Central Eyre Iron Project
Environmental Impact Statement

APPENDIX K

GREENHOUSE GAS IMPACT ASSESSMENT

Iron Road Limited

Central Eyre Iron Project (CEIP)
Greenhouse Gas Impact Assessment

FINAL - APPROVED

30 March 2015

SGE121001_RP01

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1 Executive summary

The activities associated with Iron Road's Central Eyre Iron Project (CEIP) were reviewed to identify those actions that result in the use of energy that may, directly or indirectly, result in the generation of greenhouse gases, or may result in a change in the carbon stocks of the land upon which the actions are occurring.

The most significant actions identified were the use of diesel for mobile fleet associated with the construction and operation of the open pit mining operations, the use of diesel associated with the rail movement of iron ore from the mine site to the Port facility and the use of purchased electricity for iron ore processing, including crushing and conveying activities. Together with other more minor sources of emissions, the volume of greenhouse gases generated by the Project was estimated to be around 1,765,540 t of CO_2-e per annum. In addition to this, a once-off emission of around 1,316,891 t of CO_2-e would occur associated with the construction of the Project, including the result of the displacement of carbon stocks in vegetation, topsoil and subsoil as a result of land clearing activities associated with the development of the mining operations, Port facility and infrastructure corridor, embodied energy emissions and emissions associated with the transport of construction materials. Placed into the context of current and projected South Australian, Australian and global CO_2-e emissions, the Project has been shown to contribute less than 5.9% to South Australia's current emissions, 0.32% of Australia's current emissions and makes a negligible contribution to global greenhouse gas emissions.

Iron Road has made significant reductions to the initial "business as usual" greenhouse gas footprint of the Project through incorporating energy efficiency into its decision making, including implemented mitigation measures such as:

- A significant reduction in the initial diesel-power haul truck fleet from approximately 93 trucks to 12 trucks through the use of in-pit crushing, conveying and stacking systems which use greener grid-based electricity as the energy supply;
- The implementation of water saving strategies within the processing plant, including tailings dewatering, that result in a 70% reduced demand for raw water and associated reduction in water pumping energy demands; and
- A reduction in Project footprint through the integration of the tailings and rock storage facilities, minimising the amount of land disturbance and preserving the soil carbon stocks.

In addition to the statutory reporting and management requirements triggered through exceeding the threshold levels contained within various items of legislation, Iron Road has also committed to reducing its carbon footprint through actions including:

- minimising waste generation
- reducing the consumption of water through the use of efficient fixtures, fittings and appliances and the capture and re-use of stormwater
- reducing the consumption of electricity through the use of efficient fixtures, fittings and appliances and the incorporation of passive solar design
- minimising fuel consumption by sourcing products locally where possible and selecting efficient vehicles and plant.

2 Introduction

The proposed Iron Road Limited Central Eyre Iron Project (CEIP, the Project) would consume energy, primarily in the form of diesel and purchased electricity, in order to undertake activities associated with the extraction and processing of iron ore. This would, as a consequence, result in the emission of greenhouse gases.

This greenhouse gas impact assessment provides an overview of the proposed operation in the context of its potential to generate direct and indirect greenhouse gas emissions, provides an introduction to climate change science and the current legislative environment and details the Project's management and mitigation commitments.

3 Project overview

The CEIP is located on the Eyre Peninsula, South Australia. The proposed mine site at Warramboo is located 28 kilometres south east of the regional centre of Wudinna, and the proposed port is located at Cape Hardy, approximately 5 km south of Port Neill, with the port and mine site being linked by a dedicated infrastructure corridor containing rail, water and electricity infrastructure.

Mining operations would be established to remove material from an open pit, with a peak extraction rate of approximately 347 Mt per annum, the majority of which would consist of waste rock. Ore treatment would be via conventional crushing, milling and magnetic/gravity separation, producing around 21.5 Mtpa of blast furnace sinter feedstock (iron concentrate) containing around 67% iron. The sinter feedstock would be railed to a dedicated port facility for export.

Other mine site infrastructure associated with the Project would include:

- an integrated tailings and waste rock disposal facility
- an explosives magazine
- an accommodation camp at the mine site for up to 1,300 people during the construction phase of approximately three years, reducing to approximately 600 during an operations phase of approximately 25 years
- infrastructure for the temporary storage of on-site wastes pending disposal off-site
- establishment of a water supply borefield and associated piping/pumping infrastructure
- construction of offices and administration infrastructure.

Off-site infrastructure would also be required, including the development of a port facility, installation of electricity transmission infrastructure and the construction of a rail line linking the mining operations to the Port. Accommodation facilities would be developed at the Port and at Wudinna, and upgrades to some existing infrastructure, including Wudinna airport and various roads and intersections would be undertaken.

4 Greenhouse gases and climate change

Climate change refers to the significant and permanent changing of long-term average patterns of weather. Specific gases have been determined to play an important role in determining climate and contributing to climate change. They do this as a result of their chemical structure which absorbs and re-emits infra-red radiation (heat) within the upper atmosphere, altering the temperature of the Earth's atmosphere and surface, and thereby altering the prevailing climate. This leads to the term 'greenhouse effect', from which the gases are collectively named 'greenhouse gases'. Common greenhouse gases include gases such as water vapour, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFC's) and perfluorocarbons (PFC's).

The potential impact of greenhouse gases on the atmosphere is the combined effect of the radiative properties of the individual gases (that is, their ability to absorb solar and infra-red radiation) and the time that it takes for those gases to be removed from the atmosphere by natural processes. In order to compare the relative effects of different gases over a particular time period, Global Warming Potentials (GWPs) are used, referenced in units of carbon dioxide equivalents (CO_2-e). As carbon dioxide is the base unit, it has a GWP of 1. There are six major groups of greenhouse gases, for which the range of GWPs (calculated over a 100-year time period) are listed in Table 4.1 (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education 2013b).

