14 GREENHOUSE GASES AND CLIMATE CHANGE

14.1 INTRODUCTION

This chapter presents an inventory of projected future annual emissions for each greenhouse gas (GHG) and the total emissions expressed as carbon equivalents for both the construction and the operational phase of the Project over the life of the mine. To provide context, the Project's GHG emissions are presented as a percentage of Queensland's and Australia's annual greenhouse gas emissions. A detailed GHG and Climate Change technical report and inventory are presented in TR 14-1-V1.5 Wandoan Coal Project Greenhouse Gas Assessment.

Both the chapter and technical report were developed by URS on behalf of the WJV.

A separate inventory of GHG emissions from the proposed Glebe Weir raising and pipeline raw water supply option is provided in Volume 4, Chapter 4 of this EIS, and is summarised in this assessment. The GHG impacts of the other raw water supply options (Volumes 2 and 3) are expected to be significantly less than the GHG impacts of the Glebe Option.

14.2 GREENHOUSE GAS POLICY BACKGROUND

14.2.1 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. While the UNFCCC is predominantly a consensus body the Protocol sets binding targets for reduction of greenhouse gas emissions against 1990 levels for industrialised countries and the European Community over a five year period from 2008-2012. Australia has committed to a Kyoto Protocol target of 108% of 1990 emissions by 2008-2012.

The UNFCCC will meet in Copenhagen in 2009 and attempt to develop a post Kyoto (2012) international framework agreement on climate change.

14.2.2 AUSTRALIA'S CLIMATE CHANGE POLICY

The Australian policy on climate change was released in July 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.

In developing a broader climate change strategy the Government has also drawn on the findings of the Garnaut Review (2008, www.garnautreview.org.au), which considered the potential impacts that climate change will have on Australia's environment and economy. The review also makes recommendations on preferred emission reduction trajectory for Australia.

Carbon Pollution Reduction Scheme (CPRS)

In July 2008, the Australian Government released its Green Paper on the Carbon Pollution Reduction Scheme following the draft Garnaut review, which considered the potential impacts that climate change will have on Australia's environment and economy. The following summary of the proposed Carbon Pollution Reduction Scheme is based on the content of the Green Paper.

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. Liable entities will be required to obtain carbon pollution permits to acquit their GHG emission obligations under the CPRS. The CPRS is proposed to commence in July 2010.

The Green Paper proposes that key features of the CPRS will include:

- the CPRS will cover stationary energy, transport, fugitive emissions, industrial processes, waste and forestry sectors, and all six greenhouse gases counted under the Kyoto Protocol from the time the scheme begins
- a long-term emissions abatement goal of 60% by 2050 (against 2000 levels) will be set
- significant emitters (more than 25,000 tonnes CO_2 equivalent (or CO_2-e)/pa) of greenhouse gases need to acquire a 'carbon pollution permit' for every tonne of greenhouse gas they emit
- at the end of each year, each liable firm would need to surrender a 'carbon pollution permit' for every tonne of CO_2-e emissions produced in that year
- as the cap of total allowable GHG emissions is decreased, liable entities will compete to purchase the number of 'carbon pollution permits' that they require
- assistance may be provided to emissions intensive trade exposed facilities/companies and some power generators.

It should be noted that the details of the CPRS have not been finalised, and are subject to the outcome of the current public submission process.

The final scheme design will be released within the White Paper in December 2008.

National Greenhouse and Energy Reporting Act 2007 (NGER)

The NGER Act establishes a national framework for Australian corporations to report Scope 1 and Scope 2 (see section 3.3 of the Technical Report) 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 100 terajoules or more of energy or
- their corporate group emits 125 kilotonnes or more greenhouse gas (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.

Corporations must register by 31 August, and report by 31 October, following the financial year in which they meet a threshold. Subject to final legal advice, it is anticipated that Xstrata Coal will report under the NGER Act on behalf of the WJV.

Energy Efficiency Opportunities (EEO)

The Energy Efficiency Opportunities legislation came into effect in July 2006, and requires large energy users (over 0.5PJ of energy consumption per year) 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.

As a large energy user, Xstrata Coal is a mandatory participant in EEO. Consequently, the minimum requirements of the scheme need to be met at the Wandoan Coal Project by looking at the many factors of 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.

Greenhouse Challenge Plus

Xstrata Coal is a member of the voluntary Greenhouse Challenge Plus program, which is a Commonwealth initiative encouraging participants to report annually their greenhouse gas emissions and make progress towards quantified greenhouse abatement measures.

Wilkins Review

In February 2008, the Rudd Government announced a strategic review of climate change programs in view of the proposed introduction of an Australian emissions trading scheme.

One of the aims of the review is to develop principles of complementarity and assess whether programs are efficient, effective, appropriate and complementary to an emissions trading scheme.

This is an important Review in the context of reducing/streamlining the existing plethora of state and federal reporting and regulatory requirements on business especially in relation to greenhouse and energy reporting. The Review submitted its report to Government in July this year to date the Report has not been made public and there has been no public government response to the Review findings.

14.2.3 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.

ClimateSmart 2050

Climate Smart 2050 is the Queensland Climate Change Strategy. 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. Its initiatives include:

- the introduction of a Smart Energy Savings Program, which target large energy users and require 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.

14.3 INVENTORY METHODOLOGY

14.3.1 ACCOUNTING AND REPORTING PRINCIPLES

The greenhouse gas inventory for the Wandoan Coal Project is based on the accounting and reporting principles detailed within the Greenhouse Gas Protocol. 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.

14.3.2 INVENTORY OPERATIONAL BOUNDARIES

The Department of Infrastructure and Planning's Terms of Reference specify 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.
- Scope 2: Electricity indirect greenhouse gas emissions. This accounts for greenhouse gas emissions from the generation of purchased electricity consumed by the company.
- 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 purchased fuels; and use of sold products and services.

14.3.3 INVENTORY ORGANISATIONAL BOUNDARIES

The organisational boundary of the Project Inventory includes the mine and related infrastructure detailed below in section 14.4.

