APPENDICES

A	Revised Proposal Plan Set
B	AECOM Acoustic Data Report
C	Resonate Specialist Acoustic Advice
D	AECOM Terrestrial Ecology
E	J Diversity Marine Ecology
F	EBS Ecology (2022) Whaler's Way Coastal Raptor Memorandum
G	Coastal Raptor Boat Survey, Bebbington Feb 2022
H	WGA Traffic
I	SA Bushfire Solutions – Bushfire Emergency Management Plan
J	WAX Visual Amenity
K	SLR Air Quality
L	EnviroAdvice Water Quality
M	Updated SACES Report – May 2022
N	RDAEP Economic Report
O	Malcolm Davis Paper – Sovereign Launch
P	Fishing and Seafood industry Letters of Support
Q	Issues Matrix

TABLES / 1

TABLES / 2

FIGURES / 1

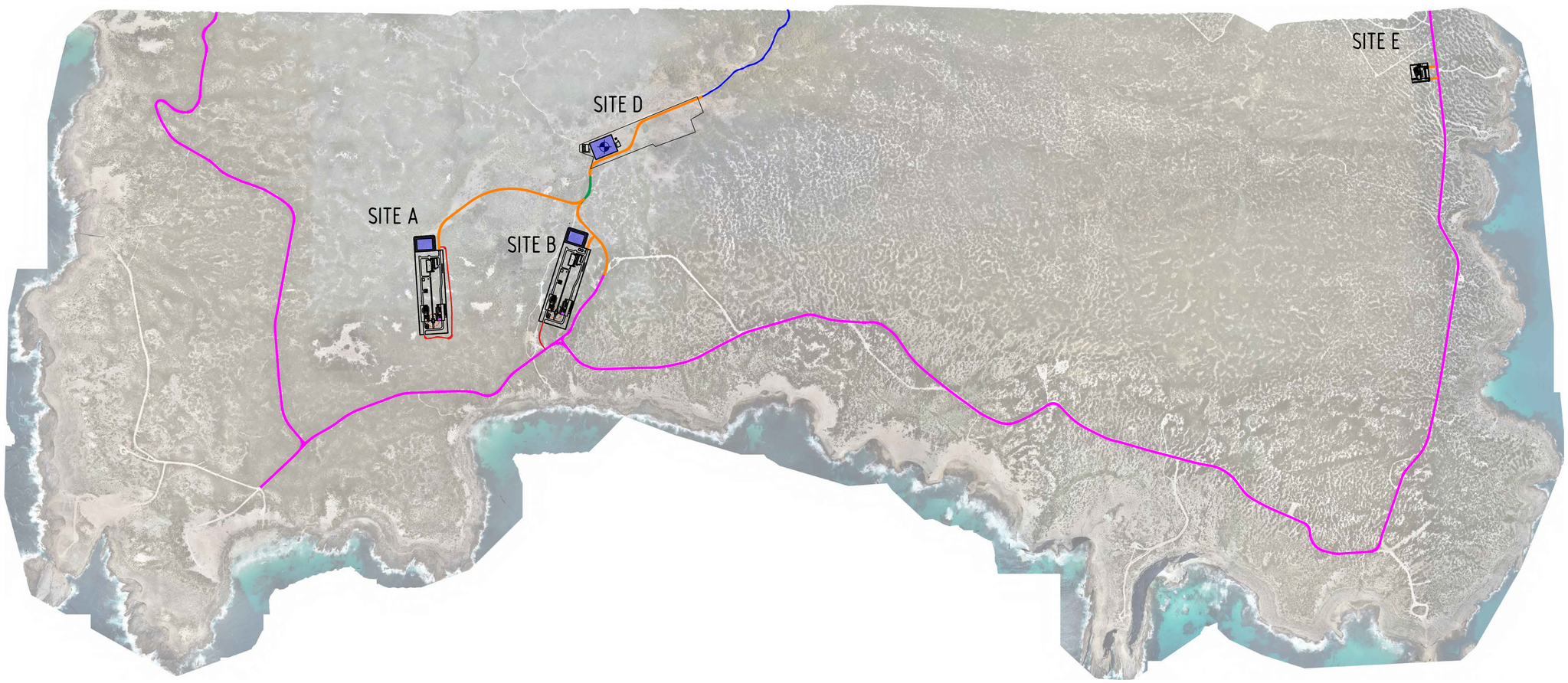
FIGURES / 2

A REVISED PROPOSAL PLAN SET

SOUTHERN LAUNCH

WHALERS WAY

WHALERS WAY ORBITAL LAUNCH COMPLEX



DRAWING INDEX

LEGEND

- EXISTING TRACK (TO BE MAINTAINED)
- EXISTING CARRIAGEWAY TO BE WIDENED TO 8.8m
- EXISTING CARRIAGEWAY TO BE WIDENED TO 5.0m
- NEW 8.8m WIDE CARRIAGEWAY
- NEW 4.0m EMERGENCY EGRESS CARRIAGEWAY
- GROUND WATER WELL 6028-1573 (COORDINATES 558977.18 E, 6134909.65 N)

V:\181\181400-181499\181404 - Southern Launch\Drafting\WGA181404-DR-CC-0001.dwg, H, 17/1/2022 2:16 PM, ikleinig

When sheet printed full size, the scale bar is 100mm.

