Climate Change and Greenhouse Gases

12. CLIMATE CHANGE AND GREENHOUSE GASES

12.1. Introduction

The purpose of this Chapter is to outline the potential effects of climate change on the Port Bonython Bulk Commodities Export Facility (BCEF) as well as determining the Greenhouse Gases (GHG) that are likely to be generated.

This assessment is intended to provide a summary of the potential effects of climate change on the Project, based on current understanding of climate change science, likely mitigation measures and emerging design approaches. The analysis highlights uncertainties of climate change projections which may reflect potential impacts to the Project in the future.

For ease of reading, this Chapter is divided into two sections: (a) Climate Change and (b) Greenhouse Gas Emissions.

12.2. Climate Change

12.2.1. Background Information

The Intergovernmental Panel on Climate Change (IPCC) has indicated that climate change is linked to increased emissions of greenhouse gases caused by human activity. "Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture" (IPCC, 2007).

The South Australian Research and Development Institute (SARDI) released a series of regional Climate Change projections reports for South Australia in 2010 (including a report for Eyre Peninsula) (DENR, 2010b), which represent the most recent interpretation of region-specific climate change projections. These reports were produced specifically for regional Natural Resources Management boards as a summary of climate change projections for 2030 (mid-term) and 2070 (long term).

The projections provide an estimate of the average climate for these years under future greenhouse gas emission scenarios, taking into account the consistency of climate models.

The SARDI Climate Change Projections report for Eyre Peninsula (DENR, 2010b) is based upon a synthesis of the information from a Scientific and Industrial Research Organisation (CSIRO) 2006 report, *Climate Change under Enhanced Greenhouse Conditions in South Australia* (Suppiah et al, 2006) and the 2007 *Climate Change in Australia Technical Report* (CSIRO, 2007).

These reports in turn are based on Global Climatic Models (GCM) prepared for the 2007 Fourth Assessment report (AR4) of the IPCC, which is the most recognised source of climate change projections internationally.

The IPCC is currently compiling the Fifth Assessment Report (AR5), which will provide a global update of knowledge on the scientific, technical and socio-economic aspects of climate change. AR5 will include three Working Group reports and a Synthesis Report due to be published in stages in early 2014.

Data in this Chapter has been sourced from the reports outlined above.

Guidance for the risk assessment and identification of adaptation measures has been sourced from the most recent edition of the Australian Standard for Climate Change Adaptation, AS 5334-2013. This standard is specific to Climate Change adaptation for settlements and infrastructure and uses a risk based approach for the assessment process.

12.2.2. Relevant Legislation and Policy

12.2.2.1. Relevant South Australian Legislation and Policy

Climate Change and Greenhouse Emissions Reduction Act 2007

The *Climate Change and Greenhouse Emissions Reduction Act 2007* provides for measures to address climate change with a view to assisting to achieve a sustainable future for South Australia to:

- Promote business and community understanding about issues surrounding climate change
- Facilitate the early development of policies and programs to address climate change; and for other purposes.

The legislation also commits the state government to work with business and the community to develop and put in place strategies to adapt to climate change. Resulting initiatives include climate change sector agreements and the development of a draft Climate Change Adaptation Framework for South Australia.

This legislation has informed subsequent climate change vulnerability assessments and adaptation plans discussed below, which have guided the identification of adaptation and mitigation measures for this Project.

Coastal Protection Act 1972

The *Coastal Protection Act 1972* makes provision for the conservation and protection of the beaches and coast of this State; and for other purposes. The purpose of this act is to provide for the management of the key coastal issues of standards applying to new development with regard to coastal flooding and erosion and associated protection works.

The assessment of climate change impact to the BCEF Project in regards to sea level rise will have regard for the policies issued by The Coast Protection Board as the official body chartered by the proclamation of the Act. The sea level rise projection adopted by the Coastal Projection Board is 1.0m by 2100, which has been used in the risk assessment for this Project.

South Australian Planning Strategy 2011

The South Australian Planning Strategy includes plans for seven regional areas of South Australia. The Strategy describes how the State Government proposes to balance population and economic growth with planning that considers climate change, preservation of the environment and the need to protect the heritage and character of regional communities.

One of its three objectives is:

- Sustainability and climate change resilience
  - Pattern of settlements is deliberately re-engineered towards greater sustainability and climate change resilience
  - Adaptation means the region responds to the risk of climate change and massively improves water and energy efficiency
  - Preserves and restores the natural environment.

Relevance and/or Project Consistency

The volume of the Planning Strategy relevant to the Eyre Peninsula (Eyre and Western Region Plan) (DPTI, 2012a) identifies the planning priorities, principles and policies necessary to achieve community and economic targets outlined by the South Australian Government.

The principles are:

- Principle One - Recognise, protect and restore the region's environmental assets
- Principle Two - Protect people, property and the environment from exposure to hazards
- Principle Three - Increase the capacity of the region to adapt and become resilient to the impacts of climate change.

Aside from Principle Three which is directly relevant to climate change, the others also address climate change. Principle 1 states the following:

- Coastal, estuarine and marine environments - Climate change may lead to sea-level rise and coastline shift, with associated impacts on ecosystems. Zoning may need to be adjusted over time to reflect these impacts. In addition, land use planning should consider the potential long-term and cumulative impacts of development on coastal and marine environments that can occur through changing hydrodynamic patterns, erosion or pollution of the environment

Biodiversity - Biodiversity should be increased with endemic species revegetation and the development of biodiversity corridors that can in turn strengthen the environment's resilience to climate change. A discussion of the impacts of climate change on terrestrial and marine ecology is given in **Chapter 7, Terrestrial Ecology and Chapter 14, Marine Ecology.**

Principle Two also states:

- Bushfire - Bushfire risk varies across the region. Appropriate planning and control measures can significantly reduce such risk to people and property. With the risk of bushfire anticipated to increase as a result of climate change, Development Plans should identify at-risk areas and adopt policy that minimises risk in accordance with that set out by the State Government.

These planning objectives have been considered and reflected in the mitigation and adaptation measures identified for the Project.

12.2.2.2. Local Government Legislation and Policy

Eyre Peninsula Integrated Climate Change Sector Agreement (EPICCA)

The Eyre Peninsula will be impacted by climate change as a consequence of higher temperatures, less rainfall and rising sea levels, amongst other factors.

To address this, the Eyre Peninsula Integrated Climate Change Sector Agreement (Minister for Sustainability and Climate Change, 2010) was formed with the South Australian Government, and brought together Eyre Peninsula Local Government Association (EPLGA), Eyre Peninsula Natural Resources Management Board (EP NRM Board) and Regional Development Australia Whyalla and Eyre Peninsula and State Government Agencies. This Agreement will lead to a Regional Climate Change Adaptation Action Plan to be developed through EPICCA in 2013, consistent with the requirements of the State Climate Change Adaptation Framework.

The development of the Adaptation Action Plan is being delivered through a two stage project utilising the Local Government Association of SA's *"Guidelines for Developing a Climate Change Adaptation Plan and Undertaking an Integrated Climate Change Vulnerability Assessment"* (2012).

These guidelines are endorsed for use across the State by the State Government's "*Prospering in a Changing Climate: South Australia's Adaptation Framework"* (DEWNR, 2012a), and are in compliance with the National Emergency Risk Assessment Guidelines (NERAG).

The findings from the stage one preliminary study by EPICCA (2013) have been drawn on to inform the assessment of the current climatic environment, impacts and mitigation measures specific to the BCEF Project.

12.2.3. Assessment Methodology

To inform the impact assessment, collation and review of data on the existing climatic environment of and around the Project site was first undertaken. This review drew on information in baseline and impact assessments undertaken for other sections of this EIS along with Project design information and external studies and reports described above. Following the study of existing conditions, regional climate change projections for the Project area were analysed to determine the predicted changes to the climatic environment for the representative years 2030 and 2070. These climatic assessments were used to inform the impact assessment and associated risk rating process.

A risk assessment was then undertaken using a framework that was primarily informed and developed with reference to AS 5334-2013 and the Australian Greenhouse Office (AGO) Climate Change Impacts and Risk Management – A Guide for Business and Government, 2006 which are the industry accepted best practice standards. AS 5334-2013 follows the International Standard ISO 31000:2009 which provides a set of internationally accepted and recognised principles on integrating risk and response planning into existing management processes. It closely aligns with the risk process undertaken for other technical investigations, as outlined in **Chapter 1, Project Introduction**.

Risk is defined as the effect of uncertainty on objectives (AS 5334-2013), with the risk management process understood to be the systematic application of management policies, procedures and practices to the tasks of communicating, establishing the context, identifying, analysing, evaluating, treating, monitoring and reviewing risk (ISO31000:2009). In the context of responding to climate change, risk does not just relate to the damage or destruction caused to the physical infrastructure at Port Bonython, it will also relate to a wealth of impacts including production, productivity, financial goals and reputation. The purpose of this risk assessment is to understand those risks that through the incorporation of appropriate recommendations can be managed.

The methodology used included desktop analysis and a high-level risk and impact assessment workshop. The objective of these activities was to identify the impacts to the Project associated with Climate Change and discuss and confirm the associated risk ratings.

The risk rating framework comprised of two key elements, which were then combined to determine the overall risk rating for each impact identified. Impact Significance Criteria were developed for utilisation during the risk assessment, representing scales of associated likelihood rating and resulting impacts. These Impact Significance Criteria are shown in **Table 12.2a** of **Section 12.2.4.** The overall priority risks were the focus of the mitigation measures identified in subsequent stages, with the aim of reducing any extreme or high level risks to the Project due to climate change.

Two risk assessments were undertaken as part of this study. The first assumed no climate change mitigation had been applied, allowing for a worst-case assessment and allocation of risk based on the most adverse scenario. The second assessment, which formed the basis for the information provided in this report, is informed by climate change mitigation approaches.

With the revised assessment incorporating these mitigation measures (for example allowing for sufficient stormwater drainage; and appropriate fire mitigation and management) the associated risk posed by the impacts of climate change has been revised enabling the risk ratings to be modified from what they will have been for the worst-case assessment based on no mitigation.

