Sorby Hills Mine Greenhouse Gas Assessment - Final

August 2012

Sorby Management Pty Ltd / Animal Plant Mineral

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Glossary

tC	Tonnes of carbon
Carbon dioxide equivalent (CO_2-e)	A measure describing how much global warming a specific greenhouse gas may cause, using carbon dioxide (CO_2) as the reference standard unit (usually expressed in t CO_2-e – tonnes of carbon dioxide equivalent).
Embodied energy	The total amount of different types of energy necessary to deliver a project including energy needed to manufacture and deliver materials, and energy used on site in construction using the materials.
EF	Emission factors convert an indicator of activity into estimated greenhouse gas emissions.
EMP	Environmental Management Plan
ESD	Environmental Scoping Document
FullCAM	Full Carbon Accounting Model
GHG/greenhouse gas	The 6 Greenhouse gases as defined in the Kyoto Protocol. These are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulphur hexafluoride (SF_6).
GJ	Giga Joule: 1 GJ = 1,000,000,000 Joules
J	Joule: A measure of energy
kJ	Kilo Joule: 1 kJ = 1,000 Joules
kW	Kilowatt: A measure of power, the rate at which energy is used 1 kW = 1,000 Watts = 1 kJ/s
kWh	Kilowatt hour (1,000 watt hours): A unit of (normally electrical) energy, equal to power of 1 kW for 1 hour.
MJ	Mega Joules: 1 MJ = 1,000,000 Joules
Tpa	Tonnes per annum
Scope 1 Emissions	Covers direct emissions from sources within the boundary of an organisation, such as fuel combustion and manufacturing processes.
Scope 2 Emissions	Covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation. Scope 2 emissions result from the combustion of fuel to generate electricity, steam or heat and do not include emissions associated with the production of fuel.
Scope 3 Emissions	Includes all other indirect emissions, not included in 2, that are a consequence of an organisation's activities, but are not sources of emissions owned or controlled by the organisation.

Executive summary

Background

This assessment comprises an estimate of greenhouse gas (GHG) emissions associated with the Sorby Hills mine (the project). The project emissions have been estimated using information from draft conceptual design of both the construction and operational phases. These estimates provide a baseline for GHG emissions, which will assist in comparisons for GHG reductions in the future.

The estimated GHG emissions presented herein are largely based on mine energy and fuel demand estimates for construction and operation.

Methodology and scope

The approach for assessing the GHG impact of this project was undertaken in accordance with the accounting standards of the Greenhouse Gas Protocol (World Resources Institute/World Business Council for Sustainable Development, 2004) and emission factors were based upon the National Greenhouse Account (NGA) Factors (Department of Climate Change, 2011).

Results

Table E-1 provides a summary of the GHG emissions for the two phases of the project consisting of construction (including clearing of woody vegetation) and operation. The project's construction phase spans over 16 weeks while the operational lifespan is of 14 years.

Table E-1 Total Scope 1 emissions during clearing, construction and operation for duration of the mine

Activity/Phase	Duration	Total Scope 1 GHG emissions (14 year mine life) (t CO_2-e)
Construction	16 weeks	671
Vegetation Clearing	part of construction	195,733
Operation	14 years	399,700
Total		**596,104**

Estimates were rounded to the nearest whole number.

Over the lifetime of the project, it is estimated that the project will emit a total of approximately 596,104 tonnes of carbon dioxide equivalent (t CO_2-e).

Summary

As evidenced in Table E-1, the largest source of emissions is from the lifetime of the mine's operational phase, followed by emissions associated with land clearing during the construction phase. Emissions generated throughout the construction phase are comparatively minor to the project's total emissions.

Overall, Australia's annual emissions for 2009/2010 were 560.8 Mt CO2-e (Department of Climate Change and Energy Efficiency, 2012). By comparison, the annual operation of the mine is projected to represent approximately 0.005% of Australia's total emissions.

Proposed greenhouse gas abatement options

There are a number of mitigation measures that can be implemented to reduce the GHG emissions associated with the project construction and operational activities. These measures are generally a combination of appropriate maintenance of equipment and the promotion of a culture of operating equipment efficiently.

The key mitigation opportunities would be derived from the activities that generate the most GHG emissions during construction and operation.