0 50 100mm

200 100 0 200 400
SCALE BAR (m)

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REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
B	21.08.20	REVISED PRELIMINARY ISSUE	LK	TJM	TJM
C	10.12.20	SITE D UPDATED	JJF	TJM	TJM
D	16.02.21	UPDATED ISSUE	LK	TJM	TJM
E	22.11.21	ALTERNATE SITE A	LK	TJM	TJM
F	02.12.21	ALTERNATE SITE A	LK	TJM	TJM
G	11.01.22	SITE 'A' ACCESS ROADS AMENDED	TD	TJM	TJM
H	17.01.22	SITE 'D' BOUNDARY ADDED	LK	TJM	TJM

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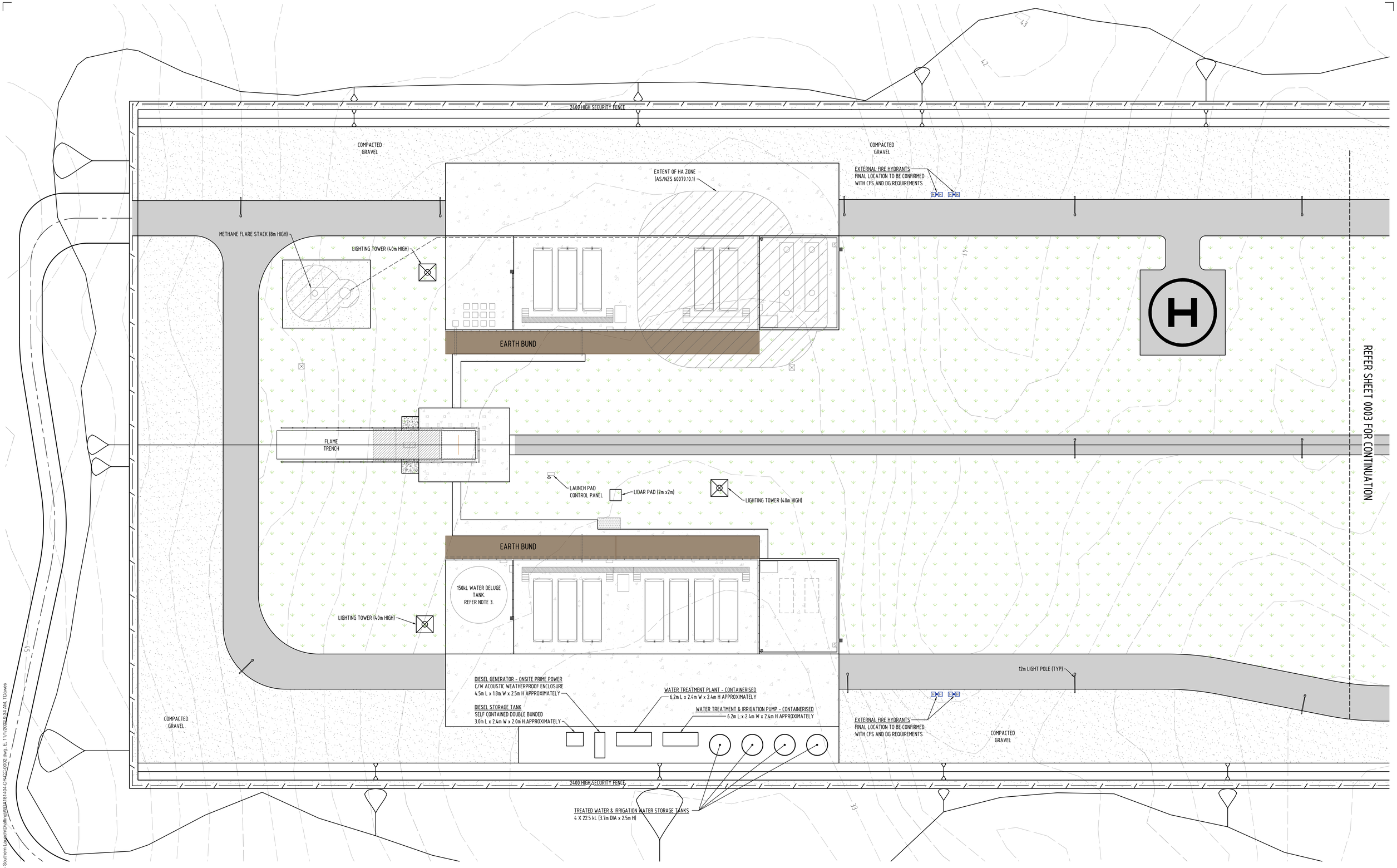
SOUTHERN LAUNCH
WHALERS WAY, SOUTH AUSTRALIA
EXISTING ALIGNMENT MODIFICATIONS
OVERALL SITE PLAN

A1 | DOCUMENT NUMBER | Project Number | Sheet No. | Rev.

Design TM | Drawn JJF | WGA181404-DR-CC-0001 H



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SITE NOTES:

1. LIGHTING FOR ROADS AND PUBLIC PEDESTRIAN SPACES IS TO BE TO AS1158.3 LEVEL PC3.
2. LIGHTING FOR EXTERNAL OUTDOOR WORKPLACE IS TO BE TO AS1680.5.
3. 3.0m HIGH TANK ON 20m HIGH RAISED PLATFORM.