The methodology and the adaptation measures proposed for the Project are based on materials presented in Climate Change Impacts and Risk Management, A Guide for Business and Government (DEH, 2006); Climate Change Adaptation Actions for Local Government (DEWR, 2007); Adapting to Climate Change, A Queensland Local Government Guide (LGAQ, 2007) and Impacts of Climate Change on Settlements in the Western Port Region, Climate Change Risks and Adaptation (WPGA, 2008).

12.2.4. Impact Significance Criteria

The Impact Significance scales of associated likelihood rating and resulting impacts that are utilised for the risk assessment are detailed in Table 2.3b.

Table 12.2a: Impact Significance scales of associated likelihood rating and resulting impacts

Rating	Environment	Public Safety	Infrastructure Assets	Financial costs and profits OR profile & reputation	Compliance
Very High	Impact is clearly affecting the nature of the ecosystem over a wide area; and/or impact is very high and possibly irreversible over a smaller, but important area or to a sensitive population or community. Recovery periods of greater than 20 years likely; and/or condition of an affected part of the ecosystem irretrievably compromised	Circumstances leading to large numbers of injuries or loss of lives.	Permanent damage and/or loss of infrastructure and or operations across the Project area. Retreat of infrastructure support and translocation of operations.	Huge financial consequence (>25% of budget or revenue); and/ or serious adverse international; and/or national coverage/ community and NGO concern.	Obvious and proven breaches of legal and regulatory requirements with the prospect of corporate or individual penalties.
High	Impact is significant at either a local or wider level or to a sensitive population or community. Recovery periods of 10 - 20 years are likely.	Isolated instances of serious injuries or loss of lives.	Extensive damage to infrastructure and operations requiring extensive repair. Permanent loss of some infrastructure, e.g. a bridge washed away by a flood event.	Major financial consequence (10 to 25% of budget or revenue); and/or significant adverse regional and State media coverage/ community and NGO concern	Significant amounts of management and advisers' effort will be required to answer charges of compliance failures.
Moderate	Impact is present at either a local or wider level. Recovery periods of 5 - 10 years anticipated	Small numbers of injuries.	Wide-spread damage and/or loss of infrastructure or operations. Damage recoverable by maintenance and minor repair.	Moderate financial consequence (5 to 10% of budget or revenue); and/ or attention from media and/or significant concern by local community / criticism by NGOs	Formal action will be required to answer perceived breaches or charges of compliance failure.
Minor	Impact is present but not to the extent that it will impair the overall condition of the ecosystem, sensitive population or community in the long term.	Serious near misses. Or minor injuries.	Localised (partial) infrastructure or operational disruption. No permanent damage. Some minor restoration work required.	Minor financial consequence (1 to 5% of budget or revenue); and/or Adverse local publicity or media attention	Minor perceived or actual breaches of compliance will be resolved.
Negligible	No impact or, if impact is present, then not to an extent that will draw concern from a reasonable person. No impact on the overall condition of the ecosystem.	Appearance of a threat but no actual harm.	No infrastructure or damage to operations.	Negligible financial consequence (< 1% of budget or revenue); and/or some complaints but Project, client, stakeholder reputation intact.	Concerns about compliance will be resolved without special action.

12.2.5. Existing Climatic Conditions for Port Bonython

12.2.5.1. General Description

The climate of the Eyre Peninsula region near Port Bonython can generally be described as mild to hot in summer and cool in winter, with low and unreliable rainfall and high evaporation throughout the year. Whyalla, the closest major settlement to Port Bonython, experiences a semi-arid climate and there is little variation between the mean monthly rainfalls.

General descriptions of climatic conditions have been adapted from *the Draft EIS for Port and Terminal Facilities at Stony Point - South Australia* (SEA, 1981), BHP Billiton's *Environmental Impact Statement for the Olympic Dam Expansion (2009), Titanium Dioxide Manufacturing Plant Whyalla, Draft Environmental Impact Statement* (Dames and Moore, 1991) and AGC's report *Whyalla Investment Park, Declaration of Environmental Factors* (AGC, 1989). Climatic data statistics have been obtained from the Bureau of Meteorology (BOM) Whyalla Aero Station, the nearest operational weather station to Whyalla, which has been collecting data since 1945.

Climate statistics for Whyalla Aero relevant to the BCEF are shown in **Table 12.2b**.

12.2.5.2. Temperature

January is the warmest month with minimum and maximum mean temperatures of 17.6 and 30 °C respectively. July is the coolest month with mean minimum and maximum temperatures ranging between 5.2 and 16.9 °C respectively. The annual average minimum and maximum temperatures are 11.4 and 23.7 °C.

12.2.5.3. Rainfall

The mean annual rainfall recorded in the Whyalla region is 272.2mm. BOM data reveals that average rainfall peaks in September at 27.1mm and is the lowest in January where the monthly mean is 14.5mm. Historically, the major rainfall period is during the winter months.

12.2.5.4. Evaporation

As is to be expected evaporation is the highest in the warmer summer months, peaking with mean rates of 11.2mm per day through January. Evaporation is lowest in the winter months, with an average daily rate of 3mm in July. This data was recorded by BOM between 1993 and 2011 at Whyalla Aero Station. Based on these mean daily evaporation rates, average annual evaporation is 2520mm.

Table 12.2b: Climate Summary Statistics for Whyalla Aerodrome 1982-2010 (BoM, 2013b)

Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max. temperature (oC)	30.1	29.5	27.2	23.9	20.5	17.2	16.9	18.5	21.6	23.8	26.6	28.2	23.7
Mean min. temperature (oC)	17.6	17.8	15.4	11.7	8.8	6.0	5.2	6.0	8.1	10.5	14.0	15.9	11.4
Mean rainfall (mm)	14.5	25.5	21.0	19.5	24.6	25.4	23.8	22.0	27.1	25	21.0	24.0	272.2
Mean no. of days with rainfall > 1mm	1.4	2.1	2.5	2.7	4.9	4.8	4.4	4.8	4.1	3.8	2.9	3.0	41.4
Mean 9am wind speed (km/h)	17.0	15.0	13.4	11.9	10.8	11.3	12.2	13.9	16.4	18.0	16.9	16.6	14.5
Mean 3pm wind speed (km/h)	24.6	23.3	21.2	19.6	17.6	17.6	19.2	21.3	22.4	24.3	23.7	24.2	21.6

12.2.5.5. Wind

The north-south alignment of Spencer Gulf, the presence of the north-south Mount Lofty Ranges to the east, and the lower Middleback Ranges to the west have a major influence on wind movements in the area.

The majority of wind speeds in the area exceed 6km/hr. and calms are rare at Stony Point due to the coastal position and hilly terrain of the site.

In the warmer, summer months and into autumn, winds are predominantly southerlies in the morning and afternoon with strengths ranging between 10 to 40km/h. in the mornings that can strengthen to in excess of 40 km/hr. in the afternoon. South easterlies and south westerlies are also common in the morning, but tend to be less frequent in the afternoon.

In the winter months and early spring, north to north westerly winds are predominant in the morning, tending to occur over 30 percent of the time. In the afternoon, winds tend to emanate from the north and south equally, moving to be predominantly from the south further into spring. When northerlies, north westerly and westerly winds occur through winter and into early spring, they tend to be strong and can exceed 40km/h. speeds, particularly in the afternoon. Southerlies through this period generally range between 10 to 40km/h. and frequently occur in the afternoons.

Total wind rose observations from BOM at Whyalla Aero station at 9am and 3pm are shown in **Figures 12.2a** and **12.2b** for July and February to illustrate the seasonal pattern and variation. These results reveal that while there is a degree of seasonal and daily variance in wind speeds and directions, overall wind predominantly originates from the south.

Figure 12.2a: Observations at 9am and 3pm, July and February Wind Rose data taken at Whyalla Aero between 1982 and 2010 (BOM, 2013b)

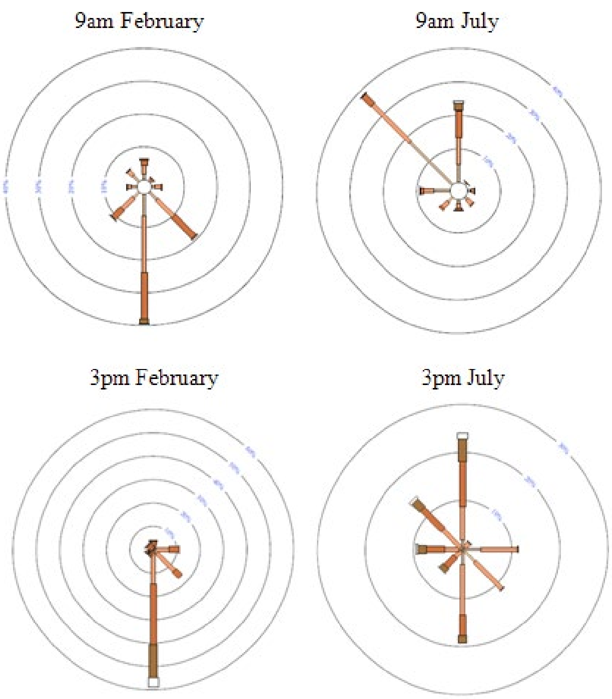
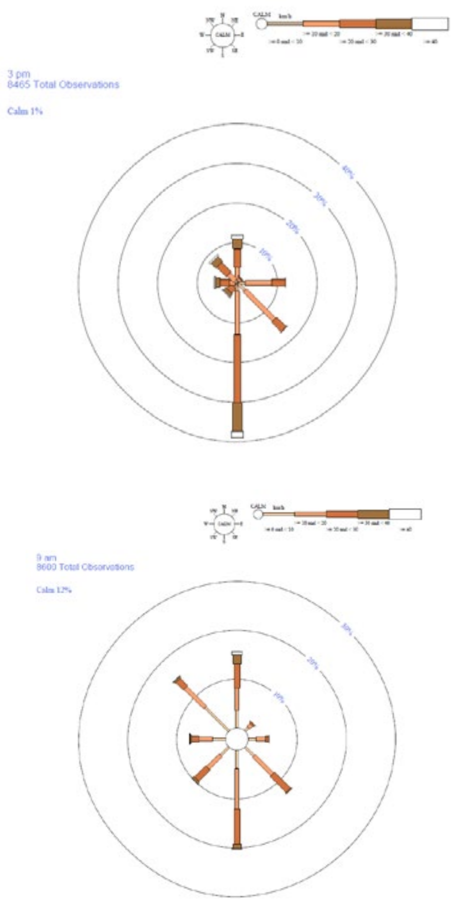


Figure 12.2b: BOM 9am and 3pm Wind Rose Data taken at Whyalla Aero taken between 1982 and 2010 (BOM, 2013b)



12.2.5.6. Extreme Weather Events

There are a mean number of 63.7 days where the temperature is greater than or equal to 30°C and a mean number of 8.2 days where the temperature reaches or exceeds 40°C. Conversely, there are a mean number of 13.9 days where the temperature falls to or below 2°C, with a mean of four days less.

