WHALERS WAY ORBITAL LAUNCH COMPLEX

Greenhouse Gas Assessment

Prepared for:

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BASIS OF REPORT

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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Abbreviations

%	percent
°C	degrees Celsius
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
DEE	Department of the Environment and Energy (Australia)
DISER	Department of Industry, Science, Energy and Resources
g	gram
GHG	greenhouse gas
GWP	Global Warming Potential
ha	hectare
HFC	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
kL	kilolitre
km	kilometre
L	litre
m^3	cubic metre
NGA	National Greenhouse Accounts (Australia)
PFC	Perfluorocarbons
SF_6	Sulfur hexafluoride
t	tonne
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WRI/WBCSD	World Resources Institute/World Business Council for Sustainable Development

Glossary

ambient	Pertaining to the surrounding environment or prevailing conditions.
atmosphere	A gaseous mass surrounding the planet that is retained by Earth's gravity. It is divided into five layers, with most of the weather and clouds found in the first layer.
biennial	(An event) lasting for two years or occurring every two years.
climatological	The science dealing with climate and climatic phenomena.
combustion	The process of burning. A chemical change, especially oxidation, accompanied by the production of heat and light.
fossil fuel	A natural fuel such as coal, diesel or gas, formed in the geological past from the remains of living organisms.
greenhouse gas	A gas that contributes to the greenhouse effect by absorbing infrared radiation, e.g., carbon dioxide.
guideline	A general rule, principle, or piece of advice. A statement or other indication of policy or procedure by which to determine a course of action.
Scope 1 emissions	Direct greenhouse gas (GHG) emissions produced from sources within the boundary of an organization and as a result of the organisation's activities.
Scope 2 emissions	Indirect GHG emissions produced during the generation of purchased electricity consumed in owned or controlled equipment or operations.
Scope 3 emissions	Indirect GHG emissions generated in the wider economy as a consequence of an organisation's activities but are physically produced by the activities of another organisation.

1 Introduction

Southern Launch is proposing to construct the Whalers Way Orbital Launch Complex on land located at the southern tip of the Eyre Peninsula approximately 25 km from Port Lincoln.

The land for the orbital launch facility has an area of about 2,640 hectares (ha) and the launch complex is proposed to the south of the site within a smaller allotment of approximately 1,200 ha. The launch complex is proposed to have the capacity for 36 launches per year and be developed in five stages:

- Stage 1: A permanent launch pad and permanent launch support infrastructure.
- Stage 2: A second permanent launch pad and permanent launch support infrastructure.
- Stage 3: A permanent range operations centre and permanent visitors centre.
- Stage 4: A permanent engine test stand and test support infrastructure.
- Stage 5: Non-conventional launch facilities (not part of the current application)

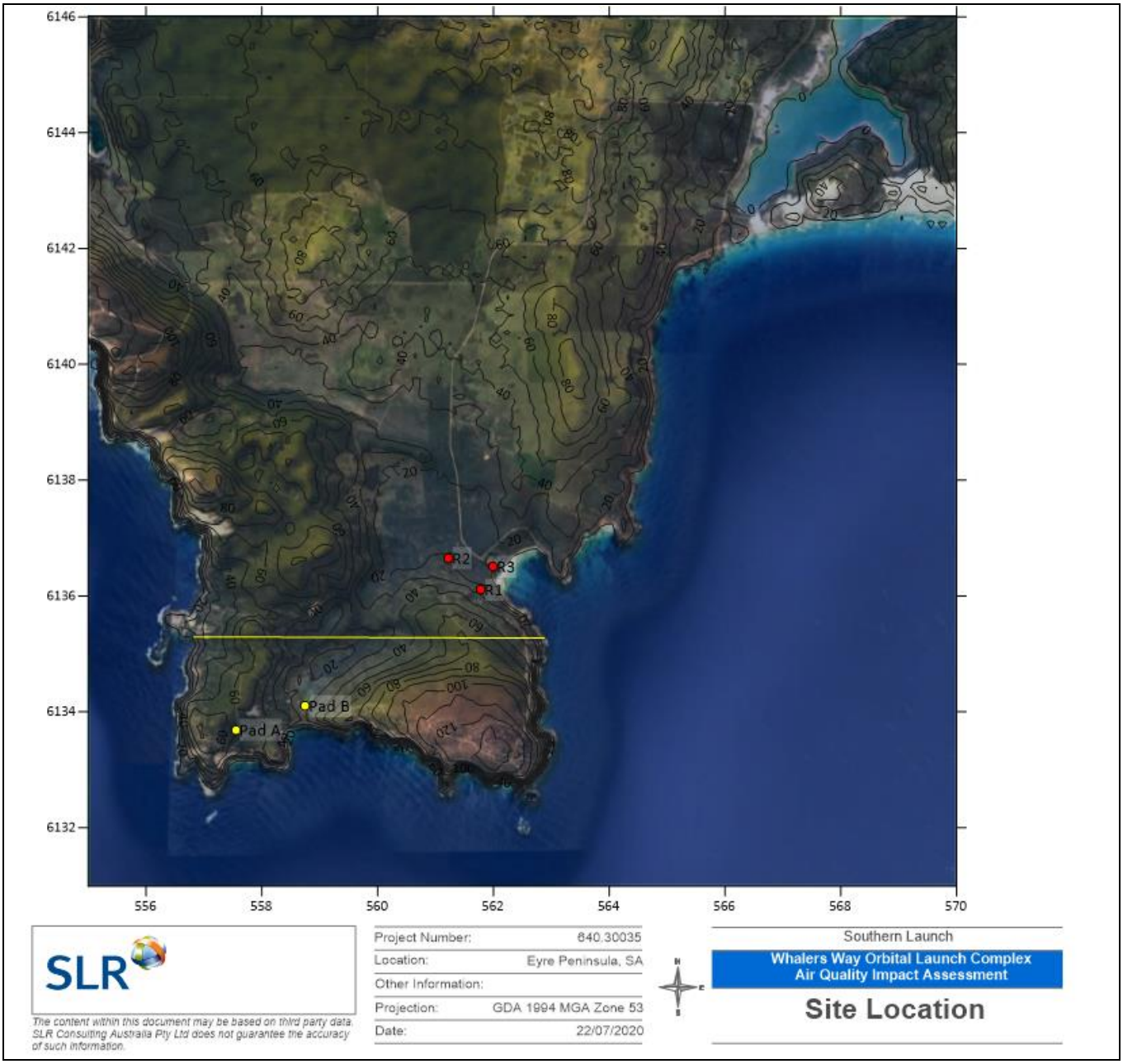
The two launch pads are referred to as Launch Site A and Launch Site B. The intention is to:

- Develop Launch Site B as Stage 1 for a range of launch vehicles sizes from micro to larger conventional (less than 10 tonnes to approximately 50 tonnes).
- Develop Launch Site A as Stage 2 for larger launch vehicles (greater than 30 tonnes to up to over 100 tonnes).

The location of the launch pads are shown in **Figure 1**.

For this greenhouse gas (GHG) assessment emissions during construction and operations were estimated and then compared to State and National GHG emission inventories to assess the potential significance of Southern Launch in the context of Australia's annual GHG emissions.

Figure 1 Site Location Showing Launch Site A, Launch Site B, Site Northern Land Boundary and Nearest Receptor Locations



1.1 Study Objectives

The objectives of the GHG assessment were to:

- Compile an inventory of Scope 1, 2 and 3 GHG emissions covering both the construction and operational phase activities of Southern Launch in accordance with Australian and/or international reporting standards.
- Assess the estimated annual GHG emissions for Southern Launch against Australia's most recent available national GHG emissions inventory data.

1.2 Assessment Approach

The overall approach used for the GHG assessment was as follows:

- Identify relevant national and international statutory requirements and policies/ standards that may be relevant to Southern Launch.
- Identify the key related GHG emissions sources during construction and operations.
- Estimate the quantities of GHG emissions generated from these sources over construction and operations periods.
- Assess Southern Launch contribution to Australia's national GHG emissions.

In accordance with standard practice, this assessment has been guided with reference to the requirements of the GHG Protocol and IPCC and Australian Government emission calculation methodologies.

The calculation of GHG emissions were performed in a five-stage process:

1. Definition of the project boundary (Section **5.1**).
2. Identification of GHG emissions sources within the project boundary (Section **5.2**).
3. Identification of activity data for each GHG emissions source (Section **5.3**).
4. Identification of emissions factors for each source (Section **5.4**).
5. Calculation of GHG emissions (Section **5.5**).
6. Assumptions used to calculate GHG emissions (Section **5.6**).

2 Project Overview

2.1 Project Description

Southern Launch is proposing to construct the Whalers Way Orbital Launch Complex on land located at the southern tip of the Eyre Peninsula. The subject site is located approximately 25 kilometres south-west of Port Lincoln.

Southern Launch seeks to establish infrastructure that will support the launch of domestic and international launch vehicles providing the safest and most cost-effective orbital launch site in the world servicing the growing demand for Polar and Sun Synchronous Orbit satellite insertion.

The Whalers Way Orbital Launch Complex will cater for launches by a variety of customers. The number of launches is anticipated to grow over time, with approximately six launches anticipated in the first year of operations, increasing to a maximum of 36 launches in year five of operations.

Infrastructure

The components of the development are detailed as follows:

- Change of use of land to introduce an additional use of an aerospace facility in the form of a launch site;
- Construction of buildings and infrastructure, including but not limited to:
  - Assembly buildings (temporary and permanent);
  - Range control facilities;
  - Diesel and / or hydrogen fuel cell powered generators;
  - Helicopter opad(s);
  - Water tanks;
  - Water capture and treatment systems;
  - Launch pads;
  - Lightning rods;
  - Anemometer towers;
  - Engine test stands;
  - Propellant (liquid, hybrid and solid) storage;
  - Secure block houses;
  - Blast walls;
  - Bunding (for blast wave deflection);
  - Installation of fibre optic and satellite communication systems;
  - Installation of high voltage power lines;
  - Construction of internal access roads;

- Land division in the form of a lease extending beyond five (5) years;
- Visitor viewing area and interpretative facilities;
- Temporary infrastructure associated with development and construction, including but not limited to:
  - Temporary concrete batching plant;
  - Temporary site and construction offices and facilities;
  - Temporary laydown areas; and
  - Temporary access tracks.