Table 4.1: Greenhouse gas global warming potentials

Greenhouse gas	GWP range
Carbon dioxide	1
Methane	21
Nitrous oxide	310
Hydrofluorocarbons (HFCs)	140 – 11,700
Perfluorocarbons (PFCs)	6,500 – 9,200
Sulphur hexafluoride	23,900

Source: National Greenhouse Accounts Factors December 2014.

As part of a continuing process, the Intergovernmental Panel on Climate Change (IPCC) constantly reviews climate change science, updating predictions based on new and revised climate change models. The most recent release of IPCC predictions was contained in the Fifth Assessment Report (AR5, IPCC 2013). The over-riding message of this update was that "warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen and the concentrations of greenhouse gases have increased".

The Fifth Assessment Report notes that "Projected climate change based on Representative Concentration Pathways (RCPs) is similar to [the Fourth Assessment Report] in both pattern and magnitude after accounting for scenario differences."

No Australian – or South Australian – specific analysis has been undertaken utilising the latest IPCC data to date, however reviews of the data associated with the Fourth IPCC Assessment Report (from 2007) in an Australian and South Australian context have been presented by CSIRO

(2006 and 2007), the South Australia Research and Development Institute (SARDI, 2010), and by the Australian Government as a component of the Garnaut Climate Change Review (2008).

Climate change projections for the years 2030 and 2070 on the Eyre Peninsula for various emissions scenarios has been undertaken by SARDI (2010), the results summarised in Table 4.2. The low, medium and high categories refer to projected GHG emissions scenarios, where high represents a continued fossil-fuel-intensive society, medium represents a society with a balance of fossil and renewable energy sources and low represents a reduction in societal material intensity. Overall projections show an increase in temperature and a decrease in rainfall across the Eyre Peninsula.

Table 4.2: Summary of 50th percentile climate change projections for 2030 and 2070 on the Eyre Peninsula relative to the 1990 baseline (representing the period 1980-1999).

Variable	Season	2030			2070		
		Low	Medium	High	Low	Medium	High
Temperature (^oC)	Annual	0.8	0.8	0.8	1.25	1.75	2.25
	Summer	0.8	0.8	0.8	1.25	1.75	2.25
	Autumn	0.8	0.8	0.8	1.25	1.75	2.25
	Winter	0.45	0.8	0.8	1.25	1.75	2.25
	Spring	0.8	0.8	0.8	1.25	1.75	2.25
Rainfall (%)	Annual	-3.5	-3.5	-3.5	-7.5	-15	-15
	Summer	-3.5	-3.5	-3.5	-3.5	-7.5	-7.5
	Autumn	-3.5	-3.5	-3.5	-3.5	-7.5	-7.5
	Winter	-7.5	-7.5	-7.5	-15	-15	-15
	Spring	-7.5	-7.5	-7.5	-15	-15	-30
Potential evapotranspiration (%)	Annual	0	3.0	3.0	3.0	6.0	6.0
	Summer	0	0	0	3.0	6.0	6.0
	Autumn	3.0	3.0	3.0	6.0	6.0	10.0
	Winter	3.0	6.0	6.0	6.0	10.0	14.0
	Spring	0	0	0	0	3.0	3.0
Relative humidity (%)	Annual	0	0	0	-0.75	-0.75	-1.5
	Summer	0	0	0	0	-0.75	-0.75
	Autumn	0	0	0	0	0	-0.75
	Winter	0	0	0	-0.75	-0.75	-1.5
	Spring	-0.75	-0.75	-0.75	-1.5	-1.5	-2.5
Solar radiation (%)	Annual	0	0	0	0	1.5	1.5
	Summer	0	0	0	0	0	0
	Autumn	0	0	0	0	0	0
	Winter	1.5	1.5	1.5	3.5	3.5	3.5
	Spring	0	0	0	0	1.5	1.5
Wind speed (%)	Annual	0	0	0	0	0	0
	Summer	0	3.5	3.5	3.5	3.5	7.5
	Autumn	0	0	0	0	0	0
	Winter	-3.5	-3.5	-3.5	-3.5	-7.5	-7.5
	Spring	0	0	0	0	-3.5	-3.5

5 Legislative environment

5.1 Federal

The legislative regime around greenhouse gas management is currently in a state of flux, with the recent (July 2014) repealing of elements of past carbon emissions legislation in favour of the new “Direct Action Plan”. As a result of this, the Clean Energy Legislative Package, passed into law in November 2011 is no longer in effect, nor the *Energy Efficiency Opportunities Act 2006*, which was similarly repealed in September 2014. The *National Greenhouse and Energy Reporting Act 2007* currently forms the basis of climate change management and reporting legislation, together with the new Emissions Reduction Fund (ERF). The ERF was enacted in the *Carbon Farming Initiative Amendment Bill* in late October 2014, modifying and expanding the existing *Carbon Credits (Carbon Farming Initiative) Act 2011* framework to cover the broadest possible range of emissions reduction opportunities.

5.1.1 Direct Action Plan

The current Federal Government has repealed the previous carbon pricing mechanism from 1 July 2014 in favour of its “Direct Action Plan”. The Direct Action Plan is centred on the establishment of an ERF which will be used by the Government to purchase carbon abatement via a reverse auction system whereby eligible projects that provide the greatest carbon abatement for the least cost would be favoured over other, less carbon-effective projects (Department of the Environment 2014c).

The scheme continues to utilise the existing NGER reporting methodologies (see Section 5.1.3), together with the existing RET and CFI schemes (see Sections 5.1.5 and 5.1.6, respectively), although the latter would be adapted and assumed under the ERF, and is likely be expanded to include a wider range of emissions reduction methodologies such as the inclusion of energy efficiency-related projects (Department of the Environment 2014c). A second component to the system would establish baseline (or “business-as-usual”) emissions levels for industries, with a safeguard mechanism established to ensure that corporations or entities do not operate at carbon intensities greater than their prescribed baselines. Details of the various aspects of the Emissions Reduction Fund are detailed in the Australian Government Emissions Reduction Fund White Paper, which sets out the Government’s final positions on the design, implementation and ongoing development of the Emissions Reduction Fund (Australian Government 2014).