At this stage, the GHG inventory considered in this EIS excludes the following activities, on the basis that accurate data on fuel usage was not available at the time the Greenhouse Gas Assessment was prepared, or that the GHG emissions from those activities were considered to be immaterial (see definition of materiality in 14.3.4 below):

- diesel used for earthworks in the two year construction period (data not available at the time the GHG report was prepared)
- construction or operation of the proposed airstrip (data not available at the time the GHG report was prepared)
- development of a possible landfill (data not available at the time the GHG report was prepared)
- consumption of unleaded fuel or LPG in site vehicles. It is noted that most site vehicles run on diesel fuel, which is included in the inventory. Only small vehicles such as cars belonging to the site personnel will consume unleaded fuel and these are typically immaterial
- employee travel (either air or bus) to the Project area is excluded on materiality grounds. However it is noted that based on data provided in the EIS Traffic Impact Assessment (Volume 1, Chapter 12 of the EIS) and Project Justification (Volume 1, Chapter 2 of the EIS):
    - employee travel during the construction phase will contribute a total of approximately 166 tonnes CO2-e.
    - total GHG emissions relating to employee travel during the operational phase of the mine (30 years) are estimated at 1,015 tonnes CO2-e based on employee transport to and from the mine being ground based, by bus. This would increase to 7,227 tonnes CO2-e if employees travelling to/from Brisbane use air transport to a proposed new air strip at Wandoan. This figure is based on a Dash 8 – 400 aircraft and does not include stops at the Gold Coast or Sunshine Coast, which would slightly increase fuel consumption and therefore GHG emissions caused by an increase in the number of landing and take-off cycles.
- emissions arising from land use, land use change and forestry such as rehabilitation and clearing of the mine site, or the western or southern CSM raw water supply options are excluded on materiality grounds. However it is noted that:
    - according to the Terrestrial Ecology Impact Assessment in Volume 1 of the EIS, the development of the mine will involve clearing 673 ha of remnant vegetation and 502 ha of non-remnant vegetation, which comprises low density grazing and cropping. Based on this and using the most conservative scenario, which assumes the non-remnant vegetation is 50 years old regrowth, the total loss associated with clearing for the mine is calculated to be 182,693 tonnes CO2-e. This is equal to 1.6% of the scope 1 emissions for the calculated life of mine when comparing against the lowest emissions scenario using 100 per cent site power production from a gas fired based power station
    - a preliminary, and conservative assessment for vegetation clearing for the southern and western CSM pipeline options indicates total GHG emissions of:
        - Southern pipeline – 9,534.36 t CO2-e (remnant – 150 years); 4,045.80 t CO2-e (non-remnant – 50 years)
        - Western pipeline – 1,674.49 t CO2-e (remnant – 150 years).

14.3.4 CALCULATION APPROACH

The greenhouse gas emission inventory for the Wandoan Coal Project is based on the methodology detailed in the Greenhouse Gas Protocol (the Protocol), and the relevant emission factors in the National Greenhouse Accounts (NGA) Factors from the Commonwealth Department of Climate Change (2008), the *Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005 — Energy (Fugitive Emissions)* from the Australian Greenhouse Office (2006) and the relevant IPCC Good Practice Guidance.

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 using methodology detailed in the NGA Factors.

There are several greenhouse gases including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) that are relevant to the Project. In order to simplify inventory accounting, a unit called carbon dioxide equivalents (CO2-e) is used. This accounts for the various greenhouse warming potentials of non-CO2 gases. The greenhouse warming potential is a measure of the amount of infrared radiation captured by a gas in comparison to an equivalent mass of CO2, over a fixed lifetime. GHG inventories in this report are expressed as mass of CO2-e released, following this convention.

Activity data sources

Data from the following sources have been utilised in the formation of the inventory:

- activity data used to assess most scope 1 emissions was provided in the Wandoan Joint Venture spreadsheet WNDLP3_07 Wandoan Schedule 30Mtpa Base Case V2 and broken down by the 2 year construction period and each of the 30 years of the life of the mine, starting at 2012 (Year 1) to 2041 (Year 30)
- activity data for the three power supply options was provided in the document “PB Site maximum demand table”
- additional activity data used as a base for calculating scope 3 emissions originates from a number of sources, described in Section 3.4.1 of the GHG Assessment Technical Report.

Emissions factors

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 have been sourced from the Department of Climate Change NGA Factors Workbook, 2008.

Materiality

Emissions that are found within the organisational boundary of the Project are included in the inventory unless they are excluded on materiality grounds or data was otherwise unavailable at the time of preparing the GHG assessment. Emissions are generally immaterial if they are likely to account for less than 5% of the overall emissions profile (Scope 1 and 2). The exception to this are emissions relating to explosives, which although account for a maximum of only 3% of GHG emissions in any one year, were calculated from accurate explosive use data within the Wandoan Joint Venture spreadsheet

WNDLP3_07. Emissions not included in the inventory on the basis of materiality are listed in section 14.3.2 above.

Aggregation

Aggregation refers to the combining of several inventories, typically of different sites or operations, into an overall inventory. This chapter is specific to the Wandoan Coal Project and does not contain an aggregated inventory of other projects.

14.4 SCOPE 1 AND SCOPE 2 EMISSIONS

The GHG emissions for the Project have been estimated for a two year construction phase plus a 30 year operations phase.

The GHG inventory considered in this EIS includes the following operations within the Project's organisational boundaries:

- Scope 1 and 2 emissions from construction and operation of the mine and related infrastructure, being:
  - construction power requirements from onsite diesel generators during the construction phase (including construction and operation of accommodation facilities, dragline construction, construction of mine infrastructure area, water supply, waste management, construction of crushing plant, wash plant, conveyors and dump station, stackers and reclaimers)
  - fugitive emissions from coal seam gas from open cut mining of coal
  - fuel consumption in vehicles
  - use of explosives
  - power supply options for the operation of the mine
  - electricity consumption (including operations and accommodation facilities).

As noted above in section 14.1, construction and operation of the Glebe Weir raising and pipeline water supply option is separately reported (for completeness) in section 14.4.5 (based on Volume 4 of the EIS). Other water supply pipeline options are expected to be significantly less in GHG impacts than the Glebe Option and therefore have not been separately assessed.

14.4.1 FUGITIVE EMISSIONS

Fugitive emissions from coal mines relate to Coal Seam Gas (CSG), the majority of which is methane with the remainder being CO_2. The most uncertain component of an open cut mine's GHG inventory is the emissions arising from CSG released during mining operations. Default fugitive CSG factors quote a single emission rate for all Queensland open cut coal mines. Since CSG can contribute up to approximately 50% of total greenhouse gas emissions from a mine, it is important that the emission factor be robust and based on in-situ testing of coal seam methane content.

The Project drilled a number of boreholes in the MLA areas and employed GeoGas Pty Ltd to carry out analysis on 86 gas content tests on the coal intervals intersected in six surface drilled and cored boreholes. The sampling covered depth ranges between 15 to 90 m below ground level (bgl) and took place between 22 October 2007 and 17 November 2007.

The concentration of CH_4 in the coal seams at Wandoan was provided in a GeoGas report dated May 2008. GeoGas found that the gas content is relatively static with depth to approximately 50 m below ground level and then appears to increase. According to GeoGAS:

- the total gas content between 15 m to 45 m below ground level is 0.1 m^3/tonne with a standard deviation of 0.072 m^3/tonne, and
- the total gas content (m^3/tonne) deeper than 45 m is equal to (depth × 0.00488) - 0.12577, with a standard deviation of 0.08 m^3/tonne.