3 The Greenhouse Effect

The greenhouse effect is a naturally occurring process that aids in heating the Earth's surface and atmosphere. It results from the fact that certain atmospheric gases, such as carbon dioxide, water vapor, and methane, can change the energy balance of the planet by absorbing longwave radiation emitted from the Earth's surface. Without the greenhouse effect, life on this planet would probably not exist as the average temperature of the Earth would be around -18 degrees Celsius (°C), rather than the present 15°C.

As energy from the Sun passes through the atmosphere several things take place. A portion of the energy (26% globally) is reflected or scattered back to space by clouds and other atmospheric particles. About 19% of the energy available is absorbed by clouds, gases (like ozone), and particles in the atmosphere. Of the remaining 55% of the solar energy passing through the Earth's atmosphere, about 4% is reflected from the surface back into space. Thus, on average, about 51% of the Sun's radiation reaches the Earth's surface. This energy is then used in a few processes, including the heating of the ground surface; the melting of ice and snow and the evaporation of water; and plant photosynthesis.

The heating of the ground by sunlight causes the Earth's surface to become a radiator of energy in the longwave band (infrared radiation). This emission of energy is generally directed to space. However, only a small portion of this energy makes it back to space. Most of the outgoing infrared radiation is absorbed by GHGs.

Absorption of longwave radiation by the atmosphere causes additional heat energy to be added to the Earth's atmospheric system. The now warmer atmospheric GHG molecules begin radiating longwave energy in all directions. Over 90% of this emission of longwave energy is directed back to the Earth's surface where it once again is absorbed by the surface. The heating of the ground by the longwave radiation causes the ground surface to once again radiate, repeating the cycle described above, again and again, until no more longwave radiation is available for absorption.

The amount of heat energy added to the atmosphere by the greenhouse effect is controlled by the concentration of GHGs in the Earth's atmosphere.

Emissions of GHGs can result from natural or man-made (anthropogenic) sources. Examples of natural sources include the decomposition or burning of plant material and emissions of methane from animal digestion processes. Emissions also occur as a result of human activities and such sources include the burning of fossil fuels, the use and leakage of refrigerants, the clearing of forest and other vegetation, and the use of fertilisers, amongst other sources. This separation of natural versus anthropogenic sources is complicated by the fact that natural processes may be manipulated by humans, resulting in increased emissions of GHGs.

On Earth, human activities are changing the natural greenhouse effect. Several gases are involved in the human-caused enhancement of the greenhouse effect including (NASA, 2019):

- **Carbon dioxide** (CO_2): A minor but very important component of the atmosphere, CO_2 is released through natural processes such as respiration and volcanic eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased the atmospheric CO_2 concentration by more than a third since the Industrial Revolution began. This is the most important long-lived "forcing" of climate change.

- **Methane** (CH_4): A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture (especially rice cultivation), as well as ruminant digestion and manure management associated with domestic livestock. On a molecule-for-molecule basis, CH_4 has far more greenhouse warming potential than CO_2, but is also one which is much less abundant in the atmosphere.
- **Nitrous oxide** (N_2O): A powerful GHG produced by soil cultivation practices, especially the use of commercial and organic fertilisers, but also (in lesser amounts) from fossil fuel combustion, nitric acid production, and biomass burning.
- **Chlorofluorocarbons** (CFCs): Synthetic compounds, entirely of industrial origin, used in a number of applications, but now largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. They are also GHGs.

Over the last century, the burning of fossil fuels such as coal and oil has increased the concentration of atmospheric CO_2. This happens because the coal or oil burning process combines carbon with oxygen in the air to make CO_2. To a lesser extent, the clearing of land for agriculture, industry, and other human activities has also increased concentrations of GHGs. Vegetation and soils typically act as a carbon sink, storing carbon dioxide that is absorbed through photosynthesis. When the land is disturbed, part of the stored carbon dioxide is emitted through mechanisms such as burning or decomposition of vegetation etc., re-entering the atmosphere. Land disturbance will often also remove the associated carbon sink decreasing the potential for future CO_2 removal.

Quantifying linkages between emissions of GHGs from an individual project to resulting global GHG concentrations and climate warming is not possible due to a host of uncertainties and a lag in the climate system. Action by national governments aimed at reducing GHG emissions by sector and national totals will result in mitigation of climate change. Hence, accurate quantification of GHG emissions will aid the ongoing assessment of climate impacts and the development of targeted and effective policies and strategies to reduce the impact of global climate warming.

4 Relevant Legislation, Guidelines and Policies

4.1.1 The International Response to Climate Change

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the international body tasked with assessing scientific knowledge on climate change. It was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988, and endorsed by the UN General Assembly, to provide policy makers with regular scientific assessments of climate change, its impacts and future risks, and the mitigation and adaptation options.

The first meeting of the IPCC was held in Geneva in 1988. Since it was established, the IPCC has prepared five assessment reports, which have provided key inputs into the international negotiations to tackle climate change. The Fifth Assessment Report was released by IPCC in March 2014 which considers new evidence of climate change based on independent analyses from observations of the climate system and includes refined estimates of impact probability.

Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC). The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialised countries and the European community for reducing GHG emissions. These targets amount to an average of five per cent reduction against 1990 levels over the five-year period 2008-2012.

