining)
- Industrial Processes
- Solvent and Other Product Use
- Agriculture
- Land Use, Land Use Change and Forestry
- Waste.

Australia's net greenhouse gas emissions across all sectors totalled 576 Mt CO_2-e in 2006, with the energy sector being the largest emitter at 400.9 Mt CO_2-e. Emissions from coal-mining sources are captured under the energy category of the IPCC methodology. Approximately 34.5 Mt of energy sector emissions were attributable to fugitive emissions, representing 6% of national emissions. Australia's total emissions are just over 1% of the global anthropogenic emissions of 49.0 Gt CO_2-e, based on IPCC inventory data for 2004 (IPPC 2007).

Table 11.3 shows total annual Scope 1 and 2 emissions as a percentage of Australian total and energy sector emissions taken from the National Greenhouse Gas Inventory 2006. This has been calculated for the minimum, maximum and average GHG emissions from the project.

Table 11.3 Comparison of Australian and Project GHG emissions, Scope 1 and 2

	Percent of Australian Energy Sector Total	Percent of Australian Total
Minimum	0.07%	0.05%
Maximum	0.10%	0.07%
Average	0.09%	0.06%

11.5.2 Queensland Emissions

The estimated GHG emissions from Queensland for 2006 are 170.9 Mt CO_2-e, approximately 30% of Australia's total emissions. The Queensland energy sector had emissions of 96 Mt CO_2-e in 2006.
Table 11.4 shows total annual Scope 1 and 2 emissions from the project as a percentage of Queensland total and Queensland energy sector emissions taken from the National Greenhouse Gas Inventory 2006. This has been calculated for the minimum, maximum and average GHG emissions from the project.

Table 11.4 Comparison of Queensland and Project GHG emissions, Scope 1 and 2

	Percent of Queensland Energy Sector	Percent of Queensland Total
Minimum	0.31%	0.18%
Maximum	0.44%	0.25%
Average	0.39%	0.22%

When viewed in an Australian or Queensland context, the Scope 1 and 2 emissions from the project are not considered materially relevant given the project emissions are 0.44% of the Queensland energy sector at peak emissions. Future reductions in GHG emission from the project, or changes in the National and Queensland inventories, cannot be forecast.

11.5.3 Impact of the Project on Queensland Emissions Targets

The Queensland government has proposed to reduce greenhouse gas emissions by 60% by 2050 based on 2000 levels in line with the national target. This equates to a reduction of approximately 98 Mt CO_2-e.

In the years of peak greenhouse gas emissions, Scope 1 and 2 emissions from the mine will be 0.42 Mt CO_2-e. The Scope 1 and 2 emissions in peak years will be equal to 0.44% of the state inventory.

Project emissions are therefore unlikely to have a significant impact on Queensland government emissions targets.

11.6 Greenhouse Gas Reduction Measures

The following management measures are proposed for the project to minimise greenhouse gas emissions during operation of Caval Ridge Mine that will be implemented on a site level and at a corporate level.

Site-based Programs:

- Electrical Efficiency
- Diesel Efficiency
- Fugitive Emissions
- Blasting.

Corporate Programs:

- Energy Excellence Program
- Mine Methane Management
- Australian Emissions Trading Scheme.

11.6.1 Electrical Efficiency

The project will be a large consumer of electricity, primarily through dragline usage and the CHPP. It is normal operating procedure to maximise electrical efficiency at an open cut coal mine due to the business requirements to minimise costs. The following activities will be undertaken as part of the project to maximise electrical efficiency and are typical of best practice management at open cut coal mines:

- Regular monitoring of electrical load on the draglines and investigation whenever the load falls outside optimal parameters.
- A regular program of bucket inspection and repair. Poorly maintained dragline buckets reduce the efficiency of each dragline load, increasing electricity required to move a tonne of overburden.
- Minimising the distance the dragline needs to swing the bucket load from its source to the dumping location.
- Undertaking 6-monthly electrical calibration checks on the draglines as per the manufacturers instructions.
- Use of high efficiency electrical motors throughout the mine site.
- Use of variable speed drive pumps with high-efficiency linings at the coal handling and preparation plant.
- Regular monitoring of the compressed air circuit so that leaks are repaired in a timely manner, as this maximises the operating efficiency of the compressor.