5 2.5 0 5 10
SCALE BAR (m)

When sheet printed full size, the scale bar is 100mm.
0 50 100mm

INFORMATION ISSUE
NOT FOR CONSTRUCTION

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A	10.08.20	PRELIMINARY ISSUE	JJF	TJM	TJM
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D	02.12.21	ALTERNATE SITE A	LK	TJM	TJM
E	11.01.22	SITE 'A' ACCESS ROADS AMENDED	TD	TJM	TJM

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SOUTHERN LAUNCH
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EXISTING ALIGNMENT MODIFICATIONS
SITE A - SHEET 1 OF 2

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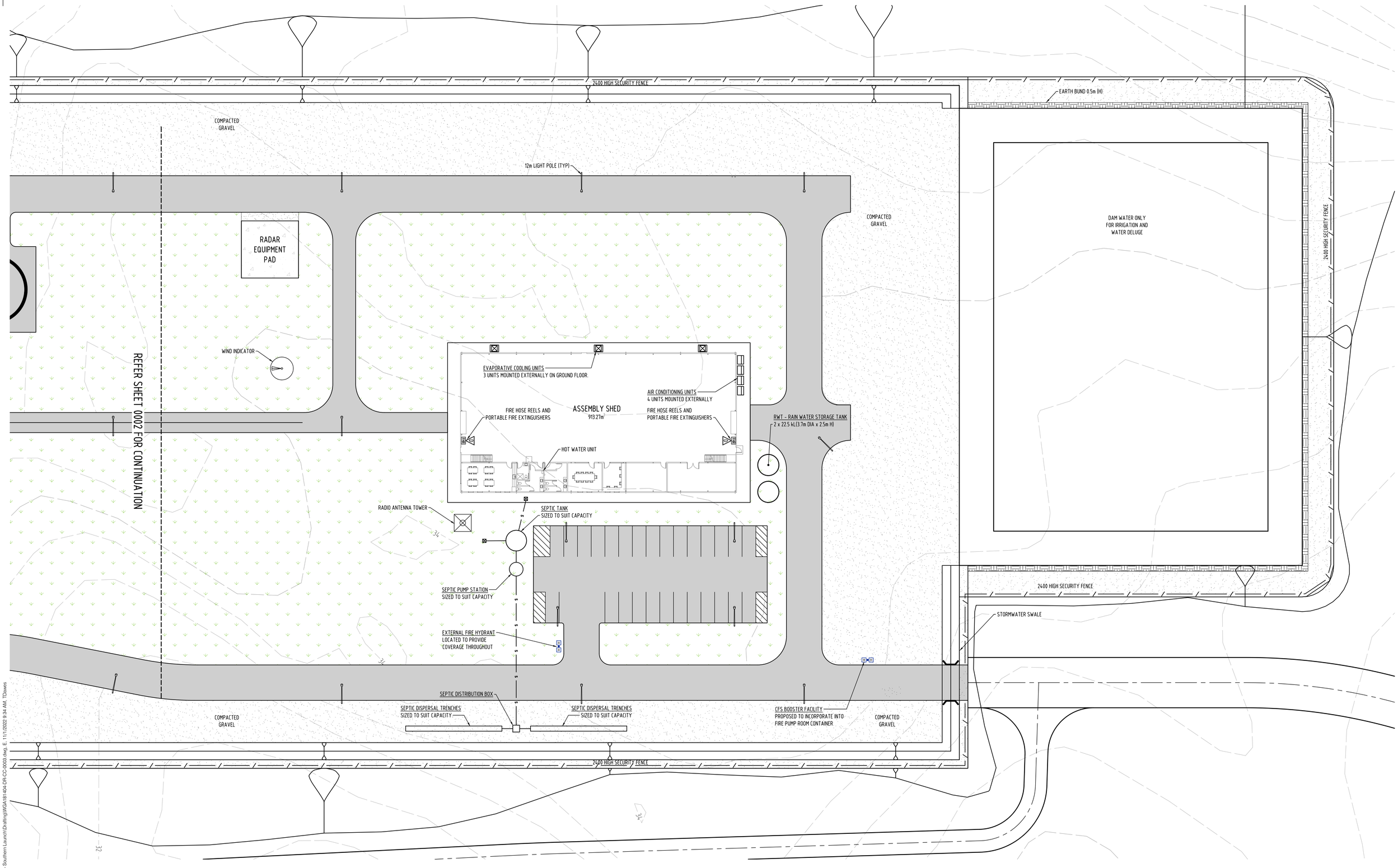

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SCALE BAR (m)

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0 50 100mm

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SOUTHERN LAUNCH
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EXISTING ALIGNMENT MODIFICATIONS
SITE A - SHEET 2 OF 2

A1
DOCUMENT NUMBER
Project Number WGA181404-DR-CC-0003 Sheet No. E Rev.
Design TM Drawn JJF

E 558697.156
N 6134167.637

2400 HIGH SECURITY FENCE

COMPACTED GRAVEL

CONCRETE PAVEMENT

EXTENT OF HA ZONE (AS/NZS 60079.10.1)

EXTERNAL FIRE HYDRANTS
FINAL LOCATION TO BE CONFIRMED WITH CFS AND DG REQUIREMENTS

4.0m

METHANE FLARE STACK (8m HIGH)

LIGHTING TOWER (40m HIGH)

FUEL AREA CLASS 2.2

FUEL AREA CLASS 2.1

FUEL AREA CLASS 3

EARTH BUND

FLAME TRENCH

LAUNCH PAD

LAUNCH PAD CONTROL PANEL

LIDAR PAD (2m x2m)

LIGHTING TOWER (40m HIGH)

REFER SHEET 0005 FOR CONTINUATION

150kL WATER DELUGE TANK.
REFER NOTE 3.