In 2008, data for Adelaide indicated that there were 15 consecutive days of 35°C or above and 13 consecutive days of 37.8°C or above (DIICCSRTE, 2013). In early 2009, south-eastern Australia recorded record-breaking high temperatures across the region with Adelaide reaching the third-highest temperature ever recorded of 45.7°C with nine consecutive days above 35°C (DIICCSRTE, 2013).

Thunderstorms with lightning generally occur during November to December and March to April each year. The Bureau of Meteorology reports that between 1990 and 1999 there was an average of 10-15 thunder-days annually in the region (UEPBMC, 2012).

The majority of the year's rainfall occurs between April and October, and is generally between 300-450mm; however the region is frequently subject to droughts (UEPBMC, 2012).

12.2.6. Regional Climate Change Projections For Port Bonython

12.2.6.1. Uncertainty

In the *2007 Fourth Assessment Report*, the IPCC recognised that "warming of the climate system is unequivocal"; however there are degrees of uncertainty associated with its associated impacts (when and to what extent the impact will manifest). This uncertainty is associated with the anticipated rate of greenhouse gas emissions in the future and correlations between temperature increases and its associated impact on sea levels, rainfall or other climate parameters.

Within the next 10-15 years, it is generally accepted that there is a low level of uncertainty regarding changes to the climate, with recent trends and emissions data able to generate projections that remain within a small range (SARDI, 2010). For years beyond this, including years 2030 to 2040, uncertainty is increased due to a lack of understanding of the sensitivity of the climate and the level of emissions that will occur. As a result, projections model scenarios over a wider range assuming different levels of emissions from medium to very high. In 2070 and beyond, the range of climate projections is more significant, due to the combined uncertainty of different emission pathways and unknown levels of climate sensitivity (SARDI, 2010).

12.2.6.2. IPCC Emissions Scenarios

To estimate future climate change, the IPCC prepared forty greenhouse gas and sulphate aerosol emission scenarios for the 21st century that combine a variety of assumptions about demographic, economic and technological driving forces likely to influence such emissions in the future. They do not include the effects of measures to reduce greenhouse gas emissions, such as the Kyoto Protocol.

Each scenario represents a variation within one of four 'storylines': A1, A2, B1 and B2. The experts who created the storylines (described below) were unable to arrive at a most likely scenario, and probabilities were not assigned to the storylines.

Table 12.2c provides an overview of each of the presented emissions scenarios. Updated greenhouse gas emissions data and climate change projections indicate that the climate for Australia is on track to meet a high emissions (A1F1) scenario, suggesting that infrastructure designs should be based upon these projections when setting design safety factors. Therefore, for the purpose of the BCEF assessment only the high scenario will be assessed, using the A1FI Scenario as defined below.

12.2.6.3. Regional Climate Change Projections

The emissions scenarios discussed below are from the IPCC Special Report on Emission Scenarios (SRES).

The general impacts of climate change that are being used to guide climate change adaptation planning in the Eyre Peninsula region suggest that the region faces a hotter, drier climate with more extreme weather events and less runoff to the Southern Ocean and that Spencer Gulf will experience rising sea levels, warmer seas and increasing acidification.

Climate change projections are presented as the best estimate (median) 50th percentile values, and uncertainties are represented by the values at the lower (10th percentile) and higher (90th percentile) range. The percentiles are found by ranking the models from lowest to highest, with the 10th percentile representing estimates generated by the *1 in 10* coolest model, with the 90th percentile conversely representing the projection estimates from the *1 in 10* warmest climate model (SARDI, 2010).

Based on a projected design-life of 100 years for the rail and approximate construction completion in 2017, climate change projections for 2030 and 2070 have been utilised in this assessment. These projections represent those closest to the forecast lifespan of the Project that can be used with a reasonable degree of confidence. Projections beyond this date have a reduced level of certainty.

It should be noted that climate change projections are not an exact science and varying degrees of uncertainty remain with regard to likelihood and severity of impact. “Although the understanding of climate change has improved markedly over the past several decades and continues to improve the issue is still beset by uncertainty, the sources of which are many and diverse” (CSIRO & BoM, 2007).

By 2030, the 50th percentile (best estimate) under high emissions scenario for Eyre Peninsula is for annual temperatures to increase by 0.8^{0}C and 2.25^{0}C by 2070. The best estimate for annual rainfall under high emissions is a reduction of 3.5 percent by 2030 and a reduction of 15 percent by 2070.

Table 12.2d shows climate change projections for key climate variables relevant to the BCEF location within the Eyre Peninsula region. As discussed in **Section 12.2.6.2** only the high emissions scenario will be used for this assessment.

12.2.6.4. Sea Level Rise

Data from tide gauges around the world shows global sea level has risen by almost 0.2 meters since 1870. Since 1993, sea level has been more accurately measured by satellites. Both sets of measurements show the rate of sea level rise has accelerated. Sea levels have been projected to rise by a global average of 0.8 metres by 2100, but indications that the rise could be significantly greater cannot be ruled out (Climate Commission, 2013).

Global sea levels increased by 1.5mm per year over the 20th century (Coast Protection Board, 2012). Over the past 15 years, this trend has increased, with global seal levels now rising approximately 3.2mm per year. The rate of sea level rise varies significantly around Australia with southern Australia experiencing increases of between 2-7mm per year since the early 1990s (DIICCSRTE, 2013).

The National Tidal Centre of the Bureau of Meteorology has reported that current (2009) annual sea level rise in the Australian region is 4.5mm, (communication to the Sea Level committee of the Coast Protection Board South Australia). This tracks above the IPCC projections. The trend at the Thevenard baseline tidal recording station on Eyre Peninsula (reported in 2009) was 4.5mm/yr (BOM, 2009).

The South Australian Coast Protection Board has reviewed the data and projections regarding sea level rise for South Australia’s coastal regions and have adopted the projections from the IPCC. These projections form the basis of the Board’s policies and standards, which are further reflected in the state Development Plan, through the Regional Coastal Areas Policies Amendment. The projections adopted by the Board are updated as new IPCC projections are released. Currently, the recommendations regarding allowance for sea level rise in South Australia to 2100 are:

- + 0.30 m to 2050
- + 0.70 m to 2100
- Total sea level rise = 1.0 m

These projections are based on the projections for 2050 and 2100 from the Fourth Assessment Report from the IPCC. The total recommended rise also includes a small margin to account for uncertainties in the projections.

Table 12.2c: Overview of IPCC Emissions Scenarios

IPCC Emissions Scenarios	Definition
A1	The A1 storyline describes a world of very rapid economic growth in which the population peaks approximately 2050 and declines thereafter and there is rapid introduction of new and more efficient technologies. The three sub-groups of A1 are fossil fuel intensive (A1FI), non-fossil fuel using (A1T), and balanced across all energy sources (A1B).
A2	The A2 storyline depicts a world of regional self-reliance and preservation of local culture. In A2, fertility patterns across regions converge slowly, leading to a steadily increasing population and per capita economic growth and technological change is slower and more fragmented slower than for the other storylines.
B1	The B1 storyline describes a convergent world with the same population as in A1, but with an emphasis on global solutions to economic, social and environmental sustainability, including the introduction of clean, efficient technologies.
B2	The B2 storyline places emphasis on local solutions to economic, social and environmental sustainability. The population increases more slowly than that in A2. Compared with A1 and B1, economic development is intermediate and less rapid, and technological change is more diverse.

Table 12.2d: Summary of Climate Change Projections for 2030 and 2070 for Eyre Peninsula, SA

Variable	Season	2030			2070		
		High			High		
Percentile		10th	50th	90th	10th	50th	90th
Temperature˚C	Annual	0.45	0.8	1.25	1.75	2.25	3.5
	Summer	0.45	0.8	1.25	1.75	2.25	3.5
	Autumn	0.8	0.8	1.25	1.75	2.25	3.5
	Winter	0.45	0.8	1.25	1.75	2.25	3.5
	Spring	0.45	0.8	1.25	1.75	2.75	3.5
Rainfall %	Annual	-15	-3.5	0	-30	-15	2
	Summer	-15	-3.5	7.5	-30	-7.5	30
	Autumn	-15	-3.5	7.5	-30	-7.5	30
	Winter	-15	-7.5	0	-30	-15	0
	Spring	-15	-7.5	0	-50	-30	0
Wind Speed %	Annual	-3.5	0	3.5	-12.5	0	3.5
	Summer	0	3.5	7.5	-7.5	7.5	17.5
	Autumn	-7.5	0	3.5	-17.5	0	12.5
	Winter	-7.5	-3.5	3.5	-17.5	-7.5	7.5
	Spring	-7.5	0	3.5	-17.5	-3.5	12.5

12.2.6.5. Bushfires, Droughts and Extreme Heat Events

Estimates for Adelaide predict that the mean number of days with temperatures above 35°C could increase from 17 days currently to 21-26 days by 2030 and to 24-47 days by 2070 (DIICCSRTE, 2013).

Projections for sites across Australia indicate that the number of 'very high' and 'extreme' fire danger days could increase by 15-70 percent by 2050, with an increase of up to 65 percent for Adelaide under 'high' climate change scenarios (Lucas et al, 2007). Regional predictions for South Australia indicate that the annual cumulative Forest Fire Danger Index (a measure of the degree of danger of fire) could increase by 25 percent by 2050 (Lucas et al, 2007).

The frequency of months experiencing drought conditions is projected to increase, with the majority of the increases observed during summer and spring months (CSIRO, 2003).