- Maintaining light fittings to maximise light delivery.
- Installing light-sensitive switches on haul road lights so that lights do not operate during the day.

11.6.2 Diesel Efficiency

Diesel consumption by on-site vehicles is a major business cost and source of greenhouse gas emissions and it is normal business practice at open cut coal mines to minimise its use. The following activities will be undertaken as part of the project to maximise electrical efficiency and are typical of best practice management at open cut coal mines:

- Haul truck scheduling, routing and idling times will be optimised through the use of sophisticated satellite tracking software designed to minimise the amount of diesel consumed.
- Pit access ramps will be designed to limit the amount of effort required for fully-laden trucks to climb.
- Haul roads will be compacted to reduce rolling resistance.
- The location of ROM and overburden dumps will be optimised to limit the amount of distance haul trucks need to cover while fully laden.
- Truck maintenance schedule, including tyre condition.
- Consideration of fuel efficiency of haul trucks during procurement

11.6.3 Fugitive emissions

There is little that can be done to minimise fugitive CSG emissions from open-cut coal mines for the following reasons:

- The open-cut coal is usually at insufficient depth to generate the required pressure for efficient CSG extraction.
- The large geographical area covered by open cut pits makes extraction of CSG and collection to a single point not possible.
- Open-cut pits have lower amounts of methane per tonne of coal due to the natural escape of methane from shallow coal seams.

The National Greenhouse Account gives emission factors for fugitive coal seam gas emissions from Queensland mines, which can be used to estimate emissions in the absence of any on-site measurements of coal seam gas. The default emission factor is 17.1 kg CO_2-e per tonne of ROM coal mined. Site specific measurements would improve the accuracy of this portion of the assessment.

11.6.4 Blasting

Control of GHG emissions from blasting cannot be achieved through energy efficiency measures. Reductions in GHG emissions can be achieved through implementing the following practices:

- Optimise blasting operations to minimise rehandling of material

- Use waste oils or renewable alternatives for diesel in ANFO as appropriate

11.6.5 Energy Excellence Program

BMA have established a comprehensive program of energy efficiency improvement review and implementation in response to the EEO Act. It aims to identify initiatives, and develop and implement processes that ensure energy efficiency and energy source substitution opportunities are integrated into mine planning and operations.

Although the program is still in its early stages, BMA has conducted energy reviews at each of its mines and considered more than 200 possible energy efficiency improvement opportunities. In accordance with the Energy Excellence assessment framework, these have been rationalised to fifteen potentially viable projects that are at varying stages of assessment, development and implementation.

More advanced Energy Excellence projects include the following:

- Last Drop - BMA has developed an open cut mining approach that protects the in situ coal from unnecessary disturbance during blasting and overburden excavation, with the aim of minimising coal losses and thereby maximising coal recovery.
- Improved Dragline Bucket Efficiency – BMA has engineered a light-weight dragline bucket that results in reduced energy consumption per cubic metre of overburden moved.
- Increased coal preparation plant yield – process improvements in BMA's CHPPs are aimed at increasing the rate of recovery of product coal from raw coal leading to reduced consumption of electricity and diesel per tonne of output.
- Waste oil for explosives – one site is trialling the use of substitution of waste oil for diesel in the making of ANFO for blasting.

These projects and others currently under consideration are projected to deliver energy savings in excess of 2.7 TJ across the BMA operations over four years.

11.6.6 Mine Methane Management

Coal seam methane accounts for almost half of BMA's total greenhouse gas emissions. The company has sought and received expressions of interest from gas operators to assist BMA in trialling coal seam methane recovery and utilisation at its South Walker Creek Mine, as a trial and precursor to gas commercialisation at other prospective BMA sites.