FUEL AREA CLASS 2.2

FUEL AREA CLASS 2.2

FUEL AREA CLASS 5.1

LIGHTING TOWER (40m HIGH)

DIESEL GENERATOR - ONSITE PRIME POWER
C/W ACOUSTIC WEATHERPROOF ENCLOSURE
4.5m L x 1.8m W x 2.5m H APPROXIMATELY

DIESEL STORAGE TANK
SELF CONTAINED DOUBLE BUNDED
3.0m L x 2.4m W x 2.0m H APPROXIMATELY

CONCRETE PAVEMENT

WATER TREATMENT PLANT - CONTAINERISED
6.2m L x 2.4m W x 2.4m H APPROXIMATELY

WATER TREATMENT & IRRIGATION PUMP - CONTAINERISED
6.2m L x 2.4m W x 2.4m H APPROXIMATELY

ASPHALT PAVEMENT

12m LIGHT POLE (TYP)

EXTERNAL FIRE HYDRANTS
FINAL LOCATION TO BE CONFIRMED WITH CFS AND DG REQUIREMENTS

COMPACTED GRAVEL

COMPACTED GRAVEL

2400 HIGH SECURITY FENCE

E 558811.874
N 6134130.865

TREATED WATER & IRRIGATION WATER STORAGE TANKS
4 X 22.5 kL (3.7m DIA x 2.5m H)

24 25 26 27 28 29

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SITE NOTES:

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When sheet printed full size, the scale bar is 100mm.

0 50 100mm

5 2.5 0 5 10
SCALE BAR (m)

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SITE B - SHEET 1 OF 2

A1

DOCUMENT NUMBER
Project Number Sheet No. Rev.

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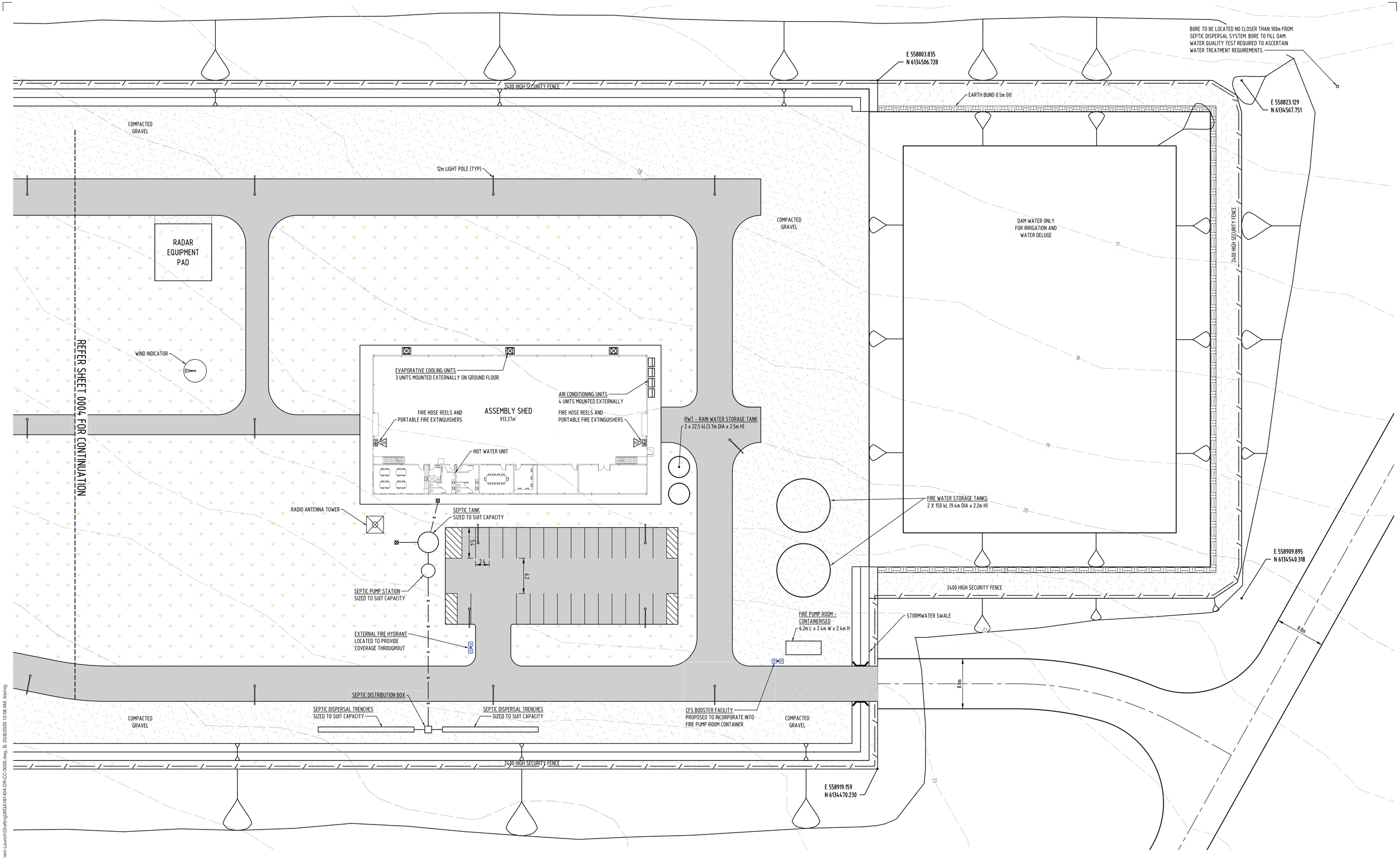