Construction

Opportunities for mitigation during construction may potentially be:

- minimising the disturbance boundary of land clearing where it is necessary for operational safety
- implementing structural design according to the relevant state and national sustainability building guidelines
- sourcing of materials for construction with a lower content of embodied emissions; for example, Zeobond produce E-Crete[1] which is a concrete product that is made without using Ordinary Portland Cement, and contains fly-ash from the electricity generation industry and slag from the steel making industry. This product is claimed to reduce carbon life cycle emissions by up to 80%. The use of recycled HDPE pipe material (i.e. green pipes), and recycled content in steel can also significantly minimise the lifespan impact of GHGe in production and use of these materials
- specifying in procurement contracts for construction and maintenance services:
    - implementing energy-efficient guidelines for construction work, such as minimal idling time for machinery or complete shut off
    - using biofuels (e.g. biodiesel, ethanol, or blends such as E10 and B880) to reduce GHGe from plant and equipment, where feasible
    - using vehicles with GHGe ratings of a minimum of 7.5 for passenger vehicles and 6 for light commercial vehicles, as described in the Green Vehicle Guide (www.greenvehicleguide.gov.au)
- sourcing locally: The practice of local sourcing of materials and labour and minimising transportation can significantly reduce GHG emissions.

[1] *ResourceSmart (2009), "Low-carbon concrete the next big thing", available at:: http://www.resourcesmart.vic.gov.au/news_and_events/business_news_3347.html*

Operation

Similar principles and measures would apply in reducing operational emissions as in construction emissions. During the operational phase, the overriding objective will be to improve operational efficiencies, where practicable, by implementing best practice technologies to reduce energy consumption and subsequent GHGe. The following measures are recommended for consideration in order to minimise GHGe:

- establish an Environmental Management System (EMS) that involves regular monitoring, auditing and reporting on energy, resource use and GHGe from all relevant activities; include energy audits with a view to progressively improving energy efficiency and investigation of renewable energy sources (e.g. on-site solar generation), where feasible
- rehabilitation of pre-existing vegetation in areas where it will not cause adverse operational safety impacts in order to mitigate emissions from vegetation clearing
- development of Key Performance Indicators for plant efficiency and GHG intensity, and periodic energy audits.

1. Introduction

1.1 Project description

The Sorby Hills project (hereafter, the project) is situated in the north-east Kimberley region of Western Australia, close to the Northern Territory border. The closest major town to the project is the regional centre of Kununurra, located approximately 50 kilometres (km) from the site.

The project will consist of the construction and operation of a mine that involves three open cut pits for lead, zinc and silver, to produce approximately 0.4 tonnes per annum (Tpa) of ore. A concentrate ore will be produced which will be transported to Kununurra by road train, and transferred to the Wydnham Port storage facility, where shipping is planned to occur once a month, for 11 months every year. The mine will operate 24 hours a day, 7 days a week, and is expected to run for 14 years (2013 to 2027), with an initial 16 week construction phase. Approximately 767 hectares (ha) of vegetation clearing will be required as part of project construction works.

1.2 Greenhouse gas assessment scope

Parsons Brinckerhoff has been commissioned by Animal Plant Mineral on behalf of Sorby Management to perform a greenhouse gas (GHG) assessment for the construction and operation of the project, including an estimation of emissions from land clearing.

The GHG assessment is based on draft conceptual designs developed for the project. This will provide a baseline that can be used as a reference point to determine future GHG emission reductions for the project. The GHG estimates are based on the most conservative values to calculate emissions, and it should be acknowledged that as the design of the project is changed, the GHG emission estimates will need to be adjusted accordingly.

The GHG estimates presented herein are based upon the 2011 National Greenhouse Account (NGA) Factors, on an annual basis.

2. Greenhouse gas framework

2.1 International policy

In 1997, the United Nations Framework Convention on Climate Change (UNFCCC) produced the Kyoto Protocol aimed at limiting greenhouse gas (GHG) emissions. The protocol was developed to work by setting a limit to individual mandatory GHG emission targets, using 1990 as a baseline level. Australia ratified the Kyoto Protocol in December 2007, agreeing to an emission target of 108% of the nation's 1990 emissions between 2008 and 2012. Australia has also committed to reducing its GHG emissions between 5 – 25% of 2000's emissions, and a longer-term target to cut emissions by 80% below 2000 levels by 2050.

2.2 Australian policy

In July 2009, the Department of Climate Change and Energy Efficiency (DCCEE) released the Australian policy on climate change. The policy aims to reduce GHG emissions, encourage low GHG intensive design and technology, and reduce the impact of climate change on a global context.

To assist with Australia's climate change policy, the Australian government also introduced several policy instruments and plans as additional measures that aim to achieve reduced emissions, including:

- Enhanced Renewable Energy Target (RET) scheme – aiming to reduce Australia's electricity supply by substituting 20% from renewable sources (i.e. solar, wind, geothermal) by 2020.
- *National Greenhouse Energy Reporting Act 2007* (NGER Act) – requiring constitutional corporations to report annually on GHG emissions, energy production and energy consumption if the thresholds defined in the Act are not met or exceeded.
- *Energy Efficiency Opportunities Act 2006* - requiring large energy users to identify, evaluate and publicly report on cost effective energy saving opportunities.