The above equations state total gas content. The GeoGAS report suggests that:

- between the surface and 40 m depth, 20% of the gas in coal is CH_4, 15% is nitrogen (N_2) and 65% is CO_2.
- between 40 and 90m depth, 90% of the gas is CH_4 and 10% CO_2.

URS has assumed that 100% of the gas content released from the coal is methane. This is conservative particularly for coal mined at less than 45 m depth, but accounts for uncertainties in the sampling and analysis.

The above concentrations are significantly lower than the standard concentrations assumed by published guidance, which are between 0.3 m^3/tonne ROM and 2 m^3/tonne ROM. Using the Ideal Gas Law, these concentrations equate to approximately 1.4 CO_2-e kg/tonne ROM gas content which is over ten times lower than the standard concentration from published guidance of 17.1 CO_2-e kg/tonne ROM. The methodology for the calculation of fugitive emissions assumes that no methane will migrate from un-worked coal seams.

Using site and seam specific gas concentration data as defined in the GeoGas report, the greenhouse gas emissions from fugitive emissions for each year of the life of the mine vary from 13,975 to 44,705 tCO_2-e per year, with a mean average of 40,290 tCO_2-e per year. Fugitive emissions from coal mining are estimated to contribute between 8% and 14% of the total scope 1 GHG emissions for any one year. This variability is due to increases in CSG emissions as a proportion of the Project's total emissions as deeper coal is extracted.

Using the published emissions factors based solely on the annual volume of run of mine coal fugitive emissions would be estimated at an average of 482,000 tCO_2-e per year. This indicates the value of conducting site-specific testing of coal seam content for open cut coal mines.

A specialist company (MBA Petroleum Consultants) has been commissioned to provide an opinion on the original GeoGas work and their report is attached as an appendix in this EIS. They note that despite the small sample density, the measurements of in-situ gas content show consistent trends on both total gas content and methane content.

Spontaneous combustion of coal

Some articles have suggested that oxidation of coal and carbonaceous wastes, such as uneconomic thin seams disposed of in overburden stockpiles, may be a source of GHG emissions. This is a result of spontaneous combustion of stockpiles, which is a known GHG source. This source has not been considered in the Project inventory because:

- there is no viable accepted methodology, at either an international or Australian level, for estimating GHG emissions from spontaneous combustion

- there is extremely large degree of variability between mines that suffer spontaneous combustion and those that do not
- the Project will implement management techniques according to ACARP guidelines to further minimise the occurrence of spontaneous combustion
- based on coal stockpile assessments conducted to date, the Wandoan coal is unlikely to be at risk of spontaneous combustion if appropriate management procedures are adopted.

14.4.2 DIESEL COMBUSTION BY VEHICLES

Diesel is consumed by vehicles and stationary energy sources (for example, generators) at mine sites. The projected consumption of diesel for each major equipment and ancillary equipment, including excavators, loaders, dozers, dump trucks, drills, graders and water trucks for each year of the life of the mine up to Year 27 was provided in the WNDLP3_07 Wandoan Schedule 30Mtpa Base Case V2. Diesel consumption in years 28 to 30 inclusive have been assumed to be equivalent to those of Year 27.

The GHG emissions associated with diesel consumption for each year of operation vary from 65,410 to 136,070 tCO_2-e per year, with an average of 111,195 tCO_2-e annually.

14.4.3 EXPLOSIVES

Explosives are used by coal mines to loosen overburden material and to break apart the coal seam for ease of loading. Greenhouse gas emissions are generated from the use of explosives at the site due to release of nitrous oxide and fuel oil combustion. The two types of explosives used on site are ammonium nitrate-fuel oil (ANFO) mixture and emulsion based explosives.

The Project will use of both ANFO and emulsion explosives. The projected use of explosives for each year of the life of the mine up to Year 30 (2040) was provided in document WNDLP3_07 referred to above in section 14.3.4.

The greenhouse gas emissions from explosives for each year of the life of the mine vary from 2,340 to 10,000 tCO_2-e per year, with a mean average of 7,440 tCO_2 per year. The contribution of explosive use to Scope 1 and 2 GHG emissions is very small and accounts for a maximum of 3% of the GHG emissions for any one year. Although the GHG emission contribution from explosives is small and under the 5 percent materiality threshold, they have been included within the inventory as explosive use has been calculated and included in the Wandoan Joint Venture spreadsheet WNDLP307 Wandoan Schedule 30Mtpa Base Case V2.

14.4.4 POWER GENERATION OR CONSUMPTION

Open cut mines consume significant amounts of electricity to power draglines, conveyers, pumps, compressors, motors, haul-road lights and offices. There are three options relevant to GHG assessment for power consumption for the Project.

- Option 1 is 100% on-site generation via twelve dual-fuel diesel and gas engine units, each having 8 MW of electrical output. Ten engine units will operate at any one time with two units remaining on stand-by. This is classed as a scope 1 emission.

- Option 2 is partial on-site generation via six dual-fuel diesel and gas engine units, each having 8 MW of electrical output. Four engine units will operate at any one time with two units remaining on stand-by. The balance of the power demand will be supplied via a grid connection. This combination results in both scope 1 and scope 2 emissions.
- Option 3 is 100% grid-purchased electricity, which is classed as a scope 2 emission.

Energy consumption is expressed as an aggregate for the entire site operations by year.

Table 14-1 below provides a comparison of GHG emissions the three power options for the Project based on operational power consumption by year and throughout the life of the mine. This includes emissions associated with on-site diesel generators during construction.

Table 14-1: Comparison of the three power consumption options

Power option	Emission scope	Annual minimum GHG emissions (tCO_2-e/yr)	Annual maximum GHG emissions (tCO_2-e/yr)	Annual average GHG emissions (tCO_2-e/yr)	Life of mine GHG emissions (tCO_2-e)
Option 1 (100% on-site generation).	Scope 1	94,736	250,346	225,674	6,770,213
Option 2 (Partial on-site generation, balance grid purchased).	Scope 1	36,694	100,138	90,270	2,708,085
	Scope 2	(export*)	309,021	270,685	8,186,474
Option 3 (100% grid-purchased electricity).	Scope 2	175,165	478,022	430,913	12,927,377

* Export of energy generated onsite to the power grid

The table above shows that 100% on site generation is the least GHG intensive power option, given the high reliance on gas. Increasing the proportion of grid electricity increases the GHG intensity of the power option, demonstrating the high reliance on coal-fired generation of the Queensland electricity grid.

14.4.5 GLEBE WEIR RAISING AND PIPELINE

Volume 4 of the EIS calculates emissions from the construction and operation of the Glebe Weir raising and pipeline. This section summarises the key findings.

Construction

Emissions from construction of the raised weir and pipeline consist of diesel for construction vehicles and from land use change.

As raising the weir will lead to permanent inundation of vegetation, which decomposes to release methane. Other chapters in this EIS estimate that approximately 129,778 t CO_2-e may be released over the lifetime of the weir through inundation of vegetation, clearing and release of carbon from soil.