SITE NOTES:

1. LIGHTING FOR ROADS AND PUBLIC PEDESTRIAN SPACES IS TO BE TO AS1158.3 LEVEL PC3.
2. LIGHTING FOR EXTERNAL OUTDOOR WORKPLACE IS TO BE TO AS1680.5.
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SCALE BAR (m)

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SITE B - SHEET 2 OF 2

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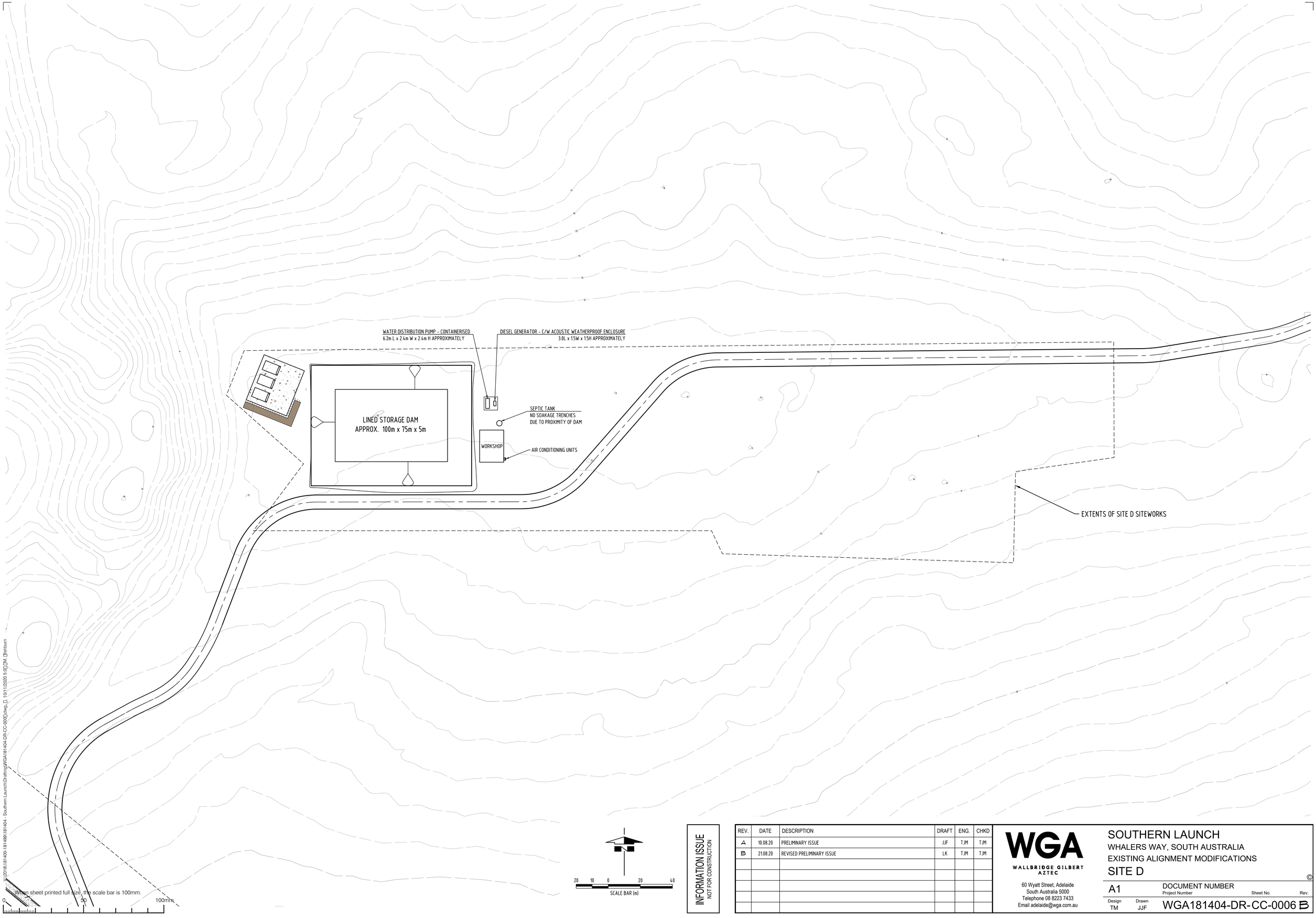
WGA181404-DR-CC-0005 B



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SCALE BAR (m)