5.1.2 *National Greenhouse and Energy Reporting Act 2007* (NGER)

The NGER framework was legislated in 2007 and contains mandatory reporting provisions for corporations and/or individual facilities owned and operated by constitutional corporations. These are triggered when their greenhouse gas emissions and/or energy use (as determined using the methodology described within the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines) meet any of the following criteria:

- The total entity GHG emissions were greater than 50,000 t of CO_2-e per year
- The total amount of energy produced was greater than 200 TJ per year

- The total amount of energy consumed was greater than 200 TJ per year
- The GHG emissions of a single facility were greater than 25,000 t of CO_2-e per year, or energy produced or consumed was greater than 100 TJ per year

Aside from supporting the carbon pricing legislation, information from NGER is also used to meet Australia's greenhouse gas reporting obligations under the United Nations Framework Convention on Climate Change (UNFCCC) and to track progress against Australia's targets under the Kyoto Protocol through the compilation of Australia's National Greenhouse Accounts (Clean Energy Regulator 2014b).

5.1.3 Renewable Energy Target (RET) Scheme

The RET scheme is designed to ensure that 20 per cent of Australia's electricity comes from renewable sources by 2020. Established in 2001, it was divided into two operational parts in 2011, consisting of the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET) (Clean Energy Regulator, 2012b). A second review of the RET scheme was completed in December 2014, concluding that changes to the policy environment in recent years have not weakened the case for the RET and that the current 2020 LRET should not be reduced, but should be re-phased slightly to increase the chances that it can be met (Climate Change Authority 2015).

5.1.3.1 Small-scale renewable energy scheme (SRES)

The SRES creates a financial incentive for households, small businesses and community groups to install eligible small-scale renewable energy systems such as solar water heaters, heat pumps, solar photovoltaic (PV) systems, small-scale wind systems, or small-scale hydro systems. It does this by legislating demand for Small-scale Technology Certificates (STCs). STCs are created for renewable energy systems at the time of installation, according to the amount of electricity they are expected to produce or displace in the future. For example, the SRES allows eligible solar PV systems to create, at the time of installation, STCs equivalent to 15 years of expected system output. RET-liable entities with an obligation under the LRET also have a legal requirement under the SRES to buy STCs and surrender them to the Clean Energy Regulator on a quarterly basis (Clean Energy Regulator 2012b).

5.1.3.2 Large-scale renewable energy target (LRET)

The LRET creates a financial incentive for the establishment or expansion of renewable energy power stations, such as wind and solar farms or hydro-electric power stations. It does this by legislating demand for Large-scale Generation Certificates (LGCs). One LGC can be created for each megawatt-hour of eligible renewable electricity produced by an accredited renewable power station. LGCs can be sold to entities (mainly electricity retailers) who surrender them annually to the Clean Energy Regulator to demonstrate their compliance with the RET scheme's annual targets. The revenue earned by the power station for the sale of LGCs is additional to that received for the sale of the electricity generated. The LRET includes legislated annual targets which will require significant investment in new renewable energy generation capacity in coming years. The large-scale targets ramp up until 2020 when the target will be 41,000 gigawatt-hours of renewable electricity generation (Clean Energy Regulator 2012b).

5.1.4 Carbon Farming Initiative (CFI)

The Carbon Farming Initiative enables individuals and entities to earn Australian carbon credit units (ACCUs) through activities that store carbon or reduce greenhouse gas emissions on the land. ACCUs earned under the Carbon Farming Initiative can be sold to people and businesses wishing to offset liability under the carbon pricing mechanism or voluntarily offset their emissions.

There are different types of activities that can be conducted under the Carbon Farming Initiative. These fall into two categories – emissions avoidance, where greenhouse gas emissions are prevented from entering the atmosphere, and sequestration, where carbon is stored on the land. The scope of emissions avoidance and sequestration activities that may be eligible under the Carbon Farming Initiative is defined under the *Carbon Credits (Carbon Farming Initiative) Act 2011*. A methodology determination must also be in place for activities under the Carbon Farming Initiative, to be considered an eligible project by the Clean Energy Regulator (Clean Energy Regulator 2014c). The *Carbon Farming Initiative Amendment Bill 2014* provided for the Clean Energy Regulator to conduct auctions and enter into contracts to purchase emissions reductions, enabled a broader range of emissions reduction projects to be approved and amended the project eligibility criteria and processes for approving projects and crediting carbon credit units (Department of the Environment 2015).

5.2 South Australia

The *Climate Change and Greenhouse Emissions Reduction Act 2007* made South Australia the first Australian state to legislate targets to reduce greenhouse emissions. The legislation sets out three targets:

- reduce greenhouse gas emissions within the state by at least 60% to an amount that is equal to or less than 40% of 1990 levels by 31 December 2050 as part of a national and international response to climate change
- increase the proportion of renewable electricity generated so it comprises at least 20% of electricity generated in the state by 31 December 2014
- increase the proportion of renewable electricity consumed so that it comprises at least 20% of electricity consumed in the state by 31 December 2014.

The legislation also commits the state government to work with business and the community to develop and put in place strategies to reduce greenhouse emissions and adapt to climate change. Resulting initiatives include climate change sector agreements, the Climate Change Adaptation Framework for South Australia (Department of Environment, Water and Natural Resources 2012) and South Australia's Greenhouse Strategy 2007-2020 (Department of Premier and Cabinet 2007), the latter two documents providing an overview of the South Australian need to adapt and respond to climate change in general, and the former are detailed in the following section.