12.2.6.6. Extreme Rainfall Events and Storm Surges

Although average rainfall is likely to decrease across the state, extreme rainfall events will increase between 0-10 percent across the state by 2050 (CSIRO, 2003), and indicate that storms may become more intense. Frequency and intensity was seen to rise most significantly for regions around Yorke Peninsula, Adelaide and Kangaroo Island (CSIRO, 2003).

While the weather patterns associated with storm frequency and storm surges are projected to decrease, the intensity of these weather patterns is likely to increase. There is also evidence that the rainfall associated with these weather patterns will increase across some areas of the coast, which suggests that flooding due to the combination of rainfall and storm surge could increase (CSIRO, 2003). However, additional modelling is required to increase the confidence in these projections (CSIRO, 2003).

12.2.6.7. Summary of Climate Change Projections

Climate Change Projections for the Eyre Peninsula in 2030 and 2070 show an overall increase in temperature and decrease in rainfall. Projections are generally only available at specific dates, such as 2030, 2050, 2070 and 2100, and not for beyond 2100.

By 2030, the 50th percentile (best estimate) under the high emissions scenario is for annual temperatures to increase by 0.8°C and 2.25°C by 2070. The best estimate for annual rainfall under medium emissions is a reduction of 3.5 percent by 2030 and a reduction of 15 percent by 2070.

The Eyre Peninsula region in which the Project is located faces a hotter, drier climate with more extreme weather events and less runoff and the Southern Ocean and Spencer Gulf will experience rising sea levels, warmer seas and increasing acidification.

More specifically, predictions for key climate variables in the Eyre Peninsula region are shown below in **Table 12.2e**. Effort has been made to apply locally-relevant projections.

Table 12.2e: Summary of predictions for key climate variables in the Eyre Peninsula, SA

Description	Impact under High Emissions Scenario
Annual temperature increase best estimate	+0.8°C by 2030 +2.25°C by 2070
Annual rainfall reduction best estimate	-3.5% by 2030 -15% by 2070
Evapotranspiration	An increase in potential evapotranspiration varying from +4% to +8%, adds to increasing aridity.
Sea surface temperature increase best estimate	+0.45°C by 2030 +0.6°C by 2070
Sea level rise recommendation adopted by the South Australian Coast Protection Board	+ 0.30 m to 2050 + 0.70 m to 2100
Wind speed change	Wind speeds may change by 3.5-7.5%
Extreme hot days (number of days over 35°) (Regional projections from Adelaide)	+21-26 days by 2030 +24-47 days by 2070
Extreme cold events and frost	Decrease in number of events
Bushfires, increase in the number of "very high" and "extreme" fire days	15-70% by 2050
Extreme rainfall events	Increase between 0-10% by 2050
Increase in months experiencing drought	Increase of 300 months in frequency by 2050

12.2.7. Climate Change Impact Assessment

12.2.7.1. Impact Areas

The effects of climate change are likely to impact a broad cross section of infrastructure assets within the BCEF, as shown in **Table 12.2f**. These effects will impact the permanent infrastructure and operations at the site, as construction activities will be completed prior to 2030 projections.

Table 12.2f: Potential Climate Change Impacts for BCEF

Assets/ Service Delivery	Climate Variable	Potential Climate Change Impacts	Significance of Impact	Likelihood	Overall Risk
Infrastructure and Property					
Rail/Road/ pavement construction and maintenance	» Extreme heat	» Changes in rates of deterioration due to extreme heat (railway buckling, material delamination, hard stand deterioration)	Moderate	Possible	Medium
	» Extreme weather events	» Changes in frequency of interruption of road/rail/shipping traffic from extreme weather events	Moderate	Possible	Medium
Stormwater/ drainage	» Extreme weather events including extreme rainfall and storm surge	» Exceedance of site drainage capacity	Moderate	Possible	Medium
Buildings (storage sheds)	» Increase in temperature extremes » Increase in extreme events » Decrease in annual rainfall	» Increased risk of damage to infrastructure from wildfire, lightning strike » Higher rates of building deterioration and associated maintenance costs due to extreme temperatures	High	Likely	High
		» Building damage from footing movements in dry soil	Minor	Unlikely	Low
	» Increased wind speeds	» More severe wind and hail storms damaging buildings and associated major infrastructure	Minor	Possible	Low
Coastal infrastructure (jetty and wharves)	» Increased rainfall intensities leading to more frequent and severe flooding » Sea level rise	» Increased frequency or permanent inundation of coastal infrastructure and utilities » Destruction and damage to marine assets » Increased erosion	Moderate	Likely	Medium
	» Ocean acidification	» Increased rates of deterioration of marine infrastructure	Minor	Possible	Low
Electricity	» Increase in temperature extremes	» Loss of power supply – extreme heat and bushfires » Increased consumption of electricity for plant cooling and site operation	Minor	Likely	Medium
Water supply	» Decrease in annual rainfall	» Insufficient water supply, contamination due to reduced runoff	Moderate	Likely	Medium
Terrestrial Ecological Values	» Decrease in annual rainfall » Increased temperature	» Entry and proliferation of some species of weeds, pests and diseases » Increase in numbers and extent of drought tolerant species » Stress to native species from more frequent droughts and hotter temperatures	Moderate	Likely	Medium

Assets/ Service Delivery	Climate Variable	Potential Climate Change Impacts	Significance of Impact	Likelihood	Overall Risk
Infrastructure and Property					
Marine Ecological Values	» Increase in water temperature » Changes to oceanic currents » Acidification	» Potential change in breeding season and migration patterns e.g. possible change in cuttlefish breeding season » Increased disease and parasite susceptibility and incursion of pest species » Changes to existing habitats at Port Bonython » Increased incidents of algal blooms » Decreased oxygen availability as a result of higher water temperatures » Changes in water pH and distribution of species	High	Likely	High
Planning and Management					
Emergency/ bushfire management	» Increase in temperature extremes	» More severe and frequent bushfire risk leading to increased requirement for emergency response & recovery operations » Risks to public safety (working conditions)	High	Likely	High
Planning/ policy development	» All	» Cost of retrofitting systems and increased cost of insurance	Moderate	Likely	Medium
Port operations	» Increase in extreme events	» Impact on port and onshore operations at the site » Operational downtime can be caused due to damage of the structure and increased repair times.	High	Likely	High
Waste	» Increase in temperature extremes	» Putrescibles wastes require more frequent collection and disposal	Minor	Possible	Low
Health and safety	» Increase in temperature extremes	» Longer and more severe heat waves leading to heat stress on employees and site personnel » Increased UV and sun exposure for employees	High	Almost Certain	Extreme
	» Increase in temperature extremes	» Increased consumption of energy for air conditioning of occupied buildings	Minor	Likely	Medium

12.2.8. Mitigation Measures

In order to address potential impacts and inform further development phases and inputs, a number of recommendations for the Project to be considered as design principles/criteria are given in **Table 12.2f**.

The application of these recommendations will build resilience across the Project infrastructure assets and support their ability to respond to potential Climate Change impacts.

12.2.8.1. Developing Adaptation Options

Generally there are four possible approaches in responding to climate change:

- Avoid – e.g. avoid locating assets in vulnerable areas
- Adapt –e.g. design and/or design standards to operate in predicted climate conditions
- Defend – e.g. install defences at or around critical infrastructure
- Retreat – e.g. develop and implement plans to relocate from the vulnerable area.

The measures discussed in this assessment respond directly to the 'Adapt' approach and seek to present a range of recommendations to support continued operation in the face of predicted climate change conditions.

12.2.8.2. Adaptation Design and Operational Procedure Recommendations

This section provides adaptation design and operational procedure recommendations for the identified Project infrastructure assets in relation to the relevant climate change variable(s) based on the impact assessment findings in **Table 12.2f** of **Section 12.2.7.** The recommendations are summarised in **Table 12.2g**.

Table 12.2g: Mitigation measures identified to respond to the impacts on the Project due to climate change

Assets/ Service Delivery	Impact	Mitigation Measure
Infrastructure and Property		
Rail/Road/ pavement construction and maintenance	» Changes in rates of deterioration due to extreme heat (railway buckling, material delamination, hard stand deterioration)	» Materials and design features will be investigated in subsequent design phases to reduce heat degradation of roads and railway infrastructure
	» Changes in frequency of interruption of road/rail/ shipping traffic from extreme weather events	» Port operation management plans shall include consideration of operating procedures in major storm events » The implications of downtimes to operations should be assessed in a more detailed risk assessment.
Stormwater/ drainage	» Exceedance of site drainage capacity	» The site design optimises layout, drainage and retention from hardened surfaces » The detailed design of the site drainage shall consider the latest climate change predictions and any relevant advice from appropriate sources, including the Australian Rainfall and Runoff Technical Committee, to adopt appropriate rainfall design scenarios
Buildings (storage sheds)	» Increased risk of damage to infrastructure from wildfire, lightning strike » Higher rates of building deterioration and associated maintenance costs due to extreme temperatures	» Adaptation features and energy efficiency measures shall be incorporated into all new or refurbished buildings and infrastructure to minimise long term maintenance costs. » Backup generation for critical port facilities shall be considered in the detailed design allowances » A bushfire management plan will be prepared for the operational phase of the Project, and will consider the additional risk of wildfire posed by climate change.
	» Building damage from footing movements in dry soil	» The detailed design of the buildings will consider the movements of footings and foundations
	» More severe wind and hail storms damaging buildings and associated major infrastructure	» The detailed design of buildings and associated major infrastructure shall consider projected wind and storm intensities and frequencies
Coastal infrastructure (jetty and wharves)	» Increased frequency or permanent inundation of coastal infrastructure and utilities » Destruction and damage to marine assets » Increased erosion	» Marine and coastal infrastructure has been designed with a safety factor to allow for sea level rise and flooding and site drainage will prevent inundation of rail and site facilities. The safety factor shall be reviewed and updated during detailed design to consider it takes into account up to date sea level rise projections » Jetty abutment will be sufficiently protected from erosion » Stormwater will likely be captured, stored and reused on site
	» Increased rates of deterioration of marine infrastructure	» Material specifications developed during subsequent design phases shall consider the impacts of climate change to ensure the required durability of the materials (cathodic protection, paints, and corrosion allowances)
Electricity	» Loss of power supply – extreme heat and bushfires » Increased consumption of electricity for plant cooling and site operation	» Backup generation for critical port facilities shall be considered in the detailed design allowances » During the detailed design, plant, pumps and other assets for site operation will be selected with consideration of energy efficiency features.