In July 2011, the Australian government unveiled the Clean Energy Future Legislative Package, which commits Australia to reduce carbon pollution by 5 % from 2000 levels by 2020 irrespective of what other countries do, and by up to 15 or 25 % depending on the scale of global action. The Clean Energy Future Legislative Package incorporates the following key elements:-

- A two-stage carbon pricing mechanism, focussing on the 500 biggest polluters, which encompasses:
  - a fixed price period – the carbon pricing mechanism commenced on 1 July 2012, with a price that is fixed for the first three years. The price started at $23 per tonne and will rise at 2.5 % each year in real terms

- an emissions trading scheme – on 1 July 2015, the carbon price will transition to a fully flexible price under an emissions trading scheme, with the price determined by the market.

- Manufacturing and energy efficiency programs for households and businesses, including development of a national energy savings initiative, as recommended by the Prime Minister's Task Group on Energy.

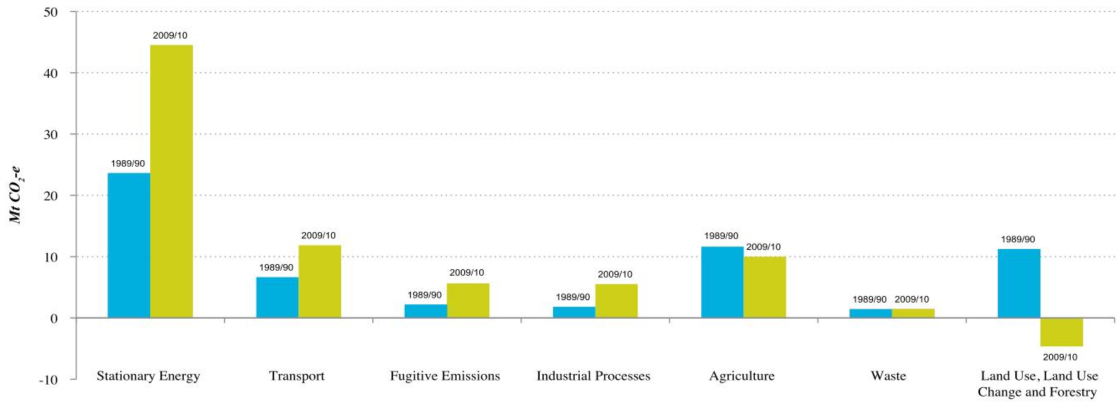
- Renewable energy program. This includes a new $10 billion Clean Energy Finance Corporation, a new Australian Renewable Energy Agency and funding for research and development. It is intended that 20 % of Australia's electricity will come from renewable sources by 2020.

- Land use program, including a Carbon Farming Initiative, Biodiversity Fund and an ongoing Carbon Farming Futures program.

The Clean Energy Future package will place a liability on carbon emissions that, over time, will encourage investment in lower carbon intensity technologies. The project is likely to be indirectly impacted by a price on carbon. Such indirect impacts are the likely increase in fuel, electricity and energy intensive material prices, which can be abated by following some of the mitigation measures outlined in Chapter 6.

2.3 State policy

The Western Australian government developed a state GHG strategy as part of a response to the state's significant increase in GHG emissions over the past 20 years (refer Figure 2-1). The GHG strategy aims to establish a realistic and effective long term commitment to address climate change and ensure all sectors contribute to solutions.



Source: Department of Climate Change and Energy Efficiency (2012b)

Figure 2-1 Western Australia GHG emissions – comparison between 1989-90 and 2009-10 (Mt CO_2-e)

3. Calculation methodology

3.1 Greenhouse gas accounting

The approach for assessing GHG emissions associated with the proposed construction and operation of Sorby Hills mine follows the accounting standards of the Greenhouse Gas Protocol (World Resources Institute/World Business Council for Sustainable Development, 2004) in conjunction with the following publications:

- National Greenhouse Account (NGA) Factors July 2011 (Department of Climate Change and Energy Efficiency, 2011). The factors supplied in this guideline have been used to calculate GHG emissions from estimates of energy and fuel consumption.
- Technical Guidelines for the estimation of GHG emissions by facilities in Australia July 2011 (Department of Climate Change and Energy Efficiency, 2011).
- published information, including manufacturer data obtained from various websites.

Where possible, data supplied by the client was used to calculate the project's GHG emissions. Where data was not practicably available, comparable information from similar projects was used drawing from publicly available data or prior experience.

3.2 Emission sources

The project GHG inventories were divided according to the construction and operation phases. Any emissions due to land clearing were included in the construction phase.