5.2.1 Climate Change Sector Agreements

Sector agreements are formal cooperative agreements between the state government and specific business entities, industry sectors, community groups and regions to help tackle climate change (Government of South Australia 2014). The agreements typically encourage actions to reduce greenhouse emissions and adapt to climate change and may include commitments to:

- reducing emissions
- improving energy efficiency
- reducing energy consumption
- promoting the use of renewable energy
- research, development and innovation in technologies or practices
- member awareness raising and behaviour change programs
- identifying opportunities to adapt to climate change.

6 Emission estimation

6.1 Introduction

A description of the assessment methodology, and an estimation of the likely emissions associated with the Project are provided in the following sections. Emissions are broken down by scope in accordance with relevant standards for emissions reporting (see 6.2.1 for details), and further, emissions are categorised into NGERs (and thus price-exposed) and non-NGERs reportable emissions in order to determine the carbon price exposure of the Project.

6.2 Methodology

6.2.1 Standards and guidelines

This greenhouse gas assessment was undertaken in accordance with the following standards and guidelines:

- National Greenhouse and Energy Reporting Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia (July 2014) – used for the determination/calculation of NGERs-reportable emissions
- National Greenhouse Accounts Factors (December 2014) – used for the determination of non-NGERs reportable direct and indirect greenhouse gas emissions
- The Greenhouse Gas Protocol (Revised Edition, March 2004) – used to set boundaries for the greenhouse gas assessment.

6.2.2 Emission scopes

Emissions generated as a result of the Project have been categorised into one of three "scopes", defined below:

- Scope 1 (Direct greenhouse gas emissions) – These emissions occur from sources that are directly owned or operated by the Project
- Scope 2 (Electricity indirect greenhouse gas emissions) – The indirect emissions occur from the generation of electricity used by the Project across the extent of its operations. They are generated at power generation sites, but attributed to the end user
- Scope 3 (Other indirect greenhouse gas emissions) – These emissions occur as a consequence of activities associated with the Project, but occur from sources not owned or controlled by the company. Reporting of scope 3 emissions is optional under all of the standards and guidelines relevant to this assessment.

6.2.3 Assessment boundaries and limitations

This assessment accounts for all emissions associated with the Project that are considered to be under Iron Road's operational control. Operational control is defined under the NGER methodology as any operations where the proponent has the authority to introduce and implement any or all of the operating, health and safety and environmental policies for the facility. For example, a contracted mining fleet would remain under the operational control of Iron Road in spite of the company not owning or directly operating the fleet. For the purpose of this assessment, this is considered to represent all activities undertaken within the Mining Lease, all Iron Road-related activities undertaken along the infrastructure corridor and all Iron Road-related activities undertaken at the Port facility. It is noted this excludes accounting for emissions associated with third parties that may use the Port facility or infrastructure corridor for their own purposes.

The emissions are calculated for both the construction and operations phases. Construction emissions include construction fleet energy consumption, land use change associated with land clearing activities, the embodied energy emissions associated with the mass of concrete and steel used in the mine and related infrastructure plus the emissions associated with the transport of these construction materials to the site. Operational emissions include the use of purchased electricity and energy use associated with the operational mining fleet.

Scope 1 and 2 emissions sources are summarised for the construction and operations phases in Table 6.1 and Table 6.2 respectively.

Table 6.1: Construction phase Scope 1 and 2 emission sources

Scope	Emission	Source	NGERs-reportable
1	Emissions released by the consumption of liquid fuels	Diesel consumption by mobile fleet	Y
	Removal of sequestered carbon in soils/vegetation	Land clearing activities	N

Table 6.2: Operations phase Scope 1 and 2 emission sources

Scope	Emission	Source	NGERs-reportable
1	Emissions released by the consumption of liquid fuels	Diesel consumption by mobile fleet	Y
		Diesel consumption by product transport to Port	Y
	Emissions from the use of explosives	Explosives used for mine blasting activities	N
	Emissions of sulphur hexafluoride gases	Refrigeration and electrical transformer systems	Y
2	Emissions associated with the purchase of electricity from main electricity grid in a state or territory	Consumption of purchased electricity	Y

With regards to scope 3 emissions, guidance provided within the Greenhouse Gas Protocol has been applied when determining the boundaries of these indirect emissions. Scope 3 emissions associated with the project may be included if they meet the following criteria:

- Size – They contribute significantly to the Project's total estimated greenhouse gas emissions
- Influence – There are potentially significant greenhouse gas emissions reductions that could be undertaken or influenced by Iron Road
- Risk – They contribute to Iron Road's risk exposure. Such risks may include financial, regulatory, supply chain, product, technology, compliance, litigation, reputational or physical risks
- Stakeholders – They are deemed critical by key stakeholders including customers, suppliers, investors, local, regional or national residents

- Outsourcing – They are outsourced activities that were either previously performed in-house, or are commonly performed in-house by other similar industries
- Other – They meet any additional criteria developed or implemented by Iron Road, the industry sector or the Government.

An assessment of the significance of Scope 3 emissions sources associated with the construction and operations phase of the Project, and whether these should be included in the overall greenhouse gas assessment, is provided in Table 6.3.

Table 6.3: Construction and operations phase Scope 3 emissions sources and assessment

Source	Significance criteria						Include?
	Size	Influence	Risk	Stakeholders	Outsourcing	Other	
Construction phase							
Raw materials / reagents embedded energy	Y	Y	N	N	N	N	Y
Operations phase							
Workforce transport (FIFO)	Y	Y	N	Y	Y	N	Y
Product transport (bulk sea freight to end user)	Y	N	N	N	N	N	N
Further processing of sinter feedstock	Y	N	N	N	N	N	N
Disposal of solid wastes	N	N	N	Y	Y	N	Y

6.3 Emissions

6.3.1 Emissions sources and estimations

Building on the emissions sources identified in Table 6.1, Table 6.2 and Table 6.3 emissions calculations are outlines in the following sections. Emissions calculations have been undertaken in accordance with the methodologies detailed within the National Greenhouse and Energy Reporting System Measurement: Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia July 2014 (Department of the Environment 2014d).