Countries must meet their targets primarily through national measures to avoid, abate or offset GHG emissions. However, the Kyoto Protocol offers additional means of meeting targets through the following market-based mechanisms:

- Emissions trading: Gives corporations or individuals the opportunity to offset their GHG emission liability by purchasing Kyoto certified carbon credits generated by carbon emission reduction projects.
- Clean Development Mechanism (CDM): Where industrialised (or “Annex One” as defined in the Protocol) nations can implement Kyoto approved GHG reduction projects in developing nations (or “Non-Annex One” as defined in the Protocol) in order to generate Carbon Emission Reductions (CERs).
- Joint Implementation (JI): Allows developed (Annex One) nations to engage in emission reduction projects with other developed (Annex One) nations to generate CERs.

These mechanisms help stimulate investment in GHG-friendly actions and technologies and to meet emission targets in a cost-effective manner. Comprehensive mechanisms have been set up under the UNFCCC that aim to ensure the validity and credibility of emissions avoidance, abatement and offset projects under the CDM and JI.

Paris Agreement

The Paris Agreement, from the 21st Conference of the Parties (COP21) in Paris in December 2015, sets in place a framework for all countries to take climate action from 2020, building on the existing international efforts in the period up to 2020. Key outcomes included:

- A global goal to hold average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels.
- All countries to set mitigation targets from 2020 and review targets every five years to build ambition over time.
- Robust transparency and accountability rules to provide confidence in countries' actions and track progress towards targets.
- Promoting action to adapt and build resilience to climate impacts.
- Financial, technological and capacity building support to help developing countries implement the Agreement.

The Greenhouse Gas Protocol Initiative

GHG accounting and reporting principles are intended to underpin all aspects of GHG accounting and reporting. The five principles outlined below are consistent with the World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) GHG Protocol Initiative (a globally adopted and leading GHG accounting strategy), and ISO 14064-1, 2, and 3 GHG guidelines (internationally accepted best practice). These principles are based on financial accounting and reporting standards and are taken from the GHG Protocol documentation (WRI, 2004).

The following outlines the basic requirements of any GHG assessment, as defined by WRI/WBCSD:

- **Relevance:** The relevance of a company's GHG report relates to the information which it contains. The information should allow stakeholders, both internal and external to the organisation, to make informed decisions about GHG management. An important aspect of relevance is the selection of appropriate boundary conditions which reflect the reality of the company's operations. The operation of the company, the purpose of the information and the needs of users will all inform the choice of the inventory boundary.
- **Completeness:** All relevant emission sources within the chosen inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is compiled. WRI (2004) states that no materiality threshold (or minimum emissions accounting threshold) should be defined as this is not in line with the principle of completeness. However, if emissions are not able to be estimated or estimated at a sufficient level of quality, then these should be transparently documented and justified.
- **Consistency:** Consistency in an emissions inventory allows stakeholders to compare GHG emissions performance from year to year. This consistency also allows trends to be identified and performance against objectives and targets to be tracked. Any changes in the inventory (accounting approaches, boundaries, calculation methods) need to be transparently documented and justified.
- **Transparency:** All processes, procedures, assumptions and limitations of an inventory should be presented clearly and accurately. Information needs to be recorded, compiled and analysed in a way that enables internal reviewers and external auditors to verify the credibility of the inventory. Specific exclusions and inclusions are to be documented and justified, assumptions disclosed and appropriate references provided for the calculation methods applied and the data sources used. Transparency is essential in the production of a credible GHG inventory.
- **Accuracy:** Accuracy describes how close the estimates of GHG emissions are to the 'true' value. The accuracy of a GHG inventory should be sufficient for stakeholders to make decisions with reasonable assurance of the integrity of the reported information. Quality management measures should be implemented to maximise inventory accuracy.

Additional to the principles of GHG reporting, data materiality can be used to simplify the accounting process by omitting low level emission sources which do not make a significant contribution to overall Project emissions. Emissions which are within emission reporting errors or make up less than 5% or of the total Project emissions are deemed to be immaterial as their inclusion or omission does not have significant bearing on Project behaviours or processes (DoE, 2008)

4.1.2 Australian GHG Policy and Regulation

Australia ratified the Kyoto Protocol (the Protocol) in 2007 and as such made a commitment to reducing GHG emissions. In response to this ratification Australia adopted a number of Federal and State Government initiatives to achieve a reduction in GHG emissions to 5% below 2000 levels.

Ahead of the Paris Conference, countries were invited to submit indicative post-2020 targets, known as Intended Nationally Determined Contributions (INDCs). Australia's target is to reduce emissions by 26-28% below 2005 levels by 2030, which builds on the 2020 target of reducing emissions by 5% below 2000 levels.

Australia's targets are proposed to be achieved through a suite of policies to reduce emissions, encourage technological innovation and expand the clean energy sector.

National Greenhouse and Energy Reporting (NGER)

The NGER Act 2007 provides a single national framework for the reporting and dissemination of information about the GHG emissions, GHG projects, and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds.