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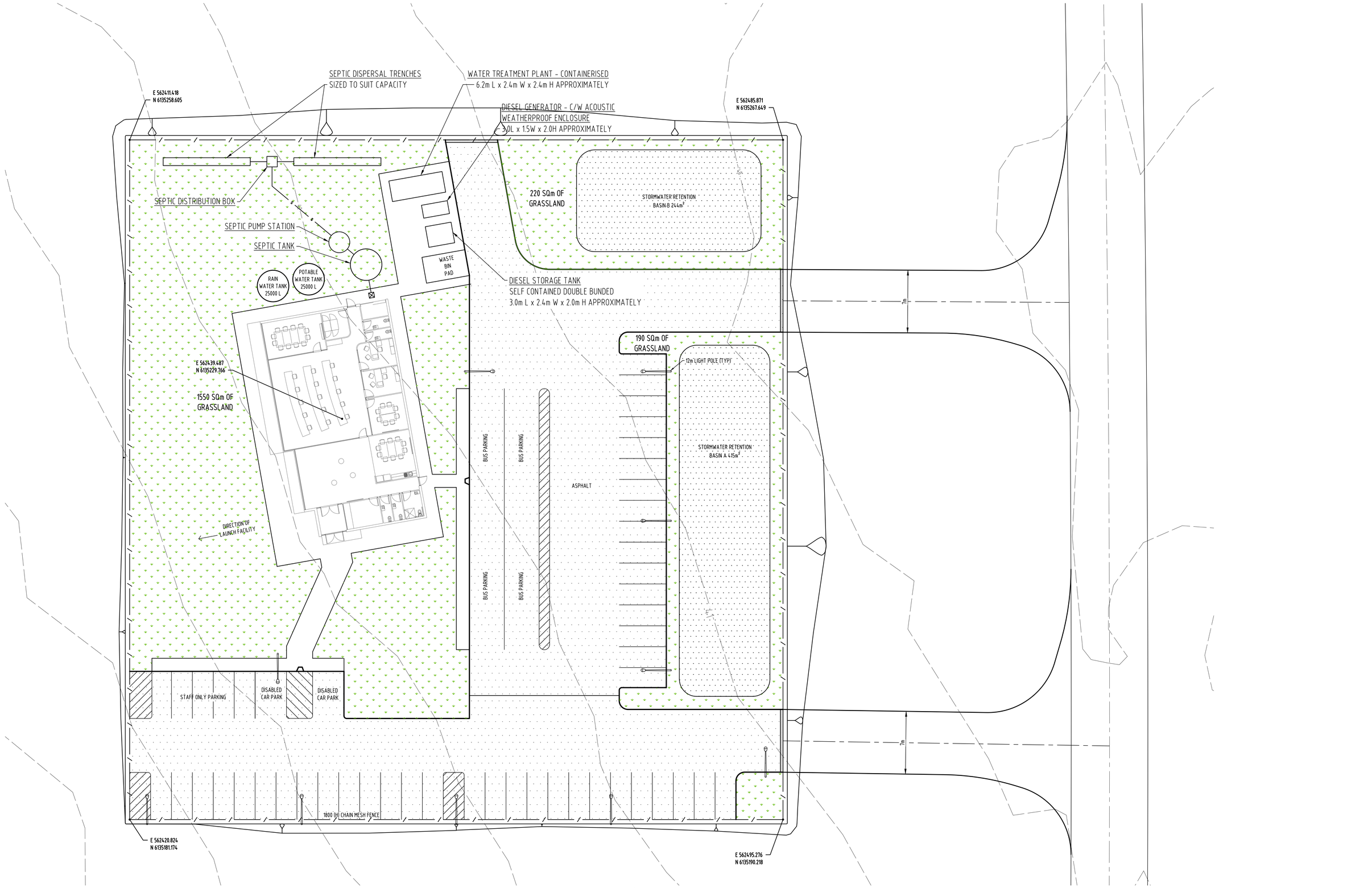
EXISTING ALIGNMENT MODIFICATIONS
SITE D

A1

DOCUMENT NUMBER
Project Number | Sheet No. | Rev.

Design TM | Drawn JJF

WGA181404-DR-CC-0006 B



SITE NOTES:

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2. LIGHTING FOR EXTERNAL OUTDOOR WORKPLACE IS TO BE TO AS1680.5.

4 2 0 4 8
SCALE BAR (m)

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C	16.02.21	UPDATED ISSUE	LK	TJM	TJM