11.6.7 Carbon Pollution Reduction Scheme

BMA supports the introduction of the Carbon Pollution Reduction Scheme (CPRS) as an article of Australia's leadership role in the pursuit of comprehensive international climate change response measures and an important policy tool for achieving greenhouse gas reductions at least cost to the Australian economy. Caval Ridge Mine will be a participant in the CPRS when it comes into force.

11.6.8 Australian Greenhouse Challenge Program

BMA, through BHP Billiton, in 1995 were one of the first participants in the Australian Greenhouse Challenge program, which was designed to encourage reductions in greenhouse gas emissions. Through BHP Billiton, BMA commenced measuring greenhouse gas emissions from our global controlled operations in 1993 and have publicly reported our greenhouse gas emissions data since then. As of 2007 BHP Billiton's reporting has also included greenhouse emissions associated with employee business air travel.

As a total business, BHP Billiton has exceeded its original target of a 10% reduction in greenhouse gas intensity between 1995 and 2000 and again exceeded its subsequent target of a further 5% reduction between 2002 and 2007.

On 18 June 2007, BHP Billiton announced new global targets of a 13% improvement in energy intensity and a 6% improvement in greenhouse gas intensity to be achieved by the year 2012 from a base year of 2006. Intensity is measured as total energy consumed, or greenhouse gases emitted, divided by total tonnes of production. Our targets were developed based on production forecasts and plans for greenhouse gas reduction projects from individual facilities and businesses. The individual forecasts were combined to achieve a weighted corporate target. Stretch reductions beyond the business forecasts were incorporated in the targets.

BMA's role in achieving the broader BHP Billition targets is outlined in Appendix R.

11.7 Climate Change Risk Impacts

Recent reports (CSIRO and Bureau of Meteorology 2007) suggest that the mine area is likely to be subject to climate change during the life span of the mine (30 years). Climate change therefore has the potential to affect operations at the mine. This section provides an assessment of the risk of climate change impacting the activities of the mine.

11.7.1 Summary of Predicted Impacts

The following tables summarise the likely effects of climate change in the vicinity of the project, in terms of temperature change, rainfall change, relative humidity, sea surface temperature, wind speed and potential evapotranspiration. The data is sourced from Climate Change in Australia technical report (CSIRO and Bureau of Meteorology 2007) and Climate Change in Queensland technical report. Projections are relative to the period 1980 – 1999 (referred to as the 1990 baseline for convenience). To provide the most accurate result possible, the best estimate results (50^{th} percentile) and the medium emissions scenario from the IPCC Special Report on Emissions Scenarios were used, as documented in Climate Change in Australia.

Table 11.5 The projected impacts of Climate Change in Queensland in 2030 and 2050

	Temperature Change (ºC)		Rainfall Change (%)		Change in Relative Humidity (%)	
	2030	2050	2030	2050	2030	2050
Annual	+1 to +1.5	+1.5 to +2	-2 to -5	-5 to -10	0.5 to -0.5	-0.5 to -1
Summer	+1 to +1.5	+1.5 to +2	2 to -2	-2 to -5	0.5 to -0.5	0.5 to -0.5
Autumn	+1 to +1.5	+1.5 to +2	-2 to -5	-5 to -10	0.5 to -0.5	0.5 to -0.5
Winter	+0.6 to +1	+1.5 to +2	-5 to -10	-5 to -10	0.5 to -0.5	-0.5 to -1
Spring	+1 to +1.5	+1.5 to +2	-5 to -10	-10 to -20	-0.5 to -1	-0.5 to -1
	Wind Speed Change (%)		**Change in Potential Evapotranspiration (%)**		**Sea Surface Temperature Change (ºC)**	
Annual	+2 to +5	+2 to +5	+2 to +4	+4 to +8	+0.6 to +1	+1 to +1.5
Summer	+2 to +5	+2 to +5	+2 to +4	+4 to +8		
Autumn	2 to -2	2 to -2	+2 to +4	+4 to +8		
Winter	2 to -2	2 to -2	+4 to +8	+4 to +8		
Spring	+5 to +10	+5 to +10	+2 to +4	+4 to +8		

It can be seen that by 2030 the average annual temperature is expected to increase by between 1ºC and 1.5 ºC. There is likely to be a corresponding decrease in rainfall of between 2% and 5% and wind speed is expected to increase by between 2% and 5%.