It is not possible to accurately estimate the number of years over which this emission occurs. If we assume that this is released linearly over the operational period of the mine, it equates to approximately 4,300 tonnes of CO_2 per year.

During the two year construction period:

- Scope 1 emissions are estimated at 12,012 tonnes CO_2-e
- Scope 2 emissions are estimated at 81 tonnes CO_2-e
- Scope 3 emissions are estimated at 16,295 tonnes CO_2-e.

Operation

Operational emissions result from the use of electricity for pumps. Annual operational emissions are expected to be 569 tonnes CO_2-e per year, based on calculations shown in Chapter 10, Volume 4 of the EIS.

14.4.6 SUMMARY OF SCOPE 1 AND SCOPE 2 EMISSIONS

Annual greenhouse gas emissions

Table 14-2 summarises the Project's annual average Scope 1 and Scope 2 GHG emissions and the range of contribution to GHG emissions for each activity for each of the power production or consumption scenarios.

For the 100% on-site power generation option, gas consumption is the biggest individual GHG source, accounting for approximately 58%, on average, of the total emissions inventory. This decreases to approximately 17% of total emissions for partial on-site generation. Purchased electricity accounts for 52% of total GHG emissions for partial on-site generation, and approximately 73% of GHG emissions when all power is purchased from the grid.

Table 14-2: Annual Scope 1 and 2 greenhouse gas emissions

Scope	Mine activity	Average Greenhouse Emissions for mine activities (t CO_2-e)		
		100% on-site generation	Partial on-site generation	100% grid-purchased electricity
1	Fugitive emissions	40,291 (10%)	40,291 (8%)	40,291 (7%)
1	Diesel consumption – trucks	111,195 (29%)	111,195 (21%)	111,195 (19%)
1	Total explosives	7,440 (2%)	7,440 (1.4%)	7,440 (1.3%)
1	Diesel consumption – power	1,711 (0.4%)	684 (0.1%)	0
1	Gas consumption – power	225,674 (58%)	90,270 (17%)	0
2	Purchased electricity	0	270,685 (52%)	430,913 (73%)
	Total average annual GHG Emissions	386,310	520,565	589,838

The total average annual Scope 1 and 2 emissions can be compared to the emissions associated with a modern and comparatively efficient 750MW coal fired power station in Queensland emitting 6.0Mt CO2-e per year. The tonnes CO2-e associated with the scope 1 and scope 2 emissions from mine activities would be between 6.32% and 9.72% of that emitted by the power station depending on the power supply option.

The Wandoan Joint Venture will be obliged to report under the NGER Act given that emissions for the Project's Scope 1 and 2 emissions will exceed the 25 kilotonne threshold from the first year of operation.

Life of Mine Greenhouse Gas Emissions

Table 14-3 shows the total Scope 1 and Scope 2 emissions over the life of the mine of the two year construction period and 30 year operations period based on existing technology. Over the life of the mine total GHG emissions are estimated to be 11.6 Mt CO_2-e if power is generated by an on-site power station. This would rise by 6.1 Mt CO_2-e to 17.7 Mt CO_2-e if the mine were powered by electricity purchased from the Queensland grid.

Table 14-3: Life of Mine Scope 1 and Scope 2 Greenhouse Gas Emissions

Scope	Mine activity	Life of Mine Greenhouse Emissions for mine activities (t CO2-e)		
		100% on-site generation	Partial on-site generation	100% grid-purchased electricity
1	Fugitive emissions	1,208,728	1,208,728	1,208,728
1	Diesel consumption – trucks	3,335,844	3,335,844	3,335,844
1	Total explosives	223,192	223,192	223,192
1	Diesel consumption – power	102,290	71,497	50,969
1	Gas consumption – power	6,770,213	2,708,085	0
2	Purchased electricity	0	8,186,474	12,927,377
	Total GHG emissions	11,640,266	15,733,880	17,746,110

The GHG emissions presented are based on current knowledge about the mine operations and GHG emissions from diesel and electricity generation, and may in fact change over the life of the mine due to technology improvements and policy changes.

Should Energy Usage Option 3 be determined to be the preferred option for the Project, emissions from the Project's purchased electricity will change as the generation mix in the National Electricity Market changes with the introduction of new generation capacity utilising various fuels, the available supply of renewable electricity in the National Energy Market and the amount of inter-state electricity trading. In addition, the CPRS may influence the overall Australian GHG inventory by capping emissions and making carbon emissions a tradable commodity, which will influence the overall composition of the generation grid and therefore, the Projects scope 2 emissions.

14.5 INVENTORY UNCERTAINTY ANALYSIS

14.5.1 UNCERTAINTY ANALYSIS BACKGROUND

A measure of the uncertainty within the inventory is a standard part of a GHG inventory as indicated by the GHG Protocol. Uncertainties associated with the GHG inventory are either related to scientific uncertainty or estimation uncertainty. Analysing and quantifying scientific uncertainty is extremely problematic as it often involves for example estimating uncertainty in the global warming potential values and as a consequence, an estimate of scientific uncertainty is beyond the capacity of this inventory. Estimation uncertainty can be classified further into two types: model uncertainty and parameter uncertainty. Model uncertainty refers to the uncertainty associated with mathematical equations. This is also beyond the scope of the Project Inventory.

Parameter uncertainties within this inventory can be divided into two parts: uncertainty relating to activity data and uncertainty relating to emission factors. Activity uncertainties relate to measured quantities, such as production, consumption, monitored data etc.

Emission factor uncertainty considers the conversion from measured activities to GHG emissions.

The method used to calculate uncertainty is based on the IPCC guidelines, namely the Error Propagation Function analysis. The activity and emission factor uncertainties are defined using qualitative techniques, and then values are assigned to each source on the following basis:

- low uncertainty: 0 – 5%
- medium uncertainty: 6 – 20%
- high uncertainty: >21%.

The Error Propagation Function analysis is then used to determine the level of uncertainty of each source contributes to the overall uncertainty of the inventory, weighted by the percent of contribution of each source towards the total inventory.

14.5.2 INVENTORY UNCERTAINTY ANALYSIS

Table 14-5 shows the results of the uncertainty analysis used to define the uncertainty within annual GHG emissions. Production Year 24 for the partial on-site generation option was selected as the base year, as this includes a combination of on-site and grid-purchased electricity, and is the year with the highest Scope 1 and 2 GHG emissions for this power scenario.