6.3.1.1 Construction phase

6.3.1.1.1 Total diesel consumption

The total construction-phase diesel consumption associated with construction of the Project is summarised in Table 6.4

Table 6.4: Construction phase total diesel consumption

Area	Consumer	Diesel consumption (GL)[1]
Surface mine	Building and infrastructure	0.16
	Mine dewatering and water management	0.05
	Pre-production mining and haul roads	1.12
Ore treatment facilities	Ore treatment facilities	0.00
	Building and infrastructure	0.18

Area	Consumer	Diesel consumption (GL)[1]
	Dry process crushing and classification	1.76
	Wet process beneficiation and grinding	4.70
	Process water	0.04
	Utilities	0.16
	Laboratory	0.01
Mine site facilities	Mine infrastructure facilities and services	0.33
	Earthworks and site preparation	0.23
	Water	0.00
	Mine stockyards and train load-out	0.73
	Electrical infrastructure	0.08
	Utilities	0.00
Off-site facilities	Off-site facilities	0.02
	Power supply	0.23
	Rail systems	6.11
	Port and marine	5.14
	Water storage and supply	0.95
	Utilities	0.15
	Airport	0.00
	Roads	0.58
	TOTAL	22.75

[1] Total construction diesel consumptions obtained from Iron Road

Table 6.5 summarises the greenhouse gas emissions associated with the construction-phase diesel consumption.

Table 6.5: Construction phase mobile fleet diesel greenhouse gas emissions estimates

Energy demand	Consumption (kL)	Energy content (GJ/kL)	Emission factor (kg CO_2-e/GJ)			GHG emission (t CO_2-e)
			CO_2	CH_4	N_2O	
Mobile fleet diesel	22.75	38.6	69.2	0.2	0.5	61,372

6.3.1.1.2 *Total electricity consumption*

The total construction-phase electricity consumption associated with construction of the Project is summarised in Table 6.6.

Table 6.6: Construction phase total electricity consumption

Area	Consumer	Electricity consumption (kWh)[1]
Surface mine	Building and infrastructure	1,938
	Mine dewatering and water management	636
	Pre-production mining and haul roads	13,392
Ore treatment facilities	Ore treatment facilities	10
	Building and infrastructure	2,144
	Dry process crushing and classification	21,081
	Wet process beneficiation and grinding	56,243
	Process water	527
	Utilities	1,938
	Laboratory	126
Mine site facilities	Mine infrastructure facilities and services	3,971
	Earthworks and site preparation	2,738
	Water	7

Area	Consumer	Electricity consumption (kWh)[1]
	Mine stockyards and train load-out	8,775
	Electrical infrastructure	913
	Utilities	14
Off-site facilities	Off-site facilities	288
	Power supply	2,795
	Rail systems	73,182
	Port and marine	61,612
	Water storage and supply	11,325
	Utilities	1,742
	Airport	0
	Roads	7,003
	TOTAL	272,404

[1] Total construction electricity consumptions obtained from Iron Road

Table 6.7 summarises the greenhouse gas emissions associated with the construction-phase electricity consumption.

Table 6.7: Construction-phase emissions estimate associated with the use of purchased electricity

Energy demand	Consumption (MWh)	Emission factor (t CO_2-e/MWh)	GHG emission (t CO_2-e)
Purchased electricity	272	0.61	166

6.3.1.1.3 Land use change emissions

An estimate of carbon stocks on the agricultural land that comprises the majority of the proposed land to be cleared during construction of elements of the Project was presented via the Soil Quality website, from which models developed by the Australian Government, the Grains Research & Development Corporation, The University of Adelaide, the South Australian Research and Development Institute, CSIRO and others (Soilquality, 2014) are combined. This Soil Quality model presents an estimation of carbon stocks in the top 30 cm of soils in cropped land in the Eyre Peninsula based on sampling of 28 representative sites. A summary of the findings of this study are presented in Table 6.8.

Table 6.8: Carbon stocks (0-30 cm) in the Eyre Peninsula

Carbon (t/ha)[1]	Number of sites (%)
0 – 20	7.14
20 – 40	75.00
40 – 60	17.86

[1] To convert to t CO_2-e, tonnes of carbon are multiplied by 3.67.

In order to ensure a conservative greenhouse gas estimate, it has been assumed that the lands to be cleared by the Project are comprised of the same carbon distribution as outlined in Table 6.8, thus 7.14% of cleared land has an average carbon stock of 10 t/ha (36.7 t/ha of CO_2-e), 75% has a stock of 30 t/ha (110.1 t/ha of CO_2-e) and 17.86% of cleared land has a stock of 50 t/ha of carbon, or 183.5 t/ha of CO_2-e.

A summary of land clearance associated with the Project is presented in Table 6.9.

Table 6.9: Indicative Project land clearance

Infrastructure	Clearance area (ha)
Open pit mine	1,804
Integrated landform	2,018
Other mine infrastructure	745
Infrastructure corridor	830
Port facility	135
TOTAL	5,532

The land disturbance figures detailed in Table 6.9 include buffers to account for likely disturbance adjacent to the infrastructure footprint during construction and for operational maintenance activities, and hence represent a worst case land clearance. Additionally, the total clearance is a combination of some native vegetation and a significant proportion of agricultural land. Emissions associated with land clearing are summarised in Table 6.10.

Table 6.10: Land clearance greenhouse gas emissions estimate

Clearance area (ha)	CO_2-e/ha	GHG emission (t CO_2-e)
395	36.7	14,497
4,149	110.1	456,805
988	183.5	181,298
TOTAL		652,600

As a consequence of land clearing activities associated with the Project, it is estimated that a one-off CO_2-e emission of around 652,600 t would occur. As the topsoil would be stockpiled during operations and subsequently used in rehabilitation activities, and as, with the exception of the open pit void, the majority of the Project footprint is expected to be rehabilitated and revegetated following decommissioning, these emissions are considered to represent a worst-case emissions scenario.