Assets/ Service Delivery	Impact	Mitigation Measure
Infrastructure and Property		
Water supply	» Insufficient water supply, contamination due to reduced runoff	» Stormwater will be collected on site for dust suppression and other non-potable requirements » Grey water and recycled water re-use may be incorporated into detailed design » Landscaping will make use of native and drought-tolerant species to reduce water requirements
Terrestrial Ecological Values	» Change in habitat and species composition	» Disturbance to existing habitat is minimised and that it is protected from damage so that it as resilient to change as possible
Marine Ecological Values	» Change in habitat and species composition	» Disturbance to existing habitat is minimised and that it is protected from damage so that it as resilient to change as possible
Planning and Management		
Emergency/ bushfire management	» More severe and frequent bushfire risk leading to increased requirement for emergency response & recovery operations » Risks to public safety (working conditions)	» The site will observe fire danger season and fire ban days declared by the Country Fire Service and adopt the recommended bushfire management procedures as applicable to operations » Water will be reticulated around site and stored for fire and spray water in onsite tanks for fire fighting » An Emergency Response Plan for the site will be developed prior to commencement of operations
Planning/ policy development	» Cost of retrofitting systems and increased cost of insurance	» The detailed design of infrastructure and buildings shall allow for adaptation modifications later on, should climate change have greater impact on operations where practicable
Port operations	» Impact on port and onshore operations at the site » Operational downtime can be caused due to damage of the structure and increased repair times.	» Port operation management plans shall include consideration of operating procedures in major storm events
Waste	» Putrescibles wastes require more frequent collection and disposal	» A site-wide waste management strategy shall be developed for the site and provide appropriate disposal of putrescibles
Health and safety	» Longer and more severe heat waves leading to heat stress on employees and site personnel » Increased UV and sun exposure for employees	» Detailed design of habitable buildings (including the administration and amenities buildings) will consider adequate insulation and passive design features to improve thermal comfort » Policies regarding heatwaves, sun and UV exposures will form a part of the operation management plan » Air conditioning will be provided for habitable buildings
	» Increased consumption of energy for air conditioning of occupied buildings	» Detailed design of habitable buildings (including the administration and amenities buildings) will consider adequate insulation, energy efficient design and passive design features to reduce air conditioning requirements

12.2.9. Residual Risk Assessment

Following identification of the mitigation measures in response to the impacts identified, a secondary risk assessment was undertaken to determine the residual risk that remains due to the impacts of climate change. For the results of this assessment, refer to **Table 12.2h**.

Table 12.2h: Mitigation measures identified to respond to the impacts on the Project due to climate change

Assets/Service Delivery	Impact	Initial Risk Rating		
		Significance of Impact	Likelihood	Overall Risk
Infrastructure and Property				
Rail/Road/Pavement construction and maintenance	» Changes in rates of deterioration due to extreme heat (railway buckling, material delamination, hard stand deterioration)	High	Likely	High
	» Changes in frequency of interruption of road/rail/shipping traffic from extreme weather events	Moderate	Possible	Medium
Stormwater/ drainage	» Exceedance of site drainage capacity	Moderate	Possible	Medium
Buildings (storage sheds)	» Increased risk of damage to infrastructure from wildfire, lightning strike » Higher rates of building deterioration and associated maintenance costs due to extreme temperatures	High	Likely	High
	» Building damage from footing movements in dry soil	Minor	Unlikely	Low
	» More severe wind and hail storms damaging buildings and associated major infrastructure	Minor	Possible	Low
Coastal infrastructure (jetty and wharves)	» Increased frequency or permanent inundation of coastal infrastructure and utilities » Destruction and damage to marine assets » Increased erosion	Moderate	Likely	Medium
	» Increased rates of deterioration of marine infrastructure	Minor	Possible	Low
Electricity	» Loss of power supply – extreme heat and bushfires	Minor	Likely	Medium
	» Increased consumption of electricity for plant cooling and site operation	Minor	Likely	Medium
Water supply	» Insufficient water supply, contamination due to reduced runoff	Moderate	Likely	Medium

Mitigation Measure	Residual Risk Rating		
	Significance of Impact	Likelihood	Overall Risk
» Materials and design features will be investigated in subsequent design phases to reduce heat degradation of roads and railway infrastructure	Minor	Possible	Low
» Port operation management plans shall include consideration of operating procedures in major storm events » The implications of downtimes to operations should be assessed in a more detailed risk assessment.	Minor	Possible	Low
» The site design optimises layout, drainage and retention from hardened surfaces » The detailed design of the site drainage shall draw on the latest climate change predictions and any relevant advice from appropriate sources, including the Australian Rainfall and Runoff Technical Committee, to adopt appropriate rainfall design scenarios	Negligible	Possible	Low
» Adaptation features and energy efficiency measures shall be incorporated into all new or refurbished buildings and infrastructure to minimise long term maintenance costs. » Backup generation for critical port facilities shall be included in the detailed design allowances » The detailed design of infrastructure and buildings shall allow for adaptation modifications later on, should climate change have greater impact on operations	Moderate	Possible	Medium
» The detailed design of the buildings will consider the movements of footings and foundations	Negligible	Unlikely	Low
» The detailed design of buildings and associated major infrastructure shall consider projected wind and storm intensities and frequencies	Negligible	Possible	Low
» Marine and coastal infrastructure has been designed with a safety factor to allow for sea level rise and flooding and site drainage will prevent inundation of rail and site facilities. The safety factor shall be reviewed and updated during detailed design to ensure it takes into account up to date sea level rise projections » Stormwater may be captured, stored and reused on site » A Floodplain Risk Management plan will be developed for the site	Minor	Likely	Medium
» Material specifications developed during subsequent design phases shall consider the impacts of climate change to ensure the required durability of the materials (cathodic protection, paints, and corrosion allowances).	Negligible	Possible	Low
» Backup generation for critical port facilities shall be included in the detailed design allowances	Minor	Possible	Low
» During the detailed design, plant, pumps and other assets for site operation will be selected with consideration of energy efficiency features and optimal air cooling systems that minimise the need for continuous mechanical cooling	Negligible	Possible	Low
» Stormwater will likely be collected on site for dust suppression and other non-potable requirements » Grey water and recycled water re-use will potentially be incorporated into detailed design » Landscaping will make use of native and drought-tolerant species to reduce water requirements	Minor	Likely	Medium

Assets/Service Delivery	Impact	Initial Risk Rating		
		Significance of Impact	Likelihood	Overall Risk
Planning and Management				
Emergency/bushfire management	» More severe and frequent bushfire risk leading to increased requirement for emergency response & recovery operations » Risks to public safety (working conditions)	High	Likely	High
Planning/policy development	» Cost of retrofitting systems and increased cost of insurance	Moderate	Likely	Medium
Port operations	» Impact on port and onshore operations at the site » Operational downtime can be caused due to damage of the structure and increased repair times.	High	Likely	High
Waste	» Putrescibles wastes require more frequent collection and disposal	Minor	Possible	Low
Health and safety	» Longer and more severe heat waves leading to heat stress on employees and site personnel » Increased UV and sun exposure for employees	High	Almost Certain	Extreme
	» Increased consumption of energy for air conditioning of occupied buildings	Minor	Likely	Medium

12.3. Greenhouse Gas Emissions

This section details the potential impacts of the BCEF in terms of greenhouse gas (GHG) emissions through a quantitative assessment. It quantifies the projected GHG emissions that may be released to the atmosphere as a result of construction and operational activities. In addition to the construction and operational stages, the direct GHG emissions associated with the transport of iron ore by various transport modes is assessed. Noting this will be the responsibility of third parties to consider in future.

Strategies to help better manage and reduce the projected GHG emissions are outlined.

12.3.1. Background

Australia is a signatory to the Kyoto Protocol, which identifies six major GHG that must be reported by countries that have ratified the protocol. These gases are carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons.

12.3.1.1. South Australian GHG Emissions

Activities that generate GHG emissions in South Australia can be broken down into sectors that include stationary energy, transport, fugitive emissions, industrial processes, agriculture, waste and land use, land use change and forestry (LULUCF). In this assessment, GHG emissions are expressed in terms of equivalent units of carbon dioxide (CO_2e). All non-carbon dioxide gases are converted to carbon dioxide equivalent using the Global Warming Potential index.

The latest estimate of South Australia's annual GHG emissions was 30.4 Mega tonnes (MT) of CO_2e including emissions and removals from LULUCF in 2009/2010.

Mitigation Measure	Residual Risk Rating		
	Significance of Impact	Likelihood	Overall Risk
» The site will observe fire danger season and fire ban days declared by the Country Fire Service and adopt the recommended bushfire management procedures » Water will be reticulated around site and stored for fire and spray water in onsite tanks for fire fighting » An Emergency Response Plan for the site will be developed prior to commencement of operations	Minor	Likely	Medium
» The detailed design of infrastructure and buildings shall allow for adaptation modifications later on, should climate change have greater impact on operations.	Minor	Possible	Low
» Port operation management plans shall include consideration of operating procedures in major storm events » To countermeasure downtime from mooring limitations, the mooring of ships should be timed with the weather forecast. There is a possibility to adjust operational limitations, but any change to the operational limitations should be based on a risk assessment, specifically considering safety requirements.	Moderate	Possible	Medium
» A site-wide waste management strategy shall be developed for the site and provide appropriate disposal of putrescibles	Negligible	Possible	Low
» Detailed design of habitable buildings (including the administration and amenities buildings) will incorporate adequate insulation and passive design features to improve thermal comfort » Policies regarding heatwaves, sun and UV exposures will form a part of the operation management plan » Air conditioning will be provided for habitable buildings	Moderate	Possible	Medium
» Detailed design of habitable buildings (including the administration and amenities buildings) will incorporate adequate insulation, energy efficient design and passive design features to reduce air conditioning requirements	Negligible	Possible	Low

12.3.1.2. Transport Sector and GHG Emissions

In 2009 Australia reported national GHG emissions of 560.8 MT of CO_2e, with 83.2 MT or 14 percent attributed to the transport sector (DCCEE, 2011a).