The emission sources were categorised in accordance with the National Greenhouse Accounts (NGA) Factors (2011). These categories represent the main emission sources that contribute to the release or capture of GHG emissions into the atmosphere. The categories applicable for the project are:

- energy (stationary and transport)
- waste
- land use, land use change and forestry (refer to section 3.3 for further details).

The main GHG associated with the project is carbon dioxide (CO_2), which is typically emitted from the combustion of carbon intensive fuels. It should be noted that GHG emissions are herein reported in terms of the standardised carbon dioxide equivalent (CO_2-e) values, which take into account the following greenhouse gases:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxides (N_2O)
- synthetic gases including hydrofluorocarbons (HFC's), sulfur hexafluoride (SF_6) and tetrafluoromethane (CF_4).

In accordance with the NGA factors (2011) guidelines, the major sources of direct and indirect emissions were categorised into Scope 1, 2 and 3 emissions, which are described as follows:

- **Scope 1 emissions** - direct emissions from sources within the boundaries of project operations such as fuel combustion within vehicles, plant and equipment.
- **Scope 2 emissions** - indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation. Scope 2 emissions result from the combustion of fuel to generate the electricity, steam or heat and do not include emissions associated with the production of fuel.
- **Scope 3 emissions** - indirect other emissions which include all other emissions that are not directly sourced, owned or controlled by the project owners. Likely sources would include embodied energy of materials used in the maintenance of the project, and emissions from the extraction

It should be noted that under the NGER Act, Scope 1 and 2 emission factors require mandatory reporting, while Scope 3 is voluntary. This assessment predominately presents Scope 1 emissions, as Scope 2 is not applicable to the project. Scope 2 emissions, or indirect emissions, are irrelevant to this project, as electricity is supplied from diesel on-site power generation, and not purchased from the grid, and therefore are considered scope 1 (and scope 3) emissions. Where possible, Scope 3 emissions have been included separately where it relates to upstream emissions and the embodied energy associated with consumption of fuel or materials.

3.3 Emissions sources by boundary

The project boundary for the GHG emission inventories are limited to the construction disturbance footprint proposed for the project. This includes the vegetation clearing footprint provided by the Sorby Hill's Environmental Scoping Document (ESD) (Animal Plant Mineral, 2012). Daily transportation of workers from the township of Kununurra, and the flights associated with the fly-in, fly-out lifestyle, have also been considered. The emission sources associated with the project and their respective scope categorisation is shown in Table 3-1 and Table 3-2.

Table 3-1 Construction emissions according to scopes

Scope 1	Transportation of materials, products and employees. Construction fuel usage in vehicles and equipment; diesel on-site generator(s) fuel usage; on-site waste; woody vegetation clearing.
Scope 2	Not applicable (electricity is generated from diesel on-site generators(s).
Scope 3	Extraction, production and distribution of fossil fuel used; embodied energy in raw construction materials such as steel, concrete and HDPE pipe.

Table 3-2 Operation emissions according to scopes

Scope 1	Transportation of materials, products, waste and employees. These emissions are generated from the combustion of fuels in company owned/controlled. Haulage trucks, buses, cars and airplanes to accommodate fly-in fly-out employees). Fuel use in generators for power; on-site wastewater treatment; waste generation and disposal to landfill onsite.
Scope 2	Not applicable (electricity is generated from diesel on-site generators(s).
Scope 3	Extraction, production, transmission and distribution of fossil fuel used.

3.4 Calculating greenhouse gas emissions from vegetation clearing

GHG emissions resulting from vegetation clearing were calculated using the Carbon Accounting Model v3.40 (FullCAM) (Department of Climate Change and Energy Efficiency, 2012), which consists of a carbon stock model for different forest and agricultural land uses developed by the Department of Climate Change and Energy Efficiency. FullCAM is an integration tool capable of modelling various land use management changes such as vegetation clearing and conversion of land into pastures.

FullCAM was specifically used in this GHG assessment to calculate carbon stocks representative of the affected land including existing vegetation. Vegetation carbon stocks were calibrated by classifying the existing vegetation units according to a flora and vegetation assessment by Animal Plant Mineral (2011) to provide an indication of carbon sequestration potential of each specific vegetation unit. This is done by comparing the modelled baseline carbon stocks with post-clearing carbon stocks for the existing vegetation units. The model works on the assumption that carbon content from cleared vegetation will be emitted into the atmosphere via the natural process of plant decomposition. This assumption is consistent with the proposed reuse of cleared vegetation and mine rehabilitation works.

Post–clearing carbon stocks were defined by the debris carbon stock stabilising over time. The difference in carbon stocks were then compared to give a carbon content amount. The carbon stocks were then converted from tonnes of carbon to t CO_2-e by using a 44:12 carbon ratio.