6.3.1.1.4 Embodied carbon emissions

The construction of infrastructure associated with the Project would necessitate the use of a large volume of steel and concrete, the manufacturing and transport of which would result in the generation of greenhouse gases. For the purpose of this assessment, it has been assumed that all steelwork (including structural steel, pipework and pre-assembled modules, which are conservatively assumed to be totally constructed of steel) are imported to the Project site via ship from China via common shipping lanes, a distance totalling approximately 11,000 km. Concrete is assumed to be road-transported from Adelaide, a distance of 560 km by road. The emissions associated with the manufacturing of these materials and their transport to the construction site are summarised in Table 6.11 and Table 6.12: Indicative construction material transport energy emissions, respectively.

Table 6.11: Indicative embodied energy emissions

Source[1]	Sub-area	Mass (t)	Embodied carbon (t CO_2-e/t)	GHG emission (t CO_2-e)
Steel (embodied energy)	Structural steel	29,572	2.19[3]	64,763
	Platework	2,097		4,592
	Pipework	150,098		328,715

Source[1]	Sub-area	Mass (t)	Embodied carbon (t CO_2-e/t)	GHG emission (t CO_2-e)
	PAMS	39,452		86,400
Concrete (embodied energy)[2]	In-situ concrete	192,235	0.312[4]	59,977
	Precast concrete	15,840		4,942
			TOTAL	549,389

[1] All bulk masses obtained from Iron Road.
[2] Assumes a concrete density of 2.4 t/m^3.
[3] From Rankin 2012
[4] From Hammond *et al* 2008.

Table 6.12: Indicative construction material transport energy emissions

Source	Transport distance (km)	Mass transported (t)	Transport method	Transport emissions intensity (g CO_2-e/t-km)	GHG emission (t CO_2-e)
Steel transport	11,000	221,219	Shipping	18.53[1]	45,091
Concrete transport	560	208,075	Road transport	71[2]	8,273
				TOTAL	53,364

[1] From Wang *et al* 2013, converted to km from nm
[2] From Macintosh 2007

6.3.1.2 Operations phase

6.3.1.2.1 Mobile fleet diesel consumption

The mobile fleet proposed for the operations phase of the Project varies by year, according to the mine development schedule. The peak annual mobile fleet diesel consumption is summarised in Table 6.13.

Table 6.13: Indicative operational mobile fleet diesel consumption

Fleet	Peak diesel consumption (kL/annum)
Mine (including dewatering)	25,980
Processing Plant	220
TOTAL	26,200

Table 6.14 summarises the greenhouse gas emissions associated with the operation of mobile fleet.

Table 6.14: Mobile fleet diesel greenhouse gas emissions estimates

Energy demand	Consumption (kL/annum)	Energy content (GJ/kL)	Emission factor (kg CO_2-e/GJ)			GHG emission (t CO_2-e/annum)
			CO_2	CH_4	N_2O	
Mobile fleet diesel	26,200	38.6	69.2	0.2	0.5	70,691

6.3.1.2.2 Product transport diesel consumption

The iron ore would be transported from the mine site to the Port facility via a dedicated 145 km rail line. Individual trains would consist of two diesel-electric locomotives hauling 138 wagons of around 78 t capacity each, necessitating six round-trip rail movements per day. Diesel consumption data provided by Iron Road is detailed in Table 6.15.

Table 6.15: Train diesel consumption estimate

Source	Consumption (kL/annum)
Peak annual rail diesel	8,640

Table 6.16 summarises the greenhouse gas emissions estimate associated with the movement of iron concentrate to the Port facility.

Table 6.16: Product transport diesel greenhouse gas emissions estimate

Energy demand	Consumption (kL/annum)	Energy content (GJ/kL)	Emission factor (kg CO_2-e/GJ)			GHG emission (t CO_2-e/annum)
			CO_2	CH_4	N_2O	
Product transport diesel	8,640	38.6	69.2	0.2	0.5	23,312

6.3.1.2.3 *Explosives utilisation*

Iron Road has supplied explosives consumption data based on a single blast per day of around 335 drill holes, at around 983 kg of Ammonium Nitrate / Fuel Oil (ANFO) explosive per hole, for a total of 329 t per day, or 120,085 tpa. Table 6.17 presents the greenhouse gas emissions associated with the use of explosives.

Table 6.17: Emissions estimate associated with the use of explosives

Energy demand	Consumption (tpa)	Emission factor (t/t)[1]	GHG emission (t CO_2-e/annum)
ANFO	120,085	0.17	20,414

[1] Emissions factor sourced from 2008 National Greenhouse Accounts Factors

6.3.1.2.4 *Sulphur hexafluoride installed capacity*

The total installed capacity of electrical switchgear gases on-site has been estimated at 4,800 t, based on information for other, similarly scaled operations (BHP Billiton 2009). Emissions associated with the leakage of switchgear gases have been estimated in Table 6.18.

Table 6.18: Emissions estimate associated with the leakage of electrical switchgear gases

Energy demand	Installed capacity (t)	Emission factor (t/t)	GHG emission (t CO_2-e/annum)
Sulphur hexafluoride	4,800	0.0089	43

6.3.1.2.5 *Electricity consumption*

Electricity consumption for the Project varies by year, according to the mine production schedule. The peak annual electricity consumptions are summarised in Table 6.19.

Table 6.19: Peak annual Project electricity consumption

Demand source	Electricity consumption (MWh/annum)[1]
Mine (includes dewatering)	1,106,220
Processing plant	1,408,680
Tailings management	37,000

Demand source	Electricity consumption (MWh/annum)[1]
Mine concentrate handling	16,330
Rail	980
Port	112,050
Water treatment and supply	18,040
TOTAL	2,699,300

[1] Electricity consumptions obtained from Iron Road

The emissions associated with the use of grid-based electricity in South Australia are summarised in Table 6.20.