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SOUTHERN LAUNCH
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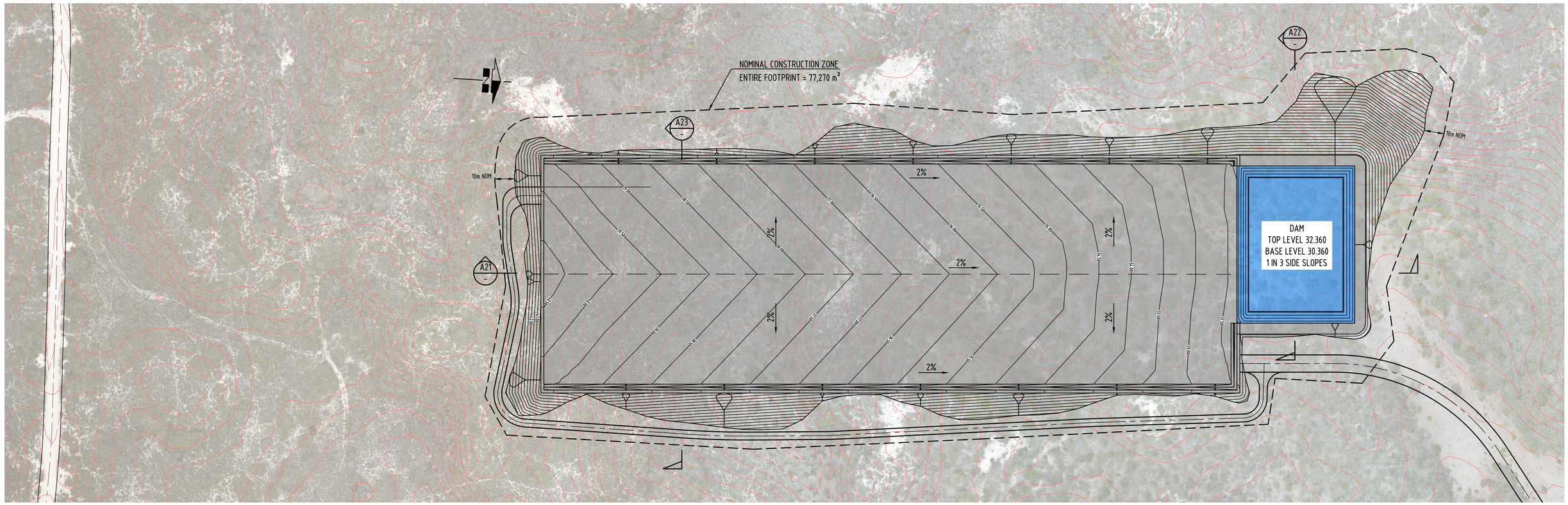
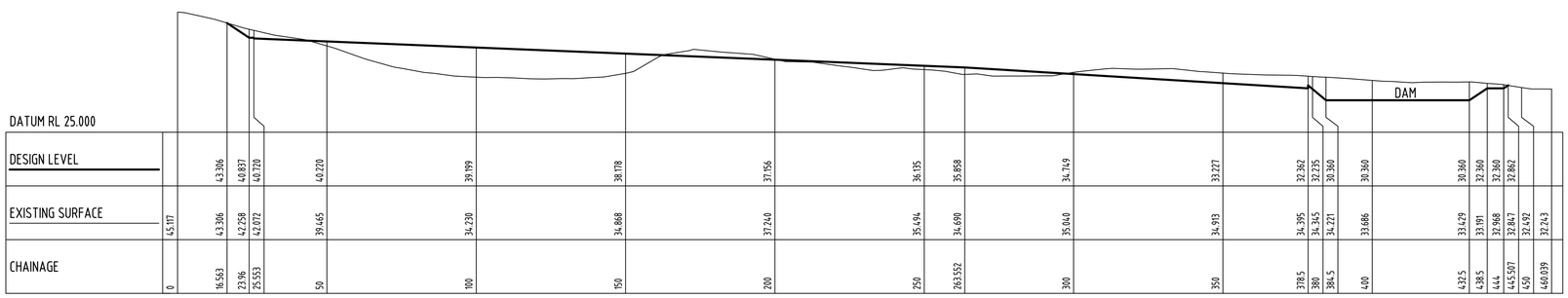
EXISTING ALIGNMENT MODIFICATIONS
SITE E

A1
DOCUMENT NUMBER
Project Number
Sheet No.
Rev.
Design TM
Drawn JJF
WGA181404-DR-CC-0007 C



DESIGN VOLUME (TO FSL)		
ZONE	CUT m3	FILL m3
AREA 'A' Option 2	65,677	64,803

NOTE: DETENTION BASIN YET TO BE SIZED AND INCLUDED IN VOLUMES



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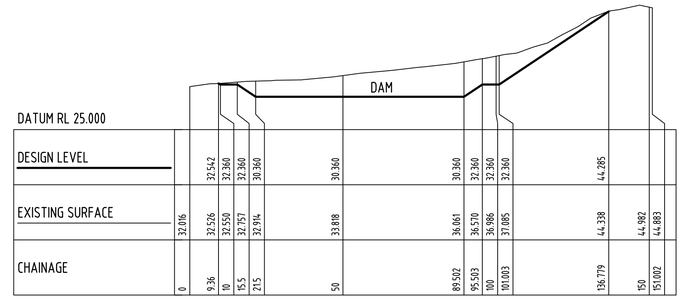

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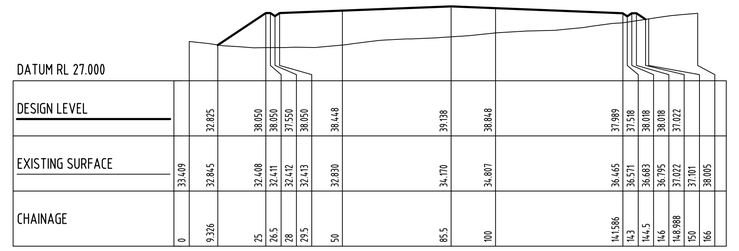

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0 50 100mm

SCALE BAR (m)
HORIZONTAL
20 10 0 20 40

SCALE BAR (m)
VERTICAL
10 5 0 10 20

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C	19.02.21	REVISED PRELIMINARY ISSUE	TD	TJM	TJM
D	22.11.21	ALTERNATE SITE A	LK	TJM	TJM
E	02.12.21	ALTERNATE SITE	LK	TJM	TJM
F	11.01.22	SITE 'A' ACCESS ROADS AMENDED	TD	TJM	TJM