The changes in temperature are expected to be less pronounced in winter. Changes in rainfall are expected to be more pronounced in winter and spring with a reduction expected in the range of 5% to 10%. It is noted that a reduction in rainfall can sometimes lead to a disproportionately greater reduction in water availability.

By 2050 average annual temperature is expected to increase by between 1.5ºC and 2 ºC. There is likely to be a corresponding decrease in rainfall of between 5% and 10%, relative humidity is expected to decrease by up to 1% and wind speed is expected to increase by between 2% and 5%.

The changes in temperature are expected to be experienced equally throughout the year. Changes in rainfall are expected to be more pronounced in spring with a reduction of to 20%. Wind speed increases are expected to be more pronounced in spring and summer with summer wind speeds expected to increase by up to 10%.

In summary, during the operating life of the mine it is expected that the local conditions will become hotter, drier and windier. Changes in rainfall and wind speed are expected to be more pronounced in the spring.

The Climate Change in Queensland report notes that a significant proportion of Queensland's agricultural, industrial and mining activity is located in central Queensland and these industries are highly dependant on water resources.

11.7.2 Risk Assessment

11.7.2.1 Methodology

The following semi-quantitative risk assessment procedure was used to evaluate the risks as a result of the various potential climate change impacts on mining operations. This approach is consistent with the Australian Standard for Risk Management AS/NZS 4360. The key steps in undertaking the risk assessment involved:

- Identification of the potential climatic impacts on mining operation
- Analysis of the risks in terms of consequence and likelihood
- Evaluate risks, including risk ranking to identify priorities for their management

To assist in the process of assigning levels of consequence and likelihood, the following measures were used.

Table 11.6 Measures of Likelihood

Level	Descriptor	Description
1	Rare	Occurs only in exceptional circumstances
2	Unlikely	Could occur but not expected
3	Possible	Could occur
4	Likely	Will probably occur in most circumstances
5	Almost Certain	Is expected to occur in most circumstances

Table 11.7 Measures of Consequence

Level	Descriptor	Environmental Impact	Mine Site Functionality	Financial (per event/per year)
1	Insignificant	Environmental consequence weeks	No loss of use	<$50,000
2	Minor	Environmental consequence <12 months	Short terms loss of use (all/part) <1 week	$50,000 to $500,000
3	Moderate	Environmental consequence 1-2 years	Loss of use (all/part) 1 wk to 1 month	$500,000 to $1 million
4	Major	Environmental consequence 2-5 years	Loss of use (all/part) 1 month to 1 year	$1 million to $10 million
5	Catastrophic	Environmental consequence >5 years	Loss of use (all/part) > 1 year	<$10 million

The following risk assessment matrix was used to determine the level of risk based on likelihood and consequence scores. Scenarios with a combined score of 10 or greater are considered to pose a high level of risk. Scenarios with a combined score of between five and eight are considered to pose a medium level of risk. Scenarios with a combined score of less than five are considered to pose a low level of risk.

Table 11.8 Risk Matrix

Likelihood	Consequence				
	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
5 (Almost Certain)	5	10	15	20	25
4 (Likely)	4	8	12	16	20
3 (Moderate)	3	6	9	12	15
2(Unlikely)	2	4	6	8	10
1 (Rare)	1	2	3	4	5

11.7.3 Results

The results of the risk assessment are presented in Table 11.9 below.