Emissions from this sector have grown over 25 percent since 1990, and the share of emissions from the transport sector has grown from 11 percent in 2004/2005 (DCCEE, 2011a). Passenger cars are the largest source of emissions from the transport sector however trucks, domestic shipping and railways contribute over 25 percent of the GHG emissions from this sector as shown in **Figure 12.3a**.

Trucks in particular are responsible for a significant share of the GHG emissions, much greater than shipping or rail, despite all three major modes being responsible for substantial shares of the overall freight task. This breakdown is illustrated in **Figure 12.3b**.

This analysis demonstrates freight handled by rail or shipping modes delivers a far superior outcome in terms of GHG emissions. The comparison illustrates one tonne-kilometre (tkm) of freight moved by rail emits approximately 14 percent of the GHG emissions of a tkm moved by road, or 22 percent in the case of domestic shipping (ThinkClimate Consulting, 2013). It should be noted that international shipping is generally more efficient than domestic shipping and will have a lower footprint.

Figure 12.3a: GHG emissions from the Australian transport sector by vehicle type (DCCEE, 2011a)

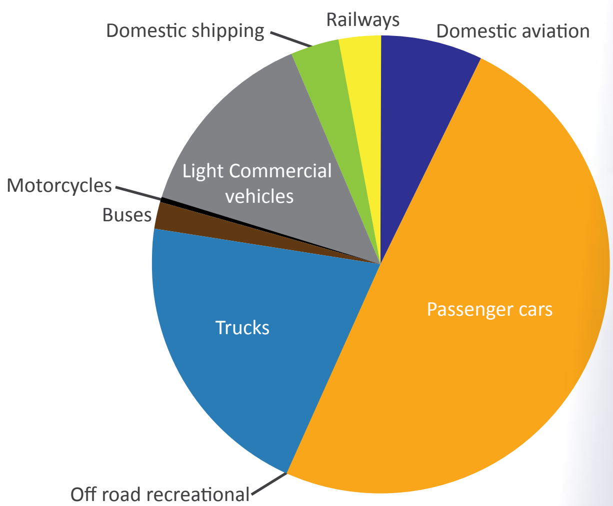
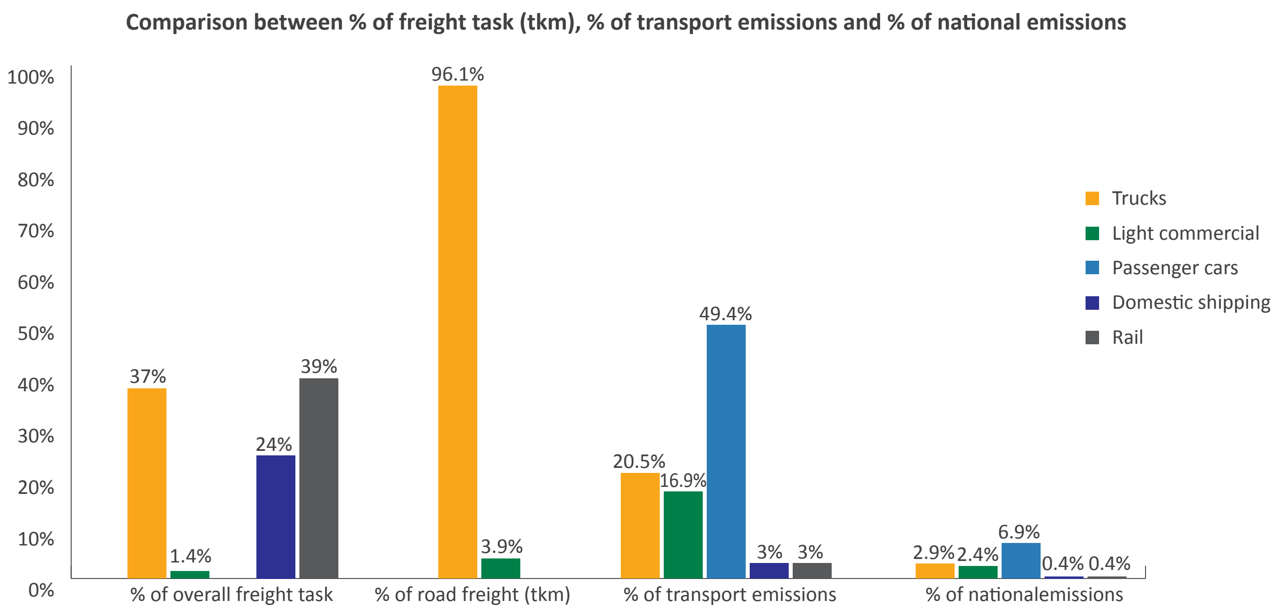


Figure 12.3b: Comparison between percentage of registered vehicles, percent of freight task (tkm), percent of transport emissions and percent of national emissions (ThinkClimate Consulting, 2013)



12.3.2. Policy Context and Legislative Framework

12.3.2.1. Federal Context

National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 200***7** provides for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy production and energy consumption. It sets out and regulates the National Greenhouse and Energy Reporting (NGER) Scheme to provide data and accounting in relation to greenhouse gas emissions and energy consumption and production. The Scheme's legislated objectives are to:

- Underpin the carbon price mechanism
- Inform policy-making and the Australian public
- Meet Australia's international reporting obligations
- Provide a single national reporting framework for energy and emissions reporting.

The assessment of GHG emissions for construction and operational components of the BCEF will comply with all relevant provisions outlined in the *National Greenhouse and Energy Reporting Act 2007.*

The DCCEE has prepared and published the National Greenhouse Accounts (NGA) Factors (DCC, 2012), which are designed for use by companies and individuals to estimate GHG emissions.

The methods described in the NGA Factors have a general application to the estimation across the range of GHG emissions relevant to the BCEF.

The National Carbon Offset Standard

The National Carbon Offset Standard is designed to ensure that consumers have confidence in the voluntary carbon offset market and the integrity of the carbon offset and carbon neutral products they purchase.

It provides guidance to businesses who wish to make their organisation carbon neutral or develop carbon neutral products in a way that achieves emissions reductions that are beyond those achieved under domestic mitigation policies and Australia's national emissions reduction targets.

The Standard specifies:

- The types of carbon offsets that constitute genuine, additional emissions reductions
- The general principles and requirements for calculating the carbon footprint of a product, organisation or event
- Requirements for reporting the carbon footprint, measures taken to reduce emissions and the amount reduced, the emissions offset, and the type of carbon offsets purchased and cancelled
- Requirements for auditing carbon footprint calculations and offset claims.

12.3.2.2. State Context

Climate Change and Greenhouse Emissions Reduction Act 2007

The *Climate Change and Greenhouse Emissions Reduction Act 2007* provides for measures to address climate change with a view to assisting to achieve a sustainable future for South Australia to:

- Set targets to achieve a reduction in greenhouse gas emissions within the State
- To promote the use of renewable sources of energy
- Promote business and community understanding about issues surrounding climate change
- Facilitate the early development of policies and programs to address climate change; and for other purposes.

The legislation sets out three targets:

- Reduce greenhouse gas emissions within the state by at least 60 percent to an amount that is equal to or less than 40 percent 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 percent of electricity generated in the state by 31 December 2014
- Increase the proportion of renewable electricity consumed so that it comprises at least 20 percent 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 and the draft Climate Change Adaptation Framework for South Australia.

The assessment of opportunities for reducing greenhouse gas emissions and increasing proportion of renewable energy generated and consumed for construction and operational components of the Project will be consistent with all relevant provisions outlined in the *Climate Change and Greenhouse Emissions Reduction Act 2007.*

South Australia's Strategic Plan (Updated 2011)

South Australia's Strategic Plan is the overarching policy document influencing the direction of South Australia. The 2011 update of the Plan has 100 targets and has been restructured to include seven new objective categories, including "Our Environment".

The Plan identifies a number of objectives/targets of particular relevance to this assessment within the 'Our Environment' category and relevant targets outlined in **Table 12.3a**.

Table 12.3a: South Australia's Strategic Plan - Relevant Objectives/Targets

Relevant Strategic Plan Target	Relevance and/or Project Consistency
59. Greenhouse gas emissions reduction Achieve the Kyoto target by limiting the state's greenhouse gas emissions to 108% of 1990 levels during 2008-2012, as a first step towards reducing emissions by 60% (to 40% of 1990 levels) by 2050.	The Project will measure its greenhouse emissions inventory and seek ways to reduce impacts.
64. Renewable energy Support the development of renewable energy so that it comprises 33% of the state's electricity production by 2020 (baseline: 2004-05) Milestone of 20% by 2014.	The Project will investigate opportunities to integrate renewable energy generation.

Tackling Climate Change: South Australia's Greenhouse Strategy 2007-2020

Tackling Climate Change: South Australia's Greenhouse Strategy 2007-2020 sets out a comprehensive and coordinated approach to the policy framework for South Australia's greenhouse targets and commitments.

The strategy takes three key approaches: reducing greenhouse emissions; adapting to climate change; and innovating in markets, technologies, institutions and lifestyle. The strategy also sets out specific goals and targets for the state, recommended ways to achieve them and key action areas.

The Plan identifies a number of objectives of particular relevance to the Project. These objectives are outlined in **Table 12.3b**.

Table 12.3b: Tackling Climate Change, SA's Greenhouse Strategy - Objectives

Themes	Relevant Objectives
Leadership	» encouraging early action in reducing greenhouse gas emissions » demonstrating best practice in reducing emissions » building capacity to tackle climate change.
Adaptation	» increasing our understanding of risks, vulnerabilities and opportunities through science and research » building resilient and healthy communities » improving hazard management and minimising risks.
Community	» promoting individual, household and community behaviour change » improving the efficient use of resources by households and communities » building greenhouse friendly communities.
Industry	» managing business risk associated with greenhouse gas emissions and climate change » reducing greenhouse gas emissions while enhancing business competitiveness » targeting commercial opportunities and developing products and services of the future.
Energy	» improving the efficiency of energy use » increasing the take-up of renewable and low emission energy technologies » ensuring energy investment and markets transition to low greenhouse gas emissions.
Transport and planning	» integrated land use and transport planning to reduce the need for motorised travel » encouraging people to use sustainable methods of travel » improving the emissions performance of vehicles and fuels » shifting transport towards low greenhouse emission modes including cycling and walking.
Buildings	» developing high performance green standards for building design, construction and operation » optimising the energy performance and subsequent cost effectiveness of buildings » increasing market and community awareness of the benefits of improved building performance » developing sustainable built environments that are responsive to climate change.
Natural resources	» strengthening the resilience of industries reliant on natural resources » considering climate change in the sustainable management of water resources and water supply » increasing the capacity of ecosystems to adapt to climate change » reducing greenhouse gas emissions from the natural resources sector and increasing carbon sinks.