Table 14-4: Scope 1 and 2 Emissions uncertainty for the Project year 24, partial on-site generation

Scope	Source of emissions	Contribution to emissions (%)	Activity uncertainty (±%)	Emission factor uncertainty (±%)	Contribution to overall uncertainty (±%)	Absolute uncertainty tCO_2-e
1	Fugitive emissions	7%	15%	40%	3%	18,239
1	Diesel consumption – trucks	21%	15%	10%	4%	22,628
1	Total explosives	2%	10%	20%	0%	2,063
1	Diesel consumption – power	0%	15%	10%	0%	137
1	Gas consumption – power	17%	10%	10%	2%	14,162
2	Purchased electricity	53%	10%	10%	7%	43,702
	Total				17%	100,930

Given that operations at the mine have not commenced, uncertainties for all activity levels have been estimated by URS on the basis of past experience and are considered to have a low or medium activity uncertainty.

With the exception of fugitive emissions, all emissions factors have been sourced from the National Greenhouse Accounts factors workbook, which are nationally derived emission factors. Therefore, the uncertainty associated with emissions factors is considered to be low. The emission factor for fugitive emissions is considered to be high due to the high standard deviation for the gas content stated in the GeoGAS report. It is important to note that while coal seam gas uncertainty is high, there is conclusive evidence that the overall amount of coal seam gas in the Juandah Coal Measures (Kogan, Macalister Upper & Lower, and Wambo coal seams) is low and significantly lower than default emission factors would suggest.

The analysis based on Year 24 of the mine's operation indicates that the overall uncertainty within the inventory is ±17%, with the majority of the uncertainty contribution due to fugitive emissions. The uncertain quantity expressed as tCO_2-e for this Year 24 of the mine's operation is estimated to be 100,930 tCO_2-e.

14.6 SCOPE 3 EMISSIONS

14.6.1 CALCULATION APPROACH

Scope 3 emissions are defined in the Greenhouse Gas Protocol as an optional reporting class that accounts GHG 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 purchased fuels, and employee business travel and commuting.

Scope 3 emissions are not routinely reported by companies because:

- emissions are difficult to estimate accurately
- the company does not have effective operational control of the emissions sources
- a company's Scope 3 emissions will be reported elsewhere by a second company as their Scope 1 emissions. As an example, emissions from coal sold to a power station for electricity generation will be reported by the power station as one of their Scope 1 emissions.

The overwhelming majority of Scope 3 emissions from the Project are due to the end use of the coal in electricity generation. Other scope 3 emissions from the Project are:

- emissions from transport of materials for the construction of the Coal Handling & Preparation Plant
- emissions from extraction and processing of diesel consumed by the Project
- emissions from the transportation of coal by rail from the mine to a port at Gladstone
- emissions from handling at a Gladstone Coal Terminal
- emissions from the transportation of coal by ship from Gladstone to end ports in Asia and South America
- emissions from handling at an overseas port
- emissions from the transportation of coal from end ports to clients' facilities
- emissions associated with waste to landfill.

Published emission factors have been used in calculating the scope 3 emissions.

Due to limitations in data availability, Scope 3 for the following sources have not been included in the inventory:

- coal handling at Wiggins Island Coal Terminal
- handling at overseas ports
- transportation of coal from end ports to clients' facilities
- waste to landfill.

14.6.2 SCOPE 3 EMISSIONS

Scope 3 emissions associated with the project are summarised in Table 14-6 below.

Table 14-5: Annual Scope 3 Greenhouse gas emissions during the operational phase of the mine.

Activity	Annual GHG emissions scope 3 (tCO_2-e/yr)			
	Minimum GHG emissions	Maximum GHG emissions	Average GHG emissions	Average contribution (%)
Transport to port by rail	18,886	71,208	63,607	0.1
Shipping	77,661	292,822	261,565	0.6
End-Use for electricity production	12,976,921	48,929,828	43,706,866	99.3

End-use

The emissions associated with the end-use of the coal in electricity production were calculated on the basis of the energy content of the coal (which has been estimated to be 5,800 GAR (kcal/kg) at 16% moisture).

Transportation

Product coal was will loaded onto trains at the site and sent by rail to a port at Gladstone. Diesel locomotives will be used to transport the coal 382km to Gladstone. Fuel consumption figures for laden and unladen trains were taken from the Surat Basin Rail EIS, which covers the derivation of these figures in detail.

It has been assumed that all product coal is exported to Asia and South America. In calculating the GHG emissions associated with shipping, the inventory assumes 80% will go to an Asian port (Yokohama, Japan) and 20% will go to a South American port (Valparaiso, Chile). Approximately 50% of the coal will be shipped via Panamax sized vessels and 50% will be shipped by Capesize vessels. The consumption of fuel oil per day of solid bulk carriers is assumed to be 33.8 tonnes of fuel oil per day for both Panamax sized vessels and Capesize vessels. This figure is taken from the 2006 IPCC guidance on calculating emissions associated with water-borne navigation. The average carrying capacity of Panamax and Capesize vessels was estimated from internet sources and is 75,000 tonnes product coal for Panamax ships and 165,000 tonnes product coal for Capesize.

A small proportion of the Project emissions, expected to be 223 tonnes CO2-e are associated with the transport of materials for the construction of the Coal Handling &

Preparation Plant. This is not considered to be material to the Project inventory and has not been included in the summary table.

14.7 LIFE OF MINE FULL FUEL CYCLE EMISSIONS

Table 14-7 summarises the Project's annual full fuel cycle GHG emissions and provides an average and range of annual GHG emissions from each source. The full fuel cycle GHG emissions have been calculated by addition of the Scope 1, 2 and 3 emissions.

Table 14-6: Full fuel cycle greenhouse gas emissions

	Annual Minimum GHG Emissions (tCO2-e)	Annual Maximum GHG Emissions (tCO2-e)	Annual Average GHG Emissions (tCO2-e)	Life of Mine GHG Emissions (tCO2-e)
100% on-site generation	20,616*	49,687,920	41,643,794	1,332,550,452
Partial on site generation	50,104*	49,800,636	41,771,718	1,336,578,092
100% grid-purchased	20,616*	49,882,434	41,834,602	1,338,656,297

* Annual minimum GHG emissions are during the construction period.

The majority of full fuel cycle emissions from the Project are associated with emissions from end-use for electricity production. The average proportion of emissions associated with end-use is approximately 99% and remains approximately constant throughout the life of the mine. Scope 1 and 2 emissions contribute between 0.9% and 1.3% over the operational life of the mine, depending on the power option.

14.8 COMPARISON WITH AUSTRALIAN AND WORLD EMISSIONS

14.8.1 AUSTRALIAN EMISSIONS

Australia's net greenhouse gas emissions across all sectors totalled 576 MtCO2-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 6.0% of national emissions.

Table 14-7 shows total annual Scope 1 and 2 emissions at different stages of the life of the mine as a percentage of Australian total and energy sector emissions taken from the National Greenhouse Gas Inventory 2006.