National Greenhouse Accounts (NGA) Factors

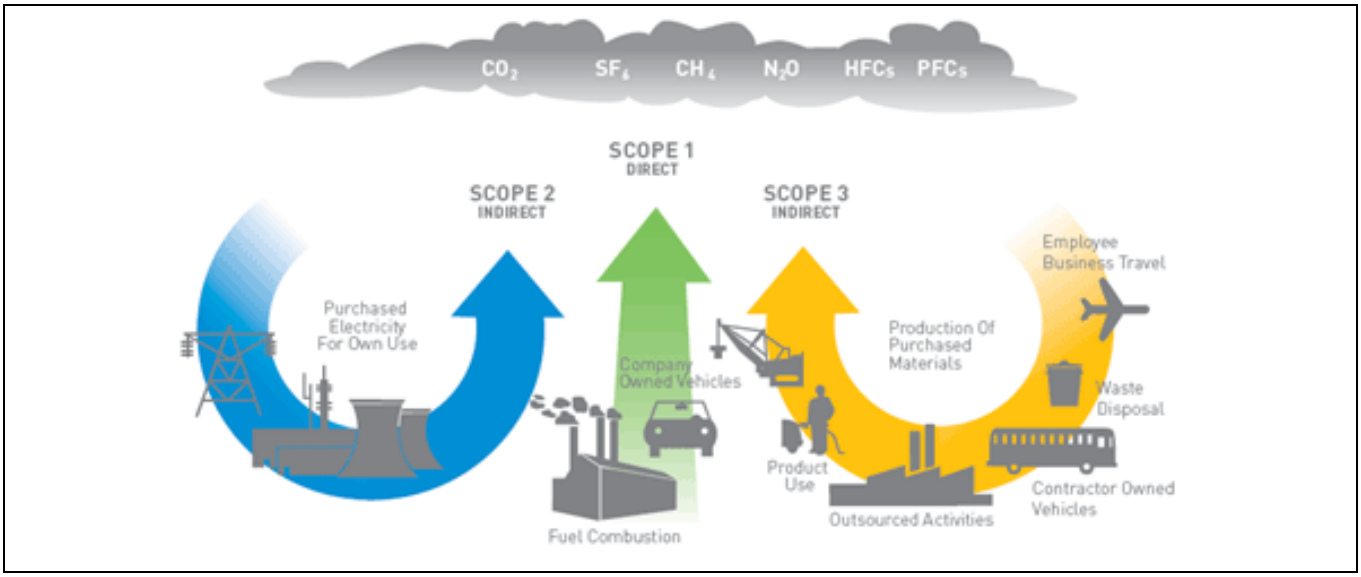
The National Greenhouse Accounts (NGA) Factors document was prepared by the Department of the Environment and Energy (DEE) and is designed for use by companies and individuals to estimate greenhouse gas emissions. The NGA default emission factors listed in this document have been estimated by the DEE using the Australian Greenhouse Emissions Information System (AGEIS) and are determined simultaneously with the production of Australia's National Greenhouse Accounts. This promotes consistency between inventories at company or facility level and the emission estimates presented in the National Greenhouse Accounts. The methods used at the national level, and reflected in the NGA Factors document, are consistent with international guidelines and are subject to international expert review each year.

4.2 Scope Definition

Emissions of GHG can be termed as being *Scope 1, Scope 2* or *Scope 3*, and '*direct*' or '*indirect*' emissions (**Figure 2**).

The definitions below for each Scope have been taken from the WRI and WBCSD GHG Protocol (WRI, 2004). These documents provide detailed information on the activities which should be included in each of the Scope 1, 2 and 3 boundaries. The definition of these boundaries allows the determination of those sources of GHG emissions that can be directly controlled by Southern Launch (Scope 1 and Scope 2), or those that Southern Launch will have some, but limited control over (Scope 3).

Figure 2 Scope 1, 2 and 3 GHG Emissions as Defined in the GHG Protocol Initiative



Source: WRI (2004)

4.2.1 Direct Emissions (Scope 1)

Direct emissions of GHG are termed Scope 1 emissions and are produced from sources within the boundary of and as a result of Southern Launch's activities. These direct emissions will arise from the following sources associated with proposed Project activities and may include:

- Transportation of materials, products or people.
- Generation of electricity.
- Combustion of liquid fuels for stationary and transport purposes.
- Clearing of vegetation.

4.2.2 Indirect Emissions (Scope 2 and Scope 3)

Indirect emissions are generated in the wider economy as a consequence of an organisation's activities but are physically produced by the activities of another organisation.

Scope 2 Emissions

The most important category of indirect emissions is from the consumption of purchased electricity (Scope 2 emissions). Scope 2 emissions relate to the GHG emissions from the generation of purchased electricity consumed within the boundary of the organisation and as a result of the organisation's activities. In Australia, this is primarily from coal fired power generation. As Southern Launch will not be connected to the grid, Scope 2 emissions have not been considered further.

Scope 3 Emissions

Scope 3 indirect emissions are related to the upstream emissions generated in the extraction and production of fossil fuels and in the emissions from contracted/outsourced activities.

Scope 3 emissions are generally Scope 1 or 2 emissions for other companies. For example, in general, diesel use by contractors is a Scope 3 emission, yet is referred to as a Scope 1 emission in the GHG inventory of the contractor. Combustion of coal to produce electricity will result in a Scope 1 emission at the power station or a Scope 2 emission for industry or householders.

4.3 Global Warming Potentials

For comparative purposes, non-CO_2 GHGs are awarded a "CO_2-equivalence" (CO_2-e) based on their contribution to the enhancement of the greenhouse effect. The CO_2-equivalence of a gas is calculated using an index called the Global Warming Potential (GWP). GWPs are periodically updated by the IPCC in line with improvements to the underlying science. The 100-year GWPs of potential relevance to the Project, as taken from the IPCC's Second, Fourth and Fifth Assessment Reports (SAR, AR4 and AR5 respectively) are presented in **Table 1**. The AR4 values (IPCC, 2007) have been used in this assessment.