Table 6.20: Emissions estimate associated with the use of purchased electricity

Energy demand	Consumption (MWh/annum)	Emission factor (t CO_2-e/MWh)	GHG emission (t CO_2-e/annum)
Purchased electricity	2,699,300	0.61	1,646,573

6.3.1.2.6 Solid waste generation rates

Indicative waste generation rates for the construction and operational phases of the Project were provided by Jacobs and are summarised in Table 6.21. The waste generation rates reflect mine workforce-related landfill emissions only and it has been assumed that other residential employees would generated and dispose of their waste as per their existing waste management practices.

Table 6.21: Indicative waste generation rates arising from on-site activities

Project phase	Duration	Personnel	Waste (t/annum)	Total waste (t)
Construction	3	1,300[1]	6,500	19,500
Operation	25	560 (permanent) 46 (FTE, shutdown)[2]	3,030	75,700
TOTAL	28		9,530	95,250

[1] Incorporates the workforce responsible for the construction of the northern half of the infrastructure corridor which will be accommodated within the proposed mining lease
[2] The shutdown workforce of 300 persons is not part of the permanent workforce with work completed annually over an approximate eight week period. The 46 persons nominated for shutdown is the annual FTE equivalent.

For the purposes of estimating the likely landfill gas emissions, the waste generation rates were broken down into waste streams and disposal methodologies by Jacobs. This information is summarised in Table 6.23.

Table 6.22: Indicative waste streams and disposal methods

Waste stream	Proportion of waste stream (%)	Total waste generation (t)	Disposal method
Paper and cardboard	0.7	714	Off-site recycling facility
Metals	16.5	15,697	Off-site recycling facility
Tyres and miscellaneous	0.4	358	Off-site recycling facility
SUB-TOTAL	17.6	16,764	
Electrical and electronic	1.1	1,070	Licenced facility (off-site)
Solid hazardous waste	34.1	32,464	Licenced facility (off-site)
SUB-TOTAL	35.2	33,534	
Masonry	27.7	26,399	On-site landfill
Inseparable/unknown	8.6	8,205	On-site landfill
SUB-TOTAL	36.3	34,604	

Waste stream	Proportion of waste stream (%)	Total waste generation (t)	Disposal method
Inseparable/unknown	8.6	8,205	Wudinna landfill
Plastics	0.4	357	Wudinna landfill
Organics	0.4	357	Wudinna landfill
Leather and textiles	0.7	714	Wudinna landfill
Timber and wood	0.4	357	Wudinna landfill
Other	0.4	357	Wudinna landfill
SUB-TOTAL	10.9	10,370	
TOTAL	100	95,250	

The total amount of material disposed of to landfill (either on-site or at Wudinna) is 44,974 t. In order to provide a conservative assessment, it has been assumed that all of this material has the potential to generate landfill methane emissions.

Estimation of landfill methane emissions were undertaken using the US EPA LandGEM model, using default factors provided within the National Pollutant Inventory emission estimation techniques methodologies. The results indicate that methane emissions from wastes associated with the Project would increase from approximately 24 t at the end of the first year of construction and peak one year after the cessation of operations at approximately 173 t. At a GWP of 21 (see Section 4), the resultant peak CO_2-e emission would be approximately 3,633 t CO_2-e per annum.

6.3.1.2.7 Workforce transport

A summary of the proposed shift and accommodation profile for the Project is presented in Table 6.23.

Table 6.23: Indicative operational workforce shift and accommodation profile

Roster / area	Proportion of workers (%)	Approximate number of workers	Passenger movements (per annum)
Residential	24	182	0
1 week on / 1 week off	12	91	4,732
2 weeks on / 1 week off	64	487	16,883
TOTAL	100	760	21,615

Emissions for the FIFO workforce have been estimated using the International Civil Aviation Organisation (ICAO 2012) Carbon Emissions Calculator assuming operations are conducted between Port Lincoln (equivalent in distance and direction to the proposal to use an upgraded Wudinna Airport) and Adelaide. The emissions associated with the movement of the FIFO workforce are summarised in Table 6.24

Table 6.24: Emissions estimate associated with workforce transport

Energy demand	Number of passenger movements (PAX/a)	Emission factor (kg CO2-e/PAX/leg)	GHG emission (t CO_2-e/annum)
Aviation Avtur	21,615	40.33	872

6.3.2 Emissions summary

6.3.2.1 Construction phase

Summaries of the NGERs-reportable and total Project emissions estimates for the construction phase are provided in Table 6.25 and Table 6.26, respectively.

Table 6.25: Construction phase Project NGERs-reportable total emissions summary

Energy demand	Greenhouse gas emission (t CO_2-e)
Diesel	61,372
Electricity	166
TOTAL	61,538

Table 6.26: Construction phase Project total greenhouse gas emissions summary

Energy demand	Greenhouse gas emission (t CO_2-e/annum)
Scope 1	
Diesel	61,372
Land clearing	652,600
SUB-TOTAL	713,972
Scope 2	
Electricity	166
SUB-TOTAL	166
Scope 3	
Embodied energy	549,389
Material transport	53,364
SUB-TOTAL	602,753
TOTAL	1,316,891

6.3.2.2 Operations phase

Summaries of the NGERs-reportable and total Project emissions estimates for the operations phase are provided in Table 6.27 and Table 6.28, respectively.