Table 14-7: Comparison of Australian and Project GHG emissions (scope 1 and 2)

Year of operation	Percent of Australian energy sector total	Percent of Australian total
1 (minimum GHG emissions)	0.06	0.04
24 (peak GHG emissions)	0.16	0.11
7 (approximate average GHG emissions)	0.15	0.1

14.8.2 QUEENSLAND EMISSIONS

Table 14-8 shows total annual Scope 1 and 2 emissions at different stages of the life of the mine as a percentage of Queensland total and Queensland energy sector emissions taken from the National Greenhouse Gas Inventory 2006. Queensland total emissions were 170.9 Mt CO_2-e according to the National Greenhouse Inventory 2006.

Table 14-8: Comparison of Queensland and Project GHG emissions (scope 1 and 2)

Year of operation	Percent of Queensland energy sector	Percent of Queensland total
1 (minimum GHG emissions)	0.27	0.15
24 (peak GHG emissions)	0.68	0.38
7 (approximate average GHG emissions)	0.61	0.34

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 0.68% of the Queensland energy sector at peak emissions.

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 MtCO2-e.

In the years of peak greenhouse gas emissions, Scope 1 and 2 emissions from the mine will be 0.66 MtCO_2-e. The Scope 1 and 2 emissions in peak years will be equal to 0.38% of the state inventory. Project emissions are therefore unlikely to have a significant impact on Queensland government emissions (and hence national and international) targets.

14.8.3 COMPARISON WITH WORLD EMISSIONS

According to the United Nations Framework Convention on Climate Change (UNFCCC), aggregate emissions from Annex I countries in 2005, including the contribution from land use, land use change and forestry (LULUCF) was 16,700 Mt CO_2-e. Emissions from non-Annex I countries including LULUCF was 11,931 Mt CO2-e in 1994, the most recent year for which data from non-Annex I countries is available.

Using these two figures, annual global GHG emissions can be estimated as 28,600 Mt CO2-e. The Project's maximum annual full fuel cycle emissions (including scope 1, 2 and 3) are approximately 49.9 Mt CO_2-e and they occur in year 6 of operation (based on the production schedule as provided in the Wandoan Joint Venture spreadsheet WNDLP3_07 Wandoan Schedule 30Mtpa Base Case V2). On a full-fuel cycle basis, this represents 0.17% of annual global emissions.

14.9 GREENHOUSE GAS REDUCTION MEASURES

14.9.1 CARBON POLLUTION REDUCTION SCHEME

The details of the proposed Carbon Pollution Reduction Scheme (CPRS) are explained in section 2.2.1 above. The scheme requires significant emitters, defined as those emitting more than 25,000 tCO_2-e per year as scope 1 emissions, to acquire permits for every tonne of greenhouse gas emitted. Those emitting more than 25,000 tCO_2-e per year scope 1 emissions greenhouse gases need to acquire a 'carbon pollution permit' for every tonne of greenhouse gas they emit. The Project will be affected as its total scope 1 emissions are well above the 25,000 tCO2-e threshold, and therefore will need to participate in the scheme.

Given that the total cap of allowable GHG emissions under the Scheme will decrease over time, the WJV (as with other significant emitters) will compete to purchase carbon pollution permits required for its operations, which in turn is expected to increase the price of permits. This will mean that the WJV (and other emitters) will have a financial incentive to decrease carbon emissions over time – and will face a financial penalty if emissions are not decreased. The WJV's proposed electricity efficiency measures are listed in section 14.9.2 below.

The Commonwealth Government has indicated in its Green Paper into the CPRS that approximately 30 per cent of carbon pollution permits may be freely allocated to emissions-intensive trade-exposed industries – which recognises the international competitive trade exposures of some industries. The Australian coal industry may be particularly exposed under the CPRS given that fugitive emissions from coal mining will be covered under the CPRS. The initial assistance level will depend on the emissions intensity per million dollars of revenue. Whether or not the Project falls under the category of a emissions-intensive trade-exposed industry, it will be required to participate in the CPRS.

To date the emission trajectory (or reduction task) to 2020 has not been announced by government but will be the key determining factor in the price of carbon.

14.9.2 ELECTRICAL EFFICIENCY

The Project will be a significant consumer of electricity, primarily through dragline usage and coal handling and preparation plant. Through leading industry practice mine planning and its Greenhouse Gas Reduction management plan, the WJV will maximise electrical efficiency in its operations. The following practices will be undertaken to maximise electrical efficiency:

- 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 regular 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
- An energy efficiency audit will be undertaken, where appropriate, during the detailed design phase
- Installation of energy saving devices, where practicable
- In developing the accommodation facilities, the WJV will endeavour to use leading industry practice in terms of sustainability and energy efficiency, including design maximising air flow, shading and beneficial landscaping, use of energy efficient (eg. solar) hotwater systems, water saving devices and energy efficiency lighting
- Investigating and implementing, where practicable, roof-mounted solar hot water systems and rainwater capture and beneficial reuse of grey water associated with the accommodation facilities
- The WJV is investigating renewable energy sources for components of the Project (such as the mine accommodation facilities). This may include on site solar generation
- The above measures will be incorporated into a Greenhouse Gas Reduction management plan.

In addition to the above measures, section 6.10 of Chapter 6 Project Operations describes sustainability measures to be adopted by the Project in terms of electrical and diesel efficiency. Chapter 28 also outlines the WJV's commitment to further energy power and efficiency savings including possible use of renewable energy for certain components of the Project.

14.9.3 DIESEL EFFICIENCY

Diesel consumption by on-site vehicles is a major business cost and source of greenhouse gas emissions and it is leading industry practice at open cut coal mines to minimise its use. The following activities will be undertaken to minimise diesel consumption:

- 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.

14.9.4 FUGITIVE EMISSIONS

There is little that can be done to minimise fugitive 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 or ROM mined.

The Project has conducted a drilling program to measure directly on-site coal seam gas contents across proposed seams and pits. This program identified the coal seam gas content to be significantly lower than the default factor, as described in section 14.1 above.

14.9.5 LAND CLEARANCE

The WJV proposes to develop and implement a Biodiversity Offset Strategy, which is proposed to include protection for an equal or greater area of similar vegetation as will be lost through the Project. The draft Biodiversity Offset Strategy proposes a target ratio of up to 3:1 in terms of the vegetation protected in offsets compared with that disturbed by the Project's mining operations.

The draft Biodiversity Offset Strategy does not specifically cover offsets for greenhouse gas emissions as these emissions will be covered by the CPRS. However, the draft strategy does assist with minimising GHG emissions associated with land clearance, as it proposes to actively increase the habitat value of the offset areas through planting, which will increase biomass and in turn the carbon sequestration potential of the forest sink. Furthermore, the WJV will rehabilitate some mining areas for nature conservation which will provide further carbon sequestration. Full details on the draft strategy are provided in Chapter 17A of the EIS.

14.9.6 INDUSTRY AND WANDOAN JOINT VENTURE (XSTRATA COAL) POLICY

Xstrata Coal supports a number of research, development and demonstration programs for low emission technology and other initiatives:

Xstrata Coal is actively involved in a number of research, development and demonstration programs for low emission technology and other initiatives, and has committed around $250 million in financial support to low emissions technology projects, including:

- Contributing significantly to the Australian coal industry's $1 billion COAL 21 Fund, through a voluntary levy on coal production to fund the development and demonstration of low emission technologies in Australia

- Corporate partner in the $AUD220 million Oxyfuel Project lead by CS Energy. The aim of the Oxyfuel Project is to test the feasibility of a clean coal technology to capture carbon dioxide from CS Energy's Callide A power station in central Queensland and store it underground. The technology is of global importance, as it has significant potential to reduce greenhouse emissions in the power sector. If the project demonstrates viability, Australia's first near-zero emission coal-fired power station could be operating within five years. Further, significant opportunities may exist from the retrofitting of this technology to existing coal-fired power stations and use in new build plant, providing the potential for significant cuts in GHG emissions from the power generation sector
- Working with the CO2CRC on the CO2 storage demonstration project in the Otway Basin, Victoria.
- As announced on 26 November 2008, Xstrata Coal has become a foundation member of the Global Carbon Capture and Storage Institute (GCCSI). The GCCSI, announced in September by Prime Minister Kevin Rudd, aims to accelerate the commercial deployment of carbon capture and storage technologies.
- The Australian Coal Association Research Program (ACARP), funded via an industry levy supports projects in the following areas:
  - Greenhouse Gas Mitigation
  - Safety and Occupational Health
  - Environment and Rehabilitation of Mined Land
  - Community Concerns and Land Access
  - Cost of Production
  - Technical Support for Marketing Australian Coals
  - Sustainable Use of Coal
- As the world's largest exporter of thermal coal, Xstrata Coal, and Australia's coal industry at large, has a vested interest in fast tracking the commercial deployment of carbon capture and storage (CCS) technologies both in Australia and globally.

14.9.7 GHG MANAGEMENT PLAN

A management plan will be developed for the Project that will incorporate the following measures to reduce the Project's GHG emissions, where practicable:

- electrical and diesel efficiency measures outlined above
- energy management, including energy audits with a view to progressively improving energy efficiency and investigation of renewable energy sources (eg. onsite solar generation) for project components (such as the mine accommodation facilities)
- voluntary initiatives outlined in this Chapter, and
- monitoring, auditing and reporting on GHG emissions as required under the NGER Act for all relevant activities.

14.10 CLIMATE CHANGE IMPACT ASSESSMENT

Recent reports suggest that the mine area is likely to be subject to climate change during the life span of the mine. 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.

14.10.1 SUMMARY OF PREDICTED IMPACTS

Table 14-10 summarises the likely effects of climate change in the vicinity of the mine area, 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 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.

It can be seen that by 2030 the average annual temperature is expected to increase by between 1ºC and 1.5ºC. 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 much greater reduction in water availability.

By 2050 average annual temperature is expected to increase by between 1.5ºC and 2ºC. 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.

Table 14-9: The impacts of climate change in Queensland in 2030 and 2050

	Temperature change (ºC)		Rainfall change (%)		Change in Relative Humidity (%)		Wind speed change (%)		Change in potential evapotranspiration (%)		Sea surface temperature change (ºC)	
	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	+2 to +5	+2 to +5	+2 to +4	+4 to +8	+0.6 to +1	+1 to +1.5
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	+2 to +5	+2 to +5	+2 to +4	+4 to +8		
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	2 to -2	2 to -2	+2 to +4	+4 to +8		
Winter	+0.6 to +1	+1.5 to +2	-5 to -10	-5 to -10	0.5 to -0.5	-0.5 to -1	2 to -2	2 to -2	+4 to +8	+4 to +8		
Spring	+1 to +1.5	+1.5 to +2	-5 to -10	-10 to -20	-0.5 to -1	-0.5 to -1	+5 to +10	+5 to +10	+2 to +4	+4 to +8		

14.10.2 RISK ASSESSMENT

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/NZS4360:2004. 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 14-10: Measures of likelihood

Measures of likelihood		
Level	Descriptor	Description
E	Rare	Occurs only in exceptional circumstances
D	Unlikely	Could occur but not expected
C	Possible	Could occur
B	Likely	Will probably occur in most circumstances
A	Almost Certain	Is expected to occur in most circumstances

Table 14-11: Measures of consequence

Measures of consequence				
Level	Descriptor	Environmental impact	Mine site functionality	Financial (per event/per year)
1	Insignificant	Env consequence weeks	No loss of use	<$50,000
2	Minor	Env consequence <12 months	Short terms loss of use (all/part) <1 week	$50,000 to $500,000
3	Moderate	Env consequence 1-2 years	Loss of use (all/part) 1 wk to 1 month	$500,000 to $1 million
4	Major	Env consequence 2-5 years	Loss of use (all/part) 1 month to 1 year	$1 million to $10 million
5	Catastrophic	Env 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 14-12: Risk matrix

Risk matrix					
Likelihood	Consequence				
	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
A (almost certain)	5	10	15	20	25
B (likely)	4	8	12	16	20
C (Possible)	3	6	9	12	15
D (Unlikely)	2	4	6	8	10
E (Rare)	1	2	3	4	5

14.10.3 RESULTS

The results of the risk assessment are presented in Table 14-14 below.

Table 14-14: Risk Assessment of the potential impacts of climate change on mine operations

Risk scenario	Likelihood	Severity	Risk score
Reduced process water availability due to decreased rainfall and increased evapotranspiration.	Likely B	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 B	Moderate 3	High 12
Increased flood risk due to increased rainfall intensity (including pit area).	Possible C	Major 4	High 12
Health impacts on mine site staff from increased temperatures (e.g., heat stress).	Possible C	Moderate 3	Medium 9
Increased soil erosion due to decrease in soil moisture and increased rainfall intensity (including access tracks).	Possible C	Moderate 3	Medium 9
Unsuccessful rehabilitation planting due to reduced rainfall and more severe storm events.	Possible C	Moderate 3	Medium 9
Increased slope failure due to decreased soil moisture and increased rainfall intensity.	Unlikely D	Major 4	Medium 8
Increased maintenance costs for infrastructure due to more severe storm events.	Possible C	Minor 2	Medium 6
Increased bushfire events due to increased temperatures and evapotranspiration potential.	Unlikely D	Moderate 3	Medium 6
Restrictions on blasting events due to increased number of windy days	Possible C	Minor 2	Medium 6
Failure/overtopping of tailings dams.	Rare E	Catastrophic 5	Medium 5
Community/workforce isolation due to higher risks of flooding events.	Rare E	Minor 2	Low 2

14.10.4 RISK MANAGEMENT MEASURES

Relevant risk management measures as described elsewhere in the EIS are summarised here. Where practicable, the Wandoan Joint Venture will undertake these measures in a cooperative approach with government, other industry and other sectors as part of the measures described in section 8.5.

High risk impacts

The following measures will be implemented to increase water use efficiency:

- Xstrata's Sustainable Development Policy sets its commitment to continually improve the efficiency with which it uses raw materials, energy and natural resources including water
- the Project will implement a water management plan and include an assessment of:
  - the operation with regard to actual and future potential water scarcity
  - water availability and potential impacts on water.

The following measures will be implemented to manage dust emissions on site, with further details provided in Chapter 13 Air Quality:

- an air quality management plan will be prepared prior to the commencement of construction
- a coupled real time weather forecasting and dust monitoring system that will initiate the application of management and mitigation strategies prior to the onset of an air quality exceedance as a result of adverse weather conditions, implemented prior to commencement of construction
- effective design and management of roads and exposed areas (eg. minimising speed of on-site traffic, regular watering, grading and if necessary use of surface treatments) to reduce wheel-generated dust
- where practicable, limit dust-generating activities such as earthworks that could potentially affect residents during high wind conditions
- stockpiles and other mine infrastructure will attempt to be located away from affecting sensitive receptors
- limiting vegetation and soil clearing to approved areas, so as to minimise exposed ground
- rehabilitate disturbed land as soon as practicable through a proactive progressive rehabilitation program.

The following measures will be implemented to reduce the likelihood of floods and/or manage the impacts of floods, as detailed in Chapter 11 Water Supply and Management:

- the proposed conceptual creek diversion channels can be feasibly constructed to the criteria specified NRW watercourse diversion guidelines
- preliminary extent of inundation and design flood levels has been identified, which may be used for the planning of mine infrastructure. The locations and major dimensions of the creek diversions and levees has been conceptualised and the flood immunities of various infrastructure and creek crossings may be identified. However, during more detailed design phases and the waterworks licence approval process, more detailed

modelling will be conducted in the immediate vicinity of the proposed structures. The hydraulic and hydrology models will be developed further for this purpose.

Medium risk impacts

The effects of heat will be managed by providing suitable working environments, equipment and protective clothing, making workers aware of the signs and symptoms of heat effects including dehydration, and ensuring that adequate hydration levels are maintained (refer to Chapter 24 for more detail).

The following measures will be implemented, where appropriate, to reduce the likelihood of soil erosion, as further detailed in Chapter 9 Geology, Mineral Resources, Overburden and Soils:

- specific sediment and erosion control plans will be prepared following detailed design, and implemented prior to the commencement of construction for mine infrastructure areas
- design of all drainage around proposed structures and permanent landforms will consider the presence of dispersive soils and apply suitable erosion reduction methods. All disturbed areas will be revegetated, or covered with material that has low erosion potential, to minimise the potential for erosion
- erosion will be remediated as soon as practicable. This may include levelling the eroded area, capping with non-dispersive topsoil, application of seed and applying erosion control measures to prevent water impacting the site
- clear the minimum amount of vegetation (including grass cover) required for Project works
- minimise disturbance of the ground layer of vegetation by controlled operation of machinery and equipment selection
- site drainage, erosion and sediment controls will be implemented and in place prior to, or as soon as possible, following the removal of vegetation
- revegetate exposed soils as soon as practical after works have been completed. This includes the rehabilitation of overburden stockpile dumps
- install erosion and sediment control measures on disturbed natural or constructed slopes to minimise erosion and sediment released into waterways. This is especially important for soils with dispersive subsoils (e.g. Cheshire, Woleebee, Rolleston and Teviot)
- minimise slope grade within infrastructure areas where possible based on results of geotechnical data obtained during detailed design phase
- locate infrastructure, parking and laydown areas at sites with minimal slope grade
- construct hardstands from erosion resistant material
- erosion monitoring will continue until the vegetation cover has become fully established
- monitoring for the development of tunnel erosion will be undertaken every three months for the 12 months following the completion of construction
- if monitoring indicates the formation of tunnel erosion, remediation works will be undertaken immediately, with further monitoring of the area until vegetation cover has become fully established.

The following measures will be implemented increase the success rate of rehabilitation planting, as further detailed in Chapter 17A Terrestrial Ecology:

- a revegetation /rehabilitation plan will include, where appropriate:

- planting of a range of locally occurring native shrubs, trees and groundcover plants, in keeping with the vegetation types present
- incorporating existing natural vegetation where possible.
- linking vegetation remnants, where practicable
- focusing on riparian vegetation to protect waterways
- excluding stock from areas rehabilitated for nature conservation objectives

- a flora and fauna monitoring program for the Project will be developed and implemented aimed at achieving a better understanding of impacts and rehabilitation actions to flora and fauna throughout the study area. Monitoring will also include exotic weeds and feral animals.

The following measures will be implemented, where practicable, in regard to the stability of overburden and to prevent slope failure, as detailed in Chapter 9:

- the setback distance of overburden piles from the crest of the wall will consider the wedge failure potential of the low wall
- design overburden dumps to limit dump heights or use benching on dumps to improve overall stability
- toe of stockpiles will be buttressed with interburden waste as soon as possible after coal is removed
- a 5 m wide bench will be left between the toe of a weathered overburden cut and the crest of a weathered overburden cut to reduce the rock fall hazard
- preliminary high wall and low wall and overburden dump design will be conducted to the cut angles contained elsewhere in the EIS.
- the area of disturbed land at any one time will be minimised through planning, staged development and designation of specific site areas.

14.11 CONCLUSIONS

The total average annual Scope 1 and 2 Greenhouse Gas Emissions for the Project will be 386,310 tCO_2-e with 100% onsite power generation, 520,565 tCO_2-e with partial on site generation and partial purchased electricity from the grid and 589,838 tCO_2-e with 100% grid purchased electricity.

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 will be 0.61 percent of the Queensland energy sector in an average emissions year, assuming the worst case GHG performance from the Project (100% of power consumption is electricity purchased from the grid). Project emissions are therefore unlikely to have a significant impact on Queensland government emissions (and hence national and international) targets.

Annual average global GHG emissions are estimated as 28,670 Mt CO_2-e. The Project's maximum full fuel cycle emissions are approximately 49.9 Mt CO_2-e per annum. On a full-fuel cycle basis, including end-use for production of electricity, this represents 0.17 percent of annual global emissions compared with data from reporting countries only. Approximately 99% of the Project's emissions are attributable to end-use of coal for electricity production which will be totally or predominantly overseas, and the demand for coal for electricity production would exist regardless of the location of the source.

With regard to the impacts of climate change on the mine's operation, during the operating life of the mine it is expected that the local conditions will become hotter, drier and windier with more intense rainfall events. The measures described in 14.10.4, Risk Mitigation Measures will assist the mine to adapt to the potential impacts of climate change on its operation.

14.12 REFERENCES

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