Short-lived gases such as carbon monoxide, nitrogen dioxide, and non-methane volatile organic compounds (NMVOCs) vary spatially and it is consequently difficult to quantify their contribution to project GHG emissions. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

No significant sources of other GHGs (such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) or sulfur hexafluoride (SF_6)) have been identified as part of the Southern Launch operations, therefore they have not been considered further as part of this assessment.

Table 1 Global Warming Potentials

Gas	Chemical Formula	IPCC GWP (100 year horizon)		
		Second Assessment Report [1]	Fourth Assessment Report [2]	Fifth Assessment Report [3]
Carbon dioxide	CO_2	1	1	1
Methane	CH_4	21	25	28
Nitrous oxide	N_2O	310	298	265

1: (IPCC, 1995)
2: (IPCC, 2007)
2: (IPCC, 2013)

5 Identification and Estimation of Southern Launch-Related GHG Emissions

5.1 Definition of the Project Boundary

The geographical boundary set for Scope 1 emissions considered in the GHG assessment covers the area at the southern tip of the Eyre Peninsula in the area named Sleaford, commonly known as “Whalers Way”. The site is located approximately 25 kilometres south-west of Port Lincoln. GHG emissions associated with construction and operation of these infrastructure areas are considered to be within the geographical boundary of this assessment. The operational boundary includes combustion of liquid fuels during transport of materials and staff, and use of off-road vehicles on site, as well as vegetation clearing in preparation for construction.

Scope 3 GHG emissions from the transport of launch vehicles, water, fuel and staff to/from Adelaide and Port Lincoln have been included (i.e. sourcing location, quantities of equipment to be transported, etc.). GHG emissions associated with production and supply of fuels used on site have been included. GHG emissions associated with the production of the different materials (embodied emissions) and their delivery to the site have not been included in the assessment as Scope 3 emissions.

5.2 Identification of Emission Sources

Construction and operational phase emission sources have been identified by review of the Project description. The emissions associated with the construction and operational phases that were considered in preparing this GHG assessment are listed in **Table 2**.

Table 2 Identified Potential GHG Emissions Sources for Southern Launch

Project Activity	Scope 1	Scope 3
CONSTRUCTION		
Land clearing	• Emissions from vegetation clearing in preparation for construction.	• Emissions associated with equipment removing vegetation from site.
Construction	• Emissions from diesel combustion in construction equipment, including drill rigs, forklifts, cranes, concrete batch plants, etc.	• Emissions associated with extraction and processing of diesel consumed.
	• Emissions from gasoline combustion in vehicles during construction.	• Emissions associated with extraction and processing of gasoline consumed.
Vehicle movements transporting staff and equipment	• Emissions from diesel combustion in light vehicles and trucks.	• Emissions associated with extraction and processing of diesel consumed.
Power generation	• Emissions from diesel combustion in portable electricity generators (gensets) used during construction.	• Emissions associated with extraction and processing of diesel consumed.
Production and supply		• Emissions associated with the production and supply of diesel and kerosene.
Haulage of materials		• Emissions associated with the transportation of water, launch vehicles and liquid fuels to site.
OPERATIONS		
Launches	• Emissions from kerosene combustion used for the launch vehicles.	• Emissions associated with extraction and processing of kerosene consumed.
Vehicle movements transporting staff and equipment	• Emissions from diesel combustion in light vehicles and trucks.	• Emissions associated with extraction and processing of diesel consumed.
Production and supply		• Emissions associated with the production and supply of diesel and kerosene.
Haulage of materials		• Emissions associated with the transportation of water, launch vehicles and liquid fuels to site.

5.3 Activity Data

Projected activity data for the Southern Launch construction and operations have been estimated based on data included in the project description and in communication with Southern Launch staff.

The activity data used in the calculations is shown in **Table 3**.

Table 3 Southern Launch GHG Emission Inventory Activity Data

Activity	Construction	Operations	Total
Scope 1			
Liquid fuel use for staff transport – Petrol	6 kL	-	6 kL
Liquid fuel use for stationary purposes (e.g. equipment, etc.) – Diesel	55,790 kL	30,798 kL	86,588 kL
Liquid fuel use for vegetation clearing equipment – Diesel	390 kL	-	390 kL
Liquid fuel use for electricity generation – Diesel	517 kL	14,983 kL	15,500 kL
Liquid fuel use for stationary purposes (e.g. on-road equipment, etc.) – Gasoline	16,343 kL	-	16,343 kL
Liquid fuel use for launch vehicles – RP-1 Kerosene (First year)	51 kL	8,923 kL	8,974 kL
Vegetation clearing	26 ha	-	26 ha
Scope 3			
Delivery of water to site – Diesel	2 kL	57 kL	59 kL
Delivery of launch vehicles to site – Diesel	5 kL	790 kL	795 kL
Delivery of diesel and gasoline to site – Diesel	57 kL	24 kL	81 kL
Delivery of kerosene to site – Diesel	0.17 kL	5 kL	5 kL
Liquid fuel use for staff transport – Petrol	-	163 kL	163 kL
Production and supply of diesel – Diesel	73,040 kL	45,781 kL	118,821 kL
Production and supply of diesel – Kerosene		127,885 kL	127,885 kL

5.4 Emission Factors

The emission factors used in the calculations for the estimates of Scope 1 and 3 GHG emissions are presented in **Table 4**. These factors were sourced from the most recent NGA Factors workbook (DEE, 2019).