3.5 Assumptions and limitations

The report considers both GHG emission sources and sinks based on information contained within the project's Environmental Scoping Document (ESD) (Animal Plant Mineral, 2012). Some of the data provided in the scoping document are subject to change which may affect the GHG calculations. In this occurrence, changes may significantly alter the results of this assessment and a revised GHG assessment is recommended. It is also noted that there will be further infrastructure development that will also contribute additional GHG emissions during the construction and operation of the project that were not accounted for in this assessment due to lack of sufficient information. This includes, but is not limited to:

- development of drainage and sewerage systems
- fencing and security elements
- storage tanks, piping, electrical systems, air-conditioning units, and other miscellaneous support structures.

Estimating the relative GHG emissions derived from the above elements is beyond the scope of this report, but at best estimate (from prior experience) is likely to represent an additional 10% of construction emissions.

There are no firm commitments to the percentage or type of future renewable energy to be used onsite, therefore this contribution to GHG emissions has not been considered in the assessment process.

Where data was unavailable or not considered robust enough, a ‘materiality test’ was used to determine the appropriate level of detail for the information required. Where it was reasonably expected that an activity would account for less than 5 per cent of the project’s total emissions, or if more detailed data would not likely alter the results considerably, then that item was not considered for the assessment.

Any estimates for components not included in the ESD or available from Animal Pant Mineral have been based on data or prior experiences from other GHG assessments for similar infrastructure

A detailed assessment of the economic impacts of a price on carbon on the proposed mine will not been considered for this assessment.

4. Project greenhouse gas emissions

4.1 Construction

Table 4.1 provides a breakdown of major direct (scope 1) GHG emissions generated during the construction of the project. This accounts for GHG emissions resulting from transport and stationary diesel consumption, putrescible waste generation, and clearing of native vegetation. Transportation of materials and employees to the site for the construction phase is not considered to be a significant contributor to construction emissions and these elements have therefore not been included in the calculations. Diesel fuel will be consumed throughout the construction phase by construction equipment such as cranes, welders and diesel generator sets. Light vehicles and haulage trucks will also consume diesel, while electricity will be generated by a diesel generator. On-site putrescible wastes will be generated by construction crews during the 16 week construction phase.

Table 4-1 Breakdown of Scope 1 emissions for the construction phase of the project

Fuels/Process	Quantity used	Scope 1 emissions t CO_2-e
Land use, land use change and forestry Net loss of carbon sequestration potential due to clearing of woodlands, shrublands and forest	767 ha	195, 733
Transport Operation of site vehicles and equipment for construction	18 kL	47
Stationary Operation of stationary construction equipment	224 kL	601
Waste Putrescible wastes disposed to landfill onsite	18 tonnes	22
Total		**196, 404**

The total emissions generated by the construction phase of the project are estimated to be 196,404 t CO_2-e over the 16 week construction period. Overall, the main emission source is the GHG emissions associated with the net loss of carbon sequestration resulting from vegetation clearing. This accounts for 99.6% of total emissions during construction. Other significant GHG emission sources are from stationary diesel consumption used for power generation, and transport and stationary diesel consumption in the construction fleet/equipment. On-site putrescible wastes from the construction crews are comparatively minor at approximately 22 t CO_2-e.

4.2 Operation

A breakdown of Scope 1 (direct) emissions for the operational phase of the project is provided in Table 4-2. Scope 1 emissions are contributed by transporting workers via bus to the camp in Kununurra, and aviation fuel to accommodate the 2 weeks on, 2 weeks off flight roster, which accounts for 478 flights annually. Emissions will also be created by 12 road train movements per week transporting the concentrate from the project site to Wyndham Port, 160 km north-west of Sorby Hills. Wastewater from the operational workforce will be treated onsite by a bio-filtration system, which will conform to the standards of the Department of Health requirements. Putrescible waste generated by the operational crew will be disposed of in an on-site landfill approximately 200 m x 100 m x 10 m in size.

Table 4-2 Breakdown of annual Scope 1 emissions for the project operations

Fuels/Process	Quantity used	Scope 1 emissions t CO_2-e / year
Transport		
Operation of site vehicles	55 kL	148
Aviation transport	478 flights	206
Operation of road trains to Wyndham Port	100 kL	269
Bus transport	15 kL	41
Stationary		
Operation of mine equipment	10,045 kL	26,948
Diesel used for power generation	300 kL	805
Stand-by diesel used for power generation	2 kL	5
Waste		
Municipal Waste (wastewater treatment)	N/A	13
Putrescible wastes disposed in landfill onsite	96 tonnes	115
Total		**28, 550**