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SOUTHERN LAUNCH
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SITE A - PRELIMINARY EARTHWORKS

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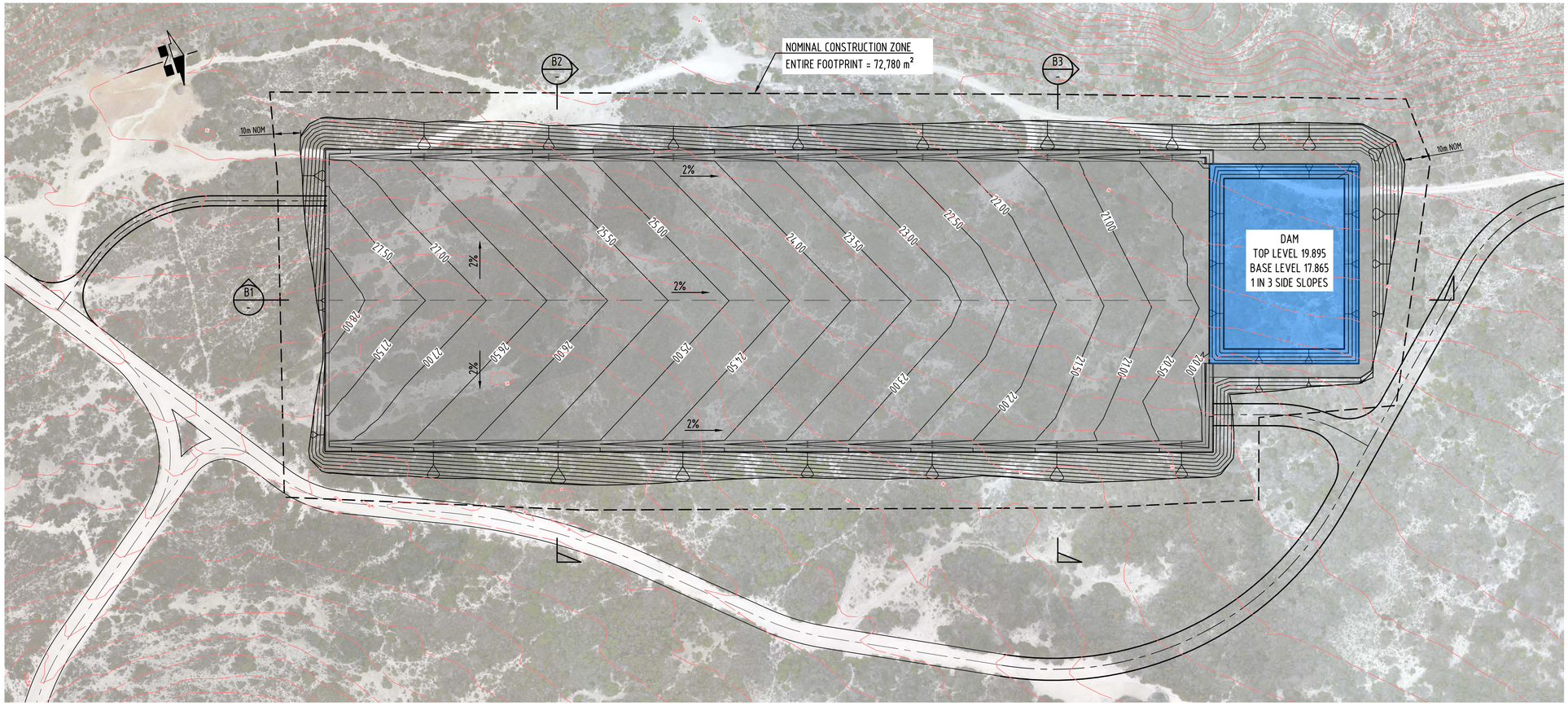

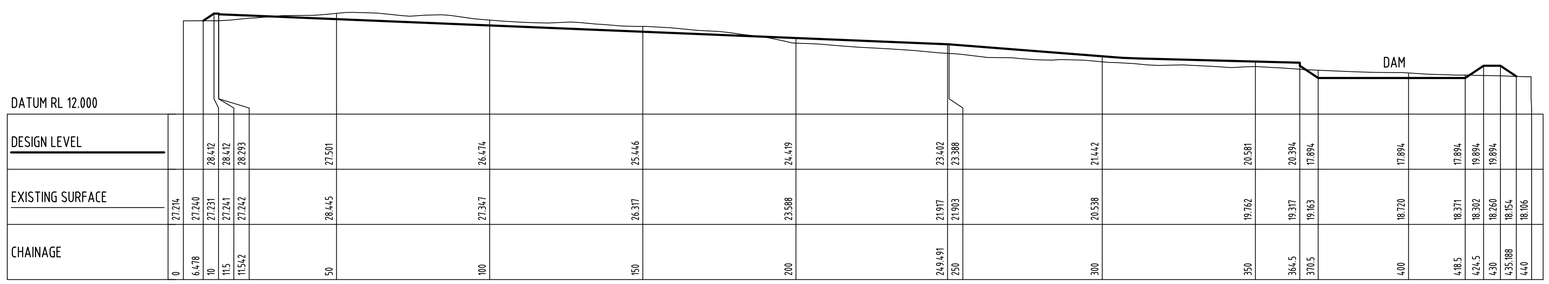

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