12.3.3. Methodology and Assumptions

This Chapter has used two international accounting standards in the preparation of this GHG assessment:

- World Business Council for Sustainable Development/World Resources Institute (WBCSD/WRI) Greenhouse Gas Protocol; A Corporate Accounting and Reporting Standard (the GHG Protocol)
- AS ISO 14064.1 – 2006: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removals (AS ISO 14064, 2006).

AS ISO 14064 cross references the GHG Protocol, so these two standards are complimentary.

The National Greenhouse and Energy Reporting Act (NGER) Technical Guidelines (2012) refer to these two international standards. Therefore the selection of these methodologies is consistent with International and Australian practice and minimises any inconsistencies between program objectives.

12.3.3.1. National GHG Emission Factors

The Department of Climate Change and Energy Efficiency (DCCEE) publishes the National Greenhouse Accounts (NGA) Factors which include GHG emission factors for general application across a broad range of GHG emissions inventories. These factors have been used in assessing emissions associated with the construction and operation of the BCEF.

The default emission factors in this publication have been estimated by the DCCEE using the Australian Greenhouse Emissions Information System (AGEIS) and are determined simultaneously with the production of Australia's National Greenhouse Accounts.

Emission factors are activity specific and can be referred to as direct and indirect emissions or Scope one, two and three emissions. DCCEE defines the following:

- **Direct emissions** are produced from sources within the boundary of an organisation and as a result of that organisation's activities
- **Indirect emissions** are emissions generated in the wider economy as a consequence of an organisation's activities, but which are physically produced by the activities of another organisation
- **Scope One** emissions are direct (or point-source) emissions
- **Scope Two** emissions are indirect emissions from the generation of the electricity purchased and consumed by the reporting organisation
- **Scope Three** emissions are indirect emissions from various other activities. Examples include embodied energy of materials, staff travel to and from site, and waste sent to landfill.

This GHG assessment includes only Scope One and Scope Two emissions relating to the proposed BCEF, which are grouped by emission sources, as explained below.

12.3.3.2. Emissions Boundaries

Emission boundaries describe the components of the proponent's activities that are to be included in the inventory. Establishing boundaries from the outset of this assessment is important to ensure the boundary is restricted to GHG emission sources within the control of SGPL.

Operational Boundaries

The operational boundaries identify emissions associated with operations and activities and categorises them as direct or indirect emissions. Operational control can be determined if the proponents have "the greatest authority to introduce and implement operating and environmental policies" (NGER Fact Sheet 4, 2009). In the case of the proposed BCEF, the operational boundaries have been based on Scope One and Scope Two emissions that the SPGL has direct control over. For example, SPGL does not have operational control over iron ore mining activities and this has been excluded from calculations. These emissions will be within the operational boundary of the relevant mining company and their responsibility to report.

Shipping emissions are also excluded, as this is beyond the operational control of SPGL, but is rather controlled by various shipping companies who utilise the BCEF. Transportation to market by Cape-size vessels is however considered to be the most efficient means of transport. Alternative combinations of road/rail transport to other port locations (e.g. Darwin, Adelaide) will considerably increase transportation GHG emissions as rail and road transport has a much higher rate of CO2e/km. This is due to a number of factors, but is principally because Cape-size vessels can carry a much larger load than alternative means of transport, reducing the number of trips required to transport material to market. Port Bonython is located close to iron ore resources, reducing travel by these less efficient means and therefore avoiding GHG emissions.

Temporal Boundaries

The GHG assessment for the construction phase is for the overall construction period estimated to total 30 months. The operational GHG assessment is based on the approximate GHG emissions generated at the BCEF over one year.

The emissions estimates provide the typical worst case scenario for GHG emissions associated with the BCEF and is estimated based on exporting up to 50MTPA of iron ore.

To determine the emissions profile of the proposed BCEF, GHG emissions associated with the construction and operational phases have been estimated in line with the *National Greenhouse and Energy Reporting Act 2007* and the GHG Protocol. The projected GHG emissions are broken down into Scope One and Scope Two emissions.

12.3.3.3. GHG Calculations

Construction Phase

The construction phase of the proposed BCEF will predominantly utilise energy through diesel generators to power the site and diesel fuelled plant, equipment and vehicles for construction works. Emissions generated from the diesel usage are direct emissions and fall under Scope One emissions. There is potential for further emissions to be generated by on-site concrete manufacture; this activity will only occur if market conditions are favourable, therefore the quantity of concrete that may be generated (and associated emissions) are not known at present and have not been included in calculations.

The range of diesel fuelled plant likely to be used at the Project during the construction phase includes:

- Graders
- Bulldozers
- Water carts
- Cranes
- Rollers
- Tip trucks
- Front end loaders
- Crusher
- Jack-up barge
- Piling hammer
- Pile top drill
- Vehicles
- Work boats
- Tugs
- Excavators
- Generators
- Welding sets
- Compressors.

The Project site is expected to be connected to the grid at approximately 20 months into the construction programme (phase 1, 25MTPA). The remaining works will be predominantly commissioning works and the rail loop's signal and communication testing. Construction activities will predominantly be powered by the grid for the final 10 months of construction.

Conveyors and machines will be commissioned individually in the first instance, as construction on each section of the BCEF is completed. Electricity consumption during this period is estimated to be 1.8MWh. The site compound will also utilise the grid connection to power site offices and sheds and is projected to consume approximately 1.25MWh during construction. Refer to **Appendix I.1** for assumptions and calculations.

12.3.3.4. Limitations and Uncertainties

In undertaking GHG accounting there is inevitably some uncertainty in data resulting from the application of data available on emission sources. This is recognised as the largest challenge facing the development of comprehensive and representative GHG inventories, particularly in early design stages when estimates only are available. The data included in this report has been based on data provided by SGPL using the best available information at the time. No direct measurements or site surveys were conducted.

Due to the early stage of design, data is lacking for certain emission sources and some areas of calculations. In these instances, assumptions have been established to estimate emission activities. These assumptions are discussed in to **Appendix I.1**.

This GHG assessment investigates Scope One and Scope Two emissions, however the following Scope One emission sources are deemed to be negligible or there is insufficient data available to make accurate calculations and are excluded from the GHG assessment:

- Synthetic greenhouse gases i.e. refrigerants, aerosols, switchgear (Scope One emissions)
- Removal of vegetation and disturbance of soil (Scope One emissions).

12.3.4. Potential Impacts

12.3.4.1. Construction

Scope One Emissions

Scope One emissions will result from the use of an estimated 3,000kL of diesel fuel used in plant, equipment, vehicles and vessels throughout the 30 month construction period (Phase One, 25MTPA). Fuel use for Phase Two of the Project has not yet been identified, and is not included in this assessment. The use of diesel fuel during Phase 1 of construction is estimated to account for 8100t CO_2e.

Fuel use will be the largest contributor to a GHG footprint during the construction phase and is estimated to represent 80 percent of overall emissions.

Scope Two Emissions

The purchase of 3.05MWh of grid power during construction is estimated to generate 2000 t CO_2e representing approximately 20 percent of GHG emissions during the construction stage.

A summary of GHG emissions associated with the construction of the proposed Project are illustrated in **Table 12.3c**.

Table 12.3c: Construction Phase GHG Emissions

Construction Stage Emission Scope	Emission Source	Consumption	GHG Emissions (tCO_2e)	% of Construction Emissions
Scope One Emissions (Phase One only)	Diesel use in plant and equipment	3000kL	8100	80%
Scope Two Emissions (Phase One only)	Purchased electricity	3000MWh	2000	20%
Total GHG emissions during construction			**10,100**	

12.3.4.2. Operations Phase

Energy use during the Project operational activities will include both Scope One and Scope Two emissions. Scope One emissions will result from fuel usage in port related infrastructure, equipment, plant, vessels and vehicles. Scope Two emissions will be generated through the consumption of purchased electricity during the operation of port related infrastructure and buildings.

Scope One Emissions

An estimated 1700kL of diesel per annum is expected to be utilised during the operation of the proposed BCEF (at the full 50mpta capacity). Fuel usage during the operational stage will primarily involve tugs, road vehicles, and loaders operating within the storage sheds.

Fuel usage during the operational stage is estimated to generate approximately 5100 t CO_2e annually, contributing approximately seven percent to the operational carbon footprint.

Scope Two Emissions

An overall usage of 106.18 GWh of electricity is projected for the annual operation of the proposed BCEF. Electricity consumption during operation will generally involve conveyors, ship loaders, sewage treatment plant operation, lighting and general port management.

Emissions associated with the BCEF's purchased electricity will be the largest contributor of GHG emissions during the operational phase. Scope Two emissions are estimated to total approximately 69,000 t CO_2e annually and represent an estimated 93 percent of the GHG emissions during operation.

A summary of GHG emissions likely to be generated per annum by the BCEF are listed in **Table 12.3d**.

12.3.4.3. Summary of GHG Emissions

The overall potential GHG emissions as a result of the construction and operation of the proposed BCEF is estimated to total 10,100 t CO_2e throughout the Stage One construction period (25MTPA option) and 74,100 t CO_2e annually during operation (assuming the full capacity of 50MTPA is reached). **Figure 12.3c** below illustrates the emissions breakdown per emission source for the construction and operation phase.