Table 6.27: Project NGERs-reportable emissions summary

Energy demand	Greenhouse gas emission (t CO_2-e/annum)
Mobile fleet diesel	70,691
Product transport diesel	23,312
Switchgear gas leakage	43
Purchased electricity	1,646,573
TOTAL	1,740,619

Table 6.28: Project greenhouse gas emissions summary

Energy demand	Greenhouse gas emission (t CO_2-e/annum)
Scope 1	
Mobile fleet diesel	70,691
Product transport diesel	23,312
Switchgear gas leakage	43
Explosives	20,414

Energy demand	Greenhouse gas emission (t CO_2-e/annum)
SUB-TOTAL	114,460
Scope 2	
Purchased electricity	1,646,573
SUB-TOTAL	1,646,573
Scope 3	
Solid waste generation	3,633
Workforce transport	872
SUB-TOTAL	4,505
TOTAL	1,765,538

Given the estimated volume of annual greenhouse gas emissions, the Project once commenced would trigger the threshold for the legislative instruments associated with the reporting and management of greenhouse gas emissions, as described in Table 6.29.

Table 6.29: Summary of Project greenhouse gas reporting and management obligations

Legislative instrument	Summary of requirements
National Greenhouse and Energy Reporting Act 2007	Requirement to report all relevant Scope 1 and Scope 2 greenhouse gas emissions in accordance with the NGERs framework as a result of the single entity producing greater than 25,000 t of CO_2-e per annum when calculated in accordance with the National Greenhouse and Energy Reporting Measurement Technical Guidelines.

7 Impact assessment

7.1 State, Australian and International context

Estimated emissions from the Project have been compared against South Australian, Australian and global current and projected emissions in order to place the volume of Project-related (operational) emissions into context. This information is summarised in Table 7.1.

Table 7.1: CEIP greenhouse gas emissions in context

Source	Unit	Current	2020	2030
South Australia[1]	CO_2-e (Mt)	29.9	47.8	52.1
	CEIP (%)	5.9	3.7	3.4
Australia[2]	CO_2-e (Mt)	558.8	685	801
	CEIP (%)	0.32	0.26	0.22
Global[3]	CO_2-e (Mt)	42,300	53,800	63,600
	CEIP (%)	Negligible	Negligible	Negligible

[1] Current emissions sourced from Department of the Environment 2014a. 2020 and 2030 emissions projections from ABARE 2007

[2] Current emissions sourced from Department of the Environment 2014b. 2020 and 2030 emissions projections from Department of the Environment, 2013

[3] Current emissions referenced to 2010. 2020 and 2030 emissions projections from ABARE 2007.

As illustrated in Table 7.1, the generation and/or emission of greenhouse gases as a result of the Project represent only a small fraction of national and global emissions. Regionally, emissions from the Project may represent up to 5.9% of South Australia's contribution to global greenhouse gas emissions. Mitigation and management measures are described in Section 8.

8 Management and mitigation

Greenhouse gas mitigation takes one of two primary forms, either demand-side or supply-side mitigation. Demand-side mitigation seeks to implement processes, systems or equipment that reduces the energy demands associated with the construction and operation of the Project. Supply-side mitigation aims to meet the required energy demand in a manner that reduces the Project's greenhouse gas footprint. A number of mitigation measures have been identified that may further reduce the greenhouse gas footprint of the operation, and these are summarised in the following sections.

8.1 Mitigation in design

Iron Road has expended significant effort in reducing the greenhouse gas footprint of the CEIP Project during the design phase by incorporating measures that have directly contributed to a reduction in projected energy demand during construction and operations. Such design decisions include:

- Decreasing the projected mining fleet from around 50 haul trucks to around 10 through the implementation of an in-pit crushing and conveying system for ore and waste rock in preference to using truck haulage. This extends to the use of luffing conveyors and stackers to construct the integrated landform rather than traditional truck end dumping. The conveying system uses electricity rather than diesel, enabling savings in greenhouse gas emissions of the order of around 200,000 tpa as a result of the high proportion of renewable electricity within the South Australian electrical grid.
- The optimisation of the processing plant operations, including extensive dewatering of the tailings and reclamation of the water, reducing the need for additional, off-site water and associated pumping energy requirements
- The integration of the tailings storage facility and rock storage facilities, significantly reducing the Project footprint and thus the carbon stocks that would be disturbed during land clearing, saving around 100,000 t of CO_2-e over the life of the operation.

8.2 Demand-side mitigation

As part of the detailed design phase the following measures will be implemented and will assist to reduce greenhouse gas emissions:

- Optimisation of the proposed in-pit crushing and conveying methodology in order to provide the best balance between the mobile fleet size (both number and size of haul trucks), whilst reducing the energy required to crush and convey waste rock and ore materials
- Optimisation of rock and ore blasting techniques to minimise the energy consumed in the primary crushing phase of the process
- Optimisation of the product train transport regimes and equipment to maximise the number of tonnes transported per unit of fuel, and reduce the potential for trains to remain idling for long periods of time
- Incorporation of energy-efficient design elements within the accommodation, administration and workshop facilities to reduce electricity demands, including the use of energy-efficient fixtures,

fittings and appliances and the use of passive solar design elements within the plant and accommodation facilities
- Minimising fuel consumption by sourcing products locally where practicable to minimise travel distances and selecting efficient plant and equipment
- The optimisation of the water balance, including the application of water-efficient fixtures, fittings and appliances, and the capture and reuse of stormwater together with water-sensitive urban design. This would necessitate the transfer of less water from the remote borefields, thus reducing energy demand.

8.3 Supply-side mitigation

As part of the detailed design phase the following measures will be implemented and will assist to reduce greenhouse gas emissions:

- Sourcing a portion of energy requirements from renewable sources through off-site purchase and/or on-site generation, including the use of solar PV installations within the water supply borefield to minimise land disturbance associated with the installation of electricity transmission lines, and to provide power for extraction and pumping infrastructure
- The use of solar hot water systems and solar PV systems for powering the site administration, accommodation and workshop facilities where practicable
- The use of biodiesel fuel blends in mining mobile fleet when commercially available.

8.3.1 Offsets

Land clearance would also be minimised through the optimised siting of infrastructure and the management of the construction footprint in an effort to minimise the displacement of existing carbon stocks. Iron Road would investigate opportunities for the application of greenhouse emission offset programs under the Emissions Reduction Fund and associated Carbon Farming Initiative.

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