Table 11.9 Risk Assessment of the potential impacts of climate change on mine operations

Risk Scenario	Likelihood	Severity	Risk
Reduced process water availability due to decreased rainfall and increased evapotranspiration.	Likely 4	Moderate 3	High 12
Decrease in soil moisture, increased winds and reduced availability of water which increases generation of dust and reduces ability to manage dust.	Likely 4	Moderate 3	High 12
Increased flood risk due to increased rainfall intensity (including pit area).	Moderate 3	Major 4	High 12
Health impacts on mine site staff from increased temperatures (e.g., heat stress).	Moderate 3	Moderate 3	Medium 9
Increased soil erosion due to decrease in soil moisture and increased rainfall intensity (including access tracks).	Moderate 3	Moderate 3	Medium 9
Unsuccessful rehabilitation planting due to reduced rainfall and more severe storm events.	Moderate 3	Moderate 3	Medium 9
Increased slope failure due to decreased soil moisture and increased rainfall intensity.	Unlikely 2	Major 4	Medium 8
Increased maintenance costs for infrastructure due to more severe storm events.	Moderate 3	Minor 2	Medium 6
Failure/overtopping of tailings dams due to increased rainfall and storm severity.	Rare 1	Catastrophic 5	Medium 5
Decrease in efficiency of equipment due to increased temperature resulting in increased operation costs	Unlikely 2	Minor 2	Low 4
Increased maintenance costs for infrastructure due to more severe bushfire events due to increased temperatures and evapotranspiration potential.	Unlikely 2	Minor 2	Low 4
Restrictions on blasting events due to increased number of windy days	Unlikely 2	Minor 2	Low 4
Community/workforce isolation due to higher risks of flooding events.	Rare 1	Minor 2	Low 2

11.7.4 Risk Management Measures

Management measures for the risk scenarios in Table 11.9 that were assessed to be a high or medium risk have been identified in Table 11.10.

Table 11.10 Risk management measures for potential impacts of climate change on mine operations

Risk Scenario	Mitigation Measures	Cross-reference within the EIS
High Risk		
Reduced process water availability due to decreased rainfall and increased evapotranspiration.	A water supply strategy will be developed, implemented and maintained.	Section 6.2.1.6
Decrease in soil moisture, increased winds and reduced availability of water which increases generation of dust and reduces ability to manage dust.	Dust control measures: Engineering controls (i.e. enclosure of conveyors) Control measures (i.e. watering of haul roads and stockpiles	Section 10.2.6
Increased flood risk due to increased rainfall intensity (including pit area).	Avoid major construction during the wet season (November to February) Stormwater management measures (requirement of the earthworks contractor) such as drainage diversions and bunding will be implemented before works occur Emergency response procedures and flood forecasting will be incorporated into operating procedures	Section 6.2.1.5
Medium Risk		
Health impacts on mine site staff from increased temperatures (e.g., heat stress).	Implement a Health and Safety Management System	Section 19.7
Increased soil erosion due to decrease in soil moisture and increased rainfall intensity (including access tracks).	Implement soil erosion controls including: Construct contour furrows or contour banks at intervals down slopes Contour ripping across the grade Graded banks	Section 4.4.9.3
Unsuccessful rehabilitation planting due to reduced rainfall and more severe storm events.	Measures to increase the success rate of rehabilitation planting including: Suitable species of vegetation are planted and established to achieve the relevant grassland and bushland post-mine land uses Potential for erosion is minimised, including likelihood of environmental impacts being caused by the release of dust The quality of surface water and seepage released from the site is such that releases of contaminants are not likely to cause environmental harm The water quality of any residual water bodies meets criteria for subsequent uses and does not have the potential to cause environmental harm The final landform is stable and not subject to slumping or erosion which will result in the agreed post-mining	Section 4.8.5

Risk Scenario	Mitigation Measures	Cross-reference within the EIS
	landform being maintained	
Increased slope failure due to decreased soil moisture and increased rainfall intensity.	Integrate slope angles, lengths and shapes compatible with the proposed land use with a drainage pattern capable of conveying runoff from newly created catchments. Final slope gradient should not exceed 17%, or approximately 10°	Section 4.4.9.3
Increased maintenance costs for infrastructure due to more severe storm events.	Implement an Emergency Response Plan.	Section 19.10
Failure/overtopping of tailings dams due to increased rainfall and storm severity.	Flood protection will be provided via the haul road running adjacent to the proposed diversion of Horse Creek and the flood protection levees that will be constructed around the perimeter of Hey and Horse Pits, excluding the stockpile areas that act as a form of flood protection bund, to prevent pit inundation.	6.2.4.3