Table 4 GHG Emission Factors

Source/Activity	Energy Content Factor (GJ/kL)	Emission Factor (kg CO_2-e/GJ)
Scope 1		
Gasoline combustion - Transport	34.2	67.62
Diesel combustion – Stationary[1]	38.6	70.2
Diesel combustion – Stationary (vegetation clearing)	38.6	70.2
Diesel combustion – Electricity generation	38.6	70.2
Kerosene combustion - Launches	36.8	70.21
Vegetation clearing		798 tCO_2-e/hectare
Scope 3		

Source/Activity	Energy Content Factor (GJ/kL)	Emission Factor (kg CO_2-e/GJ)
Gasoline combustion - Transport	38.6	67.62
Haulage of materials – Diesel	38.6	70.51
Production and supply of materials – Diesel	38.6	3.6
Production and supply of materials – Kerosene	36.8	3.6

[1] Section 2.2 of the NGA Factors workbook states "*No transport factors are provided for vehicles not registered for road use. Stationary energy factors for individual fuel types should be used in these cases.*"

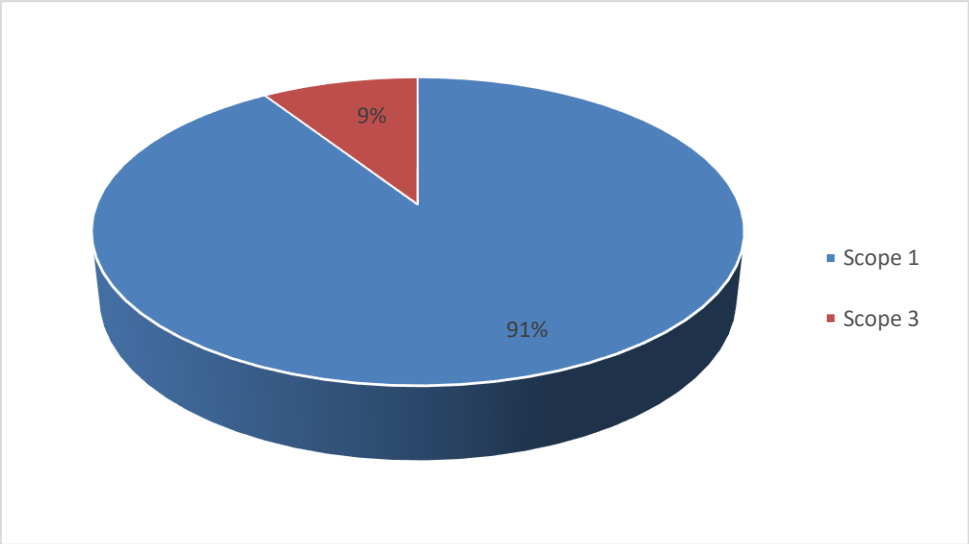
5.5 Estimated GHG Emissions

The estimated annual GHG emissions for Southern Launch are shown in **Table 5**. A chart of the estimated Scope 1 and Scope 3 emissions is provided in **Figure 3**.

Table 5 GHG Emission Inventory – Estimated Scope 1 and 3 Emissions

Activity/Source	Estimated GHG Emissions (tCO_2-e)		
	Construction	Operations	Total
Scope 1			
Liquid fuel use for staff transport – Gasoline	13	-	**13**
Liquid fuel use for transport during construction – Gasoline	37,795	-	**37,795**
Liquid fuel use for stationary purposes (e.g. equipment, etc.) – Diesel	151,175	83,454	**234,629**
Liquid fuel use for vegetation clearing equipment – Diesel	1,057	-	**1,057**
Liquid fuel use for electricity generation – Diesel	1,400	40,601	**42,001**
Liquid fuel use for launch vehicles – RP-1 Kerosene	132	23,055	**23,187**
Vegetation clearing	20,750	-	**20,750**
Sub-Total – Scope 1	***212,322***	***147,110***	***359,432***
Scope 3			
Delivery of water to site – Diesel	5	154	159
Delivery of launch vehicles to site – Diesel	12	2,149	2,161
Delivery of diesel and gasoline to site – Diesel	156	66	222
Delivery of kerosene to site – Diesel	.45	13	13.45
Liquid fuel use for staff transport – Petrol		377	377
Production and supply of diesel – Diesel	10,150	6,362	16,512
Production and supply of diesel – Kerosene		16,942	16,942
Sub-Total – Scope 3	***10,323***	***26,063***	***36,386***
TOTAL			***395,818***

Figure 3 Estimated Scope 1 and 3 GHG Emissions (percentage)



Based on information presented in **Table 5**, the total Southern Launch GHG emissions is 395,818 tCO2-e. GHG emissions from construction are estimated to be 222,645 tonnes of CO_2-e in total, 56% of the total.

The main contributor to the estimated GHG inventory is emissions from the combustion of diesel used for stationary purposes, which accounts for 60% of the total estimated GHG emissions. The second contributor is diesel consumption for electricity generation purposes, which is estimated to account for 11% of the total combined Scope 1 and Scope 3 emissions.