Annually, scope 1 emissions contributed to 28,550 t CO_2-e during the operational phase. The main GHG emissions associated with the project is predominately from the operation of mine equipment, accounting for approximately 94% of total annual emissions. This does not include power generation to supply the site with electricity, which will have an impact of approximately 805 t CO_2-e per annum; and diesel generated stand-by power, which will contribute approximately 5 t CO_2-e per year. Workers flights from Perth to Kununurra and bus transport for workers from Kununurra to the project site contribute to 247 t CO_2-e, or 1% of the project's annual operational emissions. Hauling the ore product from the project site to Wyndham Port will emit 269 t CO_2-e. Both municipal waste (regarding treatment of wastewater) and putrescibles disposed into landfill contribute to a small proportion of emissions to the annual operation of the project. This waste stream is likely to generate methane from putrescible wastes of an insignificant amount. Other materials and waste will be recycled where possible

4.3 Scope 3 emissions

Significant Scope 3 emissions resulting from the project for both construction and operation are presented in Table 4-3 below according to emissions sources and project phases.

Table 4-3 Scope 3 emissions during construction and operation of the Project for both output scenarios

Emission source	Quantity used	Scope 3 emissions t CO_2-e
Construction		
Embodied emissions of transport energy	18 kL	4
Embodied emissions of stationary energy	224 kL	46
Material embodied emissions – concrete	4800 tonnes	763
Material embodied emissions – steel	1200 tonnes	1,644
Material embodied emissions – concrete – HDPE	808 tonnes	1,615
Operation		
Embodied emissions of transport energy	170 kL (annually)	35
Embodied emissions of stationary energy	10,347 kL (annually)	2, 117
Total		**6, 224**

A significant amount of concrete, steel and HDPE pipe will be required for construction of the project, which represents 65% of Scope 3 emission sources. These materials are considered to be upstream emissions associated with the removal, manufacture and transport of the materials used. The embodied emissions associated with fuel used for both transport and stationary energy comprises 50 t CO_2-e of scope 3 emissions during the construction phase. During the operational phase, the only embodied emissions associated with operations are fuel use for both transport and stationary energy, and contribute to 2,152 t CO_2-e scope 3 emissions annually.

5. Summary

5.1 Project life emissions

The GHG assessment findings indicate that the construction phase will result in Scope 1 GHG emissions of approximately 196,404 t CO_2-e, of which 99.7% t CO_2-e is associated with land clearing. The operational phase involves mining, processing and transportation activities conducted 7 days a week, 24 hours a day, and is anticipated to generate approximately 28,550 t CO_2-e per year of scope 1 emissions; and over 14 years collectively emit 399,700 t CO_2-e. Over the project life span from 2013 to 2027, the project is estimated to emit up to 596,104 t CO_2-e of emissions (not including project close and decommissioning).

The net emissions over the expected life of the project, excluding Scope 3 emissions, are summarised in Table 5-1 below.**Error! Reference source not found.**

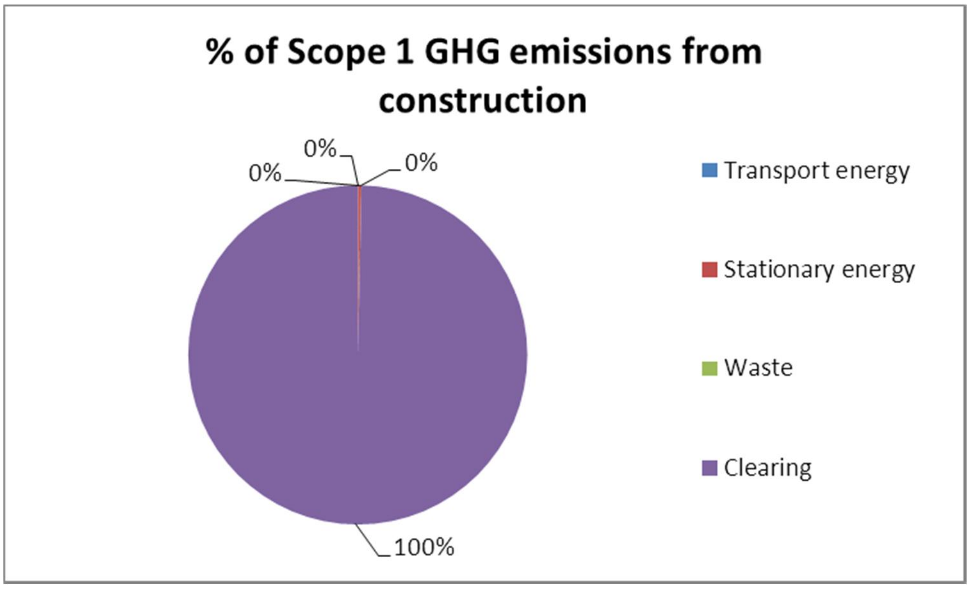
Table 5-1 Breakdown of Scope 1 net emissions for total mine life