Figure 12.3c: Emissions breakdown per scope throughout construction and operation

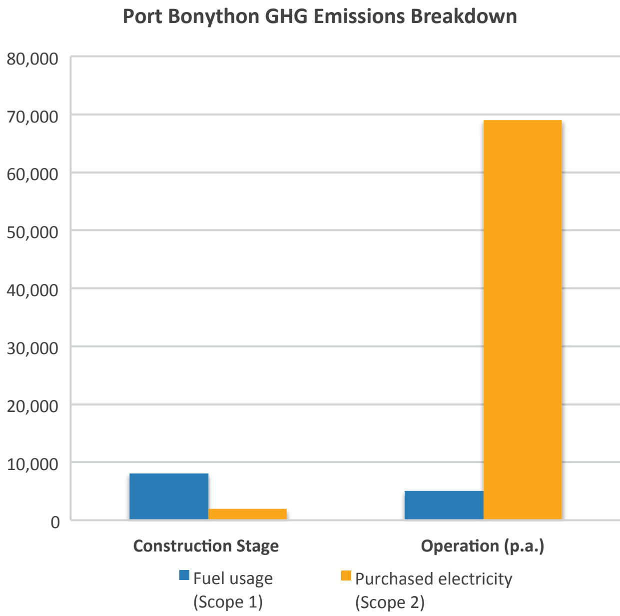


Table 12.3d: GHG emissions inventory for the operational stage

Operation Stage Emission Scope	Emission Source	Consumption (per annum)	GHG Emissions (tCO_2e)	% of Operation Emissions
Scope One Emissions	Diesel use in plant and equipment	1700kL	5100	7%
Scope Two Emissions	Purchased electricity	106,200MWh	69,000	93%
Annual GHG emissions during operation			**74,100**	

12.3.5. Management and Mitigation Measures

Globally, ports present a large cluster of industrial and logistic operations and present a substantial opportunity to reduce emissions throughout all areas of the supply chain. As illustrated in **Section 12.3.1.2** shipping as the designated mode in the transportation of iron ore in contrast to options such as rail and trucking, reduces GHG emission by an estimated 25 to 75 percent. Utilising a vessel with a larger payload also presents a significant saving of GHG emissions as per the Project's preferred Cape class vessel.

Transport activity is increasing with the resources sector rising and economic and population growth continuing. By utilising shipping as the preferred mode of transport, GHG emissions could potentially abstain from increasing at a similar degree as the increase rate of transport activity.

12.3.5.1. Current Mitigation Measures Incorporated into Various Stages of the Project

A number of mitigation measures have been incorporated into the Project as part of project planning and design. As many large scale facilities are unable to connect to the grid at an early stage in a Project's lifetime, the standard practice during Port construction and in many instances, a Port's operation, is to power the site by energy intensive generators. The utilisation of generators produce significant amounts of GHG emissions in order to operate large scale equipment including ship loaders and conveyors, and the port's buildings and sheds.

The Project's ability to source power from the grid during a third of the construction programme and all of the Project's operational lifetime will have a significant reduction in GHG emissions in comparison to fuelling the site with the use of large scale diesel generators. A previous port development estimated GHG emissions reduction of 9.5 percent could be achieved if the site was able to connect to the grid instead of utilising diesel generators during operation (Golder Associates, 2012). By applying this percentage reduction, an approximate 6600 t CO_2e will potentially be saved each year through utilising grid electricity. Further savings will be apparent during the construction stage once the Project is connected to mains power for the remaining 10 months of the construction programme.

12.3.5.2. Additional Mitigation Measures

Opportunities to further reduce GHG emissions will be evaluated based on the following emissions hierarchy:

- Avoid: identify how the design, construction and operation stages can avoid activities that produce GHG emissions
- Reduce: identify how activities can be modified to reduce GHG production
- Switch: identify opportunities to switch to renewable energy and lower-emission fuel sources
- Offset: offset residual emissions in line with regulatory requirements.

Potential mitigation measures that may further reduce the proposed Project's GHG emissions in each stage of the Project are presented in **Table 12.3e;** the feasibility of these options will be explored during detailed design. A focus on energy reduction and efficiency initiatives and switching to cleaner fuels, will have the largest impact on reducing GHG emissions. Implementing various mitigation measures at different levels throughout all stages of the Project's lifetime would contribute further to emission reductions.

Renewable Energy Sources

Sourcing renewable energy will contribute to reducing the reliance on fossil fuels during the operation of the proposed BCEF. South Australia holds nearly half the nation's wind power capacity (48 percent at July 2012). The state has approximately seven percent of Australia's population with 15 wind farms operating across the state with an installed capacity of 1203 Megawatts (MW) of power (as at July 2012). The Eyre Peninsula has some of the best wind resources in Australia. Average wind speeds in these areas are anticipated to be greater than eight metres per second. If transmission grid constraints are overcome, a capacity factor of greater than 38 percent could generate up to 10,000 MW of energy.

The use of solar photovoltaic (PV) panels attached to the BCEF storage sheds and administration buildings have the potential to produce a minor amount of the Project's operational energy needs. With a suitable roof top area of approximately 370m^2, the installation of PV systems on these areas will potentially generate 82,800kWh annually (refer to **Appendix I.1** for assumptions and calculations).

Table 12.3e: Potential mitigation measures to reduce the Project's GHG emissions

Emission Source/ element	Mitigation measure	Description	Stage to be investigated and/ or implemented
Design and operational efficiencies	Efficient site design	Maximise natural light and ventilation, installing energy efficient lighting and air conditioners, and double glazed windows for permanent buildings.	Planning/Design
	Operational efficiencies	Operational efficiency can be integrated into the detailed design for port associated facilities and into the ongoing operational procedures i.e. designing an efficient site layout and defining direct transport routes to reduce distances between points of repeated travel and reduce vehicle idling times	Planning/ Design, Construction and Operation
Renewable energy	Use of renewable energy	Feasibility study into the use of wind and tidal power. Installing solar PV panels to the storage sheds and administration buildings	Planning/Design
Materials	Source local materials	Sourcing materials (reclamation, construction materials etc.) from local suppliers and quarries to reduce fuel consumption.	Planning/Design and Construction
	Recycled material content	Setting targets and benchmarks for the use of material with a recycled content	Planning/Design and Construction
	Pre-fabricated materials	Avoiding material waste by utilising pre-fabricated materials	Planning/Design and Construction
Fuel usage	Procurement of contractors who have energy saving procedures in place	Procuring contractors (in addition to the construction contractor who is committed to the reduction of fuel use and GHG emissions) that demonstrate a commitment to implementing GHG mitigation measures. Companies should demonstrate use of fuel efficient driving training and practices which have been able to result in significant fuel savings	Construction
	Electrification of equipment	Switching to electrified or hybrid equipment and vehicles	Construction and Operation
	Fuel efficient driving and operating of plant and equipment	Reducing the speed, revolutions per minute (RPMs) and limiting idling	Construction and Operation
	Utilising appropriate sized equipment for a task	Utilising fuel efficient vehicles	Construction and Operation
	Implementing a Traffic Management Plan (TMP)	A TMP will inform the procedures and processes mentioned above to reduce fuel usage	Construction and Operation
Offsets	Purchase of carbon offsets	Purchase offsets for the residual GHG emissions unable to be reduced through avoid and reduction measures	Construction and Operation

12.3.5.3. Barriers to Implementation

Implementing successful GHG mitigations measures can be challenging at any scale. Sectors relating to the proposed BCEF (infrastructure, transport and energy), face challenges in mitigating significant levels of GHG emissions generally associated with financial, technological and regulatory constraints. The Intergovernmental Panel on Climate Change (2007) lists various constraints experienced by these sectors below:

- Resistance by vested interests on the uptake of using renewable energy sources
- Lack of investment capital for new technology uptake
- Markets for low emission technologies
- Federal policy on carbon pollution and international competitiveness
- Carbon pricing
- Local availability of low-cost fossil fuel
- Partial coverage of vehicle fleet and plant equipment utilising cleaner fuels, electrification, fuel efficiency etc. may limit effectiveness.

The commitment by the State government under the *Climate Change and Greenhouse Emissions Reduction Act 2007* will assist in overcoming barriers with policy coherence and a support framework for low emission technology and the increased uptake of renewable energy. The location of the proposed Project of Port Bonython presents ideal conditions for further exploring the use of renewable energy sources and therefore reducing the reliance on fossil fuels. A feasibility study also needs to be undertaken to understand the financial costs/ benefits and payback periods for potential initiatives.

12.3.6. Residual Impacts

The implementation of GHG mitigation measures discussed in **Section 12.3.5** will further reduce the generation of GHG emissions throughout construction and operation phases in addition to the measures committed to by the proponent i.e. connecting to the grid during the construction stage and therefore limiting the need for energy intensive generators and the construction contractor addressing GHG reduction measures in its Construction Environmental Management Plan.

The mitigation measures proposed have the opportunity to install a noticeable reduction in overall GHG emissions associated with the Project through both construction and operation stages. Key measures that are likely to achieve the greatest savings in GHG emissions during construction are those focused on fuel reduction and switching to cleaner fuels (biofuels, CNG and LNG) particularity when large volumes of fuel is likely to be used. Undertaking fuel reduction initiatives such as the procurement of contractors with energy saving procedures, efficient site design and sourcing local materials and supplies has the potential to reduce emissions by a further 10 percent.

Further investigations into mitigation measures during the operational phase are recommended to quantify potential emission reductions opportunities. The areas of focus are likely to be the operational efficiencies and the use of renewable energy sources, particularly wind power. The ideal climatic conditions of the Eyre Peninsula region present the opportunity to become the largest renewable energy province in Australia that could participate in the National Electricity Market (Department for Manufacturing, Innovation, Trade, Resources and Energy and Renewables South Australia, 2013).

12.3.7. Conclusion

Once in operation, the proposed BCEF will provide the optimum transport infrastructure solution for the international transportation of iron ore. The Project will accommodate shipping vessels which can operate at the lowest GHG emissions per tonne-km when compared to other transport modes including road and rail options.

The BCEF provides the opportunity to carry out mitigation measures by following the emissions hierarchy of avoid, reduce, switch and offset. GHG mitigation measures will be successfully achieved through embedding the reduction and management of GHG emissions throughout planning/design, construction and operation stages of the Project. Policy cohesion and collaboration with investors and the government in line with the *Climate Change and Greenhouse Emissions Reduction Act 2007* will also provide an opportunity to significantly contribute to reducing GHG emissions.