5.6 Assumptions

A summary of the activity data and assumptions used in the calculations for each source is provided below.

- Project life – 30 years of life of the project, 1 year for construction and 29 years for operations.
- Liquid fuel use for staff transport – staff driving private motor vehicles using gasoline on site an average of 4 round trips per day, each round trip of 50 km, 5 working days, 52 weeks per year. Assuming a fuel consumption of 10.8 L per 100 km travelled.
- Liquid fuel use for vegetation clearing equipment – assuming 15 kL of diesel used per hectare cleared.
- Liquid fuel use for electricity generation – generator operating 10 hours a day, 6 days a week. There will be one generator at each of the four project sites (the range control, the warehouse, launch pad A and launch pad B). Each generator is 200 KVA with 41.4 L/h (100% load) fuel consumption.
- Liquid fuel use for stationary purposes – assuming diesel use during construction for mobile construction equipment, earthworks and transport.
- Liquid fuel use for vehicles during construction – assuming vehicles used for construction activities consumed gasoline.

- Liquid fuel use for launch vehicles – the number of launches is anticipated to grow over time, with approximately 6 launches anticipated in the first year of operations, increasing to a maximum of 36 launches in year five of operations. Assuming 36 launches per year from second year of operations as worst-case scenario. The RP-1 fuel use per launch for one of the larger launch vehicles is 7,000 kg (Stage 1 to 3). Assumed worst case scenario using 7,000 kg per each launch vehicle. Density of kerosene of .819 kg/L. It is assumed that engine tests will be rare and any likely emissions are already covered within the emissions as estimated for the 36 launches per year.
- Electricity – the site will not be connected to the electricity grid, therefore no Scope 2 emissions from electricity used were included.
- Vegetation clearing – a total of 26 ha of temperate oceanic native vegetation will be cleared, including 5 ha for Sites A and B, 3 ha for Sites D and E and 10 ha for roads and other facility requirements. Assuming there will be GHG emissions during construction from clearing the native vegetation.
- Delivery of launch vehicles to site – assuming a worst-case scenario of 8 t of launch vehicle mass unfuelled. They will be transported by road from Adelaide, 685 km from site. Each launch vehicle will be transported by an articulated truck with a diesel consumption of 55.2 L per 100 km, considering a round trip to and from site to Adelaide.
- Delivery of potable water to site – potable water will be sourced from Port Lincoln. Assuming worst-case scenario of water supplied by truck and stored on-site in tanks during the lifetime of the project. To cater for up to 50 staff on site during peak periods, potable water will be stored in three 25,000-litre water tanks. Assuming an average daily residential water use per person (over 12 months) 190.49 L, for 50 staff working 5 days a week for 52 weeks per year. The water will be delivered in an articulated truck with 35 kL capacity with a diesel consumption of 55.2 L per 100 km, considering a round trip to and from site to Port Lincoln.
- Delivery of diesel to site – diesel will be sourced from Port Lincoln to cover the expected amount of diesel to be required during construction and operations. It will be delivered using an articulated truck with 35 kL capacity with a diesel consumption of 55.2 L per 100 km, considering a round trip to and from site to Port Lincoln.
- Delivery of kerosene to site – kerosene will be sourced from Port Lincoln in one articulated truck per launch, with a diesel consumption of 55.2 L per 100 km, considering a round trip to and from site to Port Lincoln.

6 Benchmarking and Comparison with National Totals

Australia's net GHG emissions totalled 537.4 Mt CO_2-e in 2018 (Australian National Greenhouse Accounts, (DISER, May 2020)). The energy sector accounted for 81% of the total national emissions with transport accounting for 12% of the national energy sector emissions.

The reported 2018 total South Australia GHG emissions of 24.2 Mt CO_2-e accounted for over 4% of national GHG emissions. The energy sector contributed 18.4 Mt CO_2-e which is approximately 76% of the state emission total. Transport emissions account for approximately 38% of South Australia energy sector emission total and 2% of Australia's energy sector emissions total.

The contributions of the predicted annual GHG emissions resulting from the Southern Launch construction and operations are detailed in **Table 6**. As can be seen, the emissions are a relatively small proportion of both the Australian and South Australia total emissions, accounting for less than 0.1% of total Australian GHG production. As such, the small amount of GHG emissions generated by Southern Launch will have a minor effect on global climate change.

Table 6 Southern Launch GHG Emissions Contribution to State and National Annual Emission Totals

	Southern Launch	Total Emissions - 2018	
		Australia	South Australia
Construction and Operations (tCO_2-e)	395,819	537,446,390	24,241,070
Percentage of National/State inventory	-	0.07%	1.6%

7 Conclusion

The assessment considers emissions of Greenhouse Gases from the Southern Launch construction and operations and includes estimates of direct and indirect GHG emissions. This assessment concluded:

- The total direct (Scope 1) emissions from Southern Launch construction and operations are estimated to be approximately 359,432 tCO_2-e, while the estimated Scope 3 emissions are approximately 36,386 tCO_2-e.
- Comparison of the estimated GHG emissions with State and National GHG emission totals indicates that the GHG emissions from Southern Launch are a small proportion of both the Australian and South Australia total emissions, accounting for 0.07% of total Australian GHG production.

Given the above, it is concluded that the relatively small amount of GHG emissions generated by Southern Launch will have a minor effect on global climate change.

8 References

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