Activity/Phase	**Duration**	**Total Scope 1 GHG emissions (14 year mine life) (t CO_2-e)**
Construction	16 weeks	671
Vegetation Clearing	part of construction	195,733
Operation	14 years	399,700
Total		**596,104**

5.2 Project summary

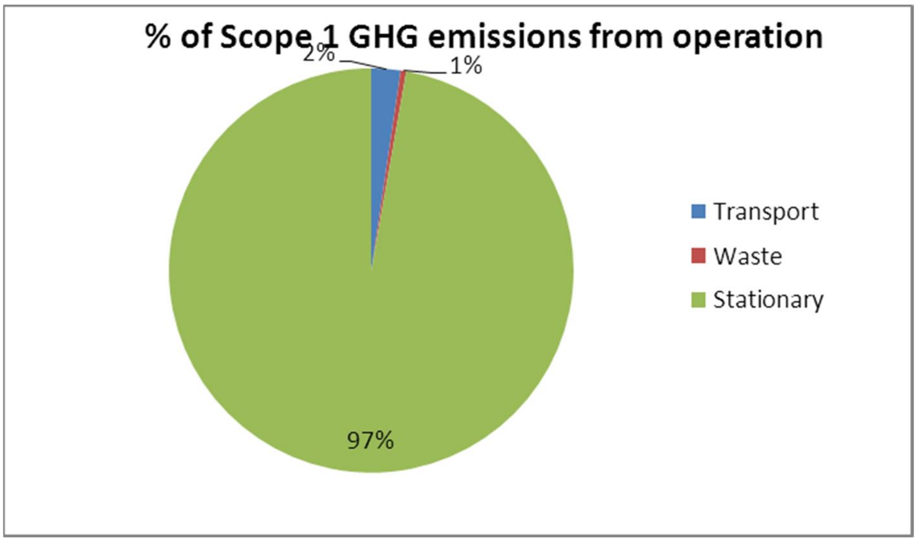
Overall, Australia's total direct annual emissions for 2009/2010 were 560.8 Mt CO2-e and Australia's direct annual emissions from the mining sector in 2009/2010 were 65.1 Mt t CO2-e (Department of Climate Change and Energy Efficiency, 2012). By comparison, the annual operation of the mine is projected to represent approximately 0.005% of Australia's total direct emissions and 0.9% of Australia's total direct mining emissions respectively.

Figure 5-1 and Figure 5-2 summarise the composition of Scope 1 emissions sources during construction and operational phases. Figure 5-3 summarises the lifetime of the project's emissions.



Percentages were rounded to the nearest whole number.

Figure 5-1 Composition of Scope 1 GHG emissions during construction phase



Percentages were rounded to the nearest whole number.

Figure 5-2 Composition of Scope 1 GHG emissions during the operational phase

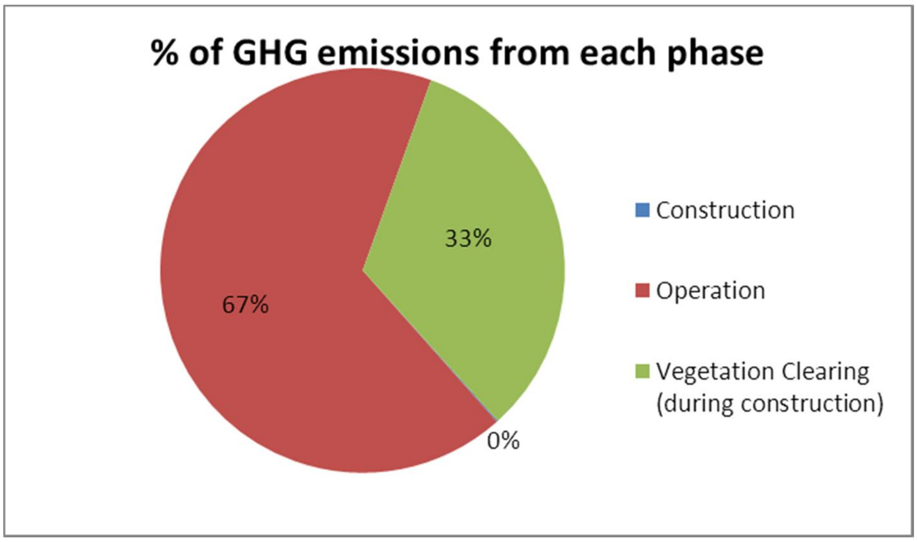


Figure 5-3 Composition of Scope 1 total project life emissions

6. Greenhouse gas abatement strategy

6.1 Greenhouse gas abatement and mitigation

There are a number of mitigation measures that can be implemented to reduce the GHG emissions associated with the project construction and operational activities. These measures are generally a combination of appropriate maintenance of equipment and the promotion of a culture of operating equipment efficiently and correctly.

The key mitigation opportunities would be derived from the activities that generate the most GHG emissions during construction and operation.

Construction

Opportunities for mitigation during construction may potentially be:

- minimising the disturbance boundary of land clearing where it is necessary for operational safety
- implementing structural design according to the relevant state and national sustainability building guidelines
- sourcing of materials for construction with a lower content of embodied emissions; for example, Zeobond produce E-Crete[2] which is a concrete product that is made without using Ordinary Portland Cement, and contains fly-ash from the electricity generation industry and slag from the steel making industry. This product is claimed to reduce carbon life cycle emissions by up to 80 per cent. The use of recycled HDPE pipe material (i.e. green pipes), and recycled content in steel can also significantly minimise the lifespan impact of GHGe in production and use of these materials
- specifying in procurement contracts for construction and maintenance services:
    - implementing energy-efficient guidelines for construction work, such as minimal idling time for machinery or complete shut off
    - using biofuels (e.g. biodiesel, ethanol, or blends such as E10 and B880) to reduce GHGe from plant and equipment, where feasible
    - using vehicles with GHGe ratings of a minimum of 7.5 for passenger vehicles and 6 for light commercial vehicles, as described in the Green Vehicle Guide (www.greenvehicleguide.gov.au)
- sourcing locally: The practice of local sourcing of materials and labour and minimising transportation can significantly reduce GHG emissions.

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Operation

Similar principles and measures would apply in reducing operational emissions as in construction emissions. During the operational phase, the overriding objective will be to improve operational efficiencies, where practicable, by implementing best practice technologies to reduce energy consumption and subsequent GHGe. The following measures are recommended for consideration in order to minimise GHGe:

- establish an Environmental Management System (EMS) that involves regular monitoring, auditing and reporting on energy, resource use and GHGe from all relevant activities; include energy audits with a view to progressively improving energy efficiency and investigation of renewable energy sources (e.g. on-site solar generation), where feasible
- rehabilitation of pre-existing vegetation in areas where it will not cause adverse operational safety impacts in order to mitigate emissions from vegetation clearing
- operation – development of Key Performance Indicators for plant efficiency and GHG intensity, and periodic energy audits.

6.2 Available options for mitigation measures

The previous section indicated that a reduction of emissions can be achieved through a series of mitigation options such as strategic choices of materials, fuels and suppliers. A list of some of these options identified and their potential to reduce the project emissions is shown in Table 6-1.These abatement options have either come from a high-level literature review or are based on previous experience on similar projects.

Table 6-1 Major emissions source and possible mitigation options

Emissions source	Project use	Suggested alternative	Potential reduction (% of GHG intensity)	Comments
Diesel	Plant and equipment	Biodiesel (B20)	14.8%	Heavy duty machinery manufacturers have different acceptance levels towards Biodiesel blends. E.g. Isuzu accept only B5, Caterpillar accepts B20 on Compact and Mid-Range Industrial Engines.
	Transport	Biodiesel (B20)	14.8%	A key issue with Biodiesel for trucks might be the reduction in power output although with blends this reduction in power is not significant.
Cementitious material	Concrete (partly or replace ordinary portland cement with fly ash or GGBFS[3]) for roadwork, structural, precast	Concrete for roadwork, structural, precast (e.g. Boral Envirocrete)	0 - 42% (depending on mix chosen)	Compared to 100% Portland, a mix of 25% Fly Ash (commonly used) reduces GHG emissions by 14%, while a mix of 40% GGBFS reduces GHG emissions by 22%. Higher ratio mixes can reduce GHG emissions up to 42%.
Concrete	Roadwork, structural, precast	Zeobond Geopolymer E-Crete	Up to 80%	This approach works particularly well for applications such as paving, concrete cladding, barriers, pre-cast panels, concrete pipes and applications where the method of placement is via conventional means such as chute or kibble.
Steel	Reinforcing	Recycled steel	Up to 75%	Every tonne of steel recycled saves 75% of the energy it takes to make a tonne of new steel.
Truck movements and fuel usage	Materials haulage	Materials haulage	Various	Despite difficulty to measure the t CO2-e reduced, it is clear that by minimizing prolonged idling typical highway vehicles can avoid 2 to 2.5 L of fuel per hour of idling.
		Movement planning	Various	Despite difficulty to measure the t CO2-e reduced, by planning delivery schedules so that there are fewer and shorter trips energy/GHG emissions can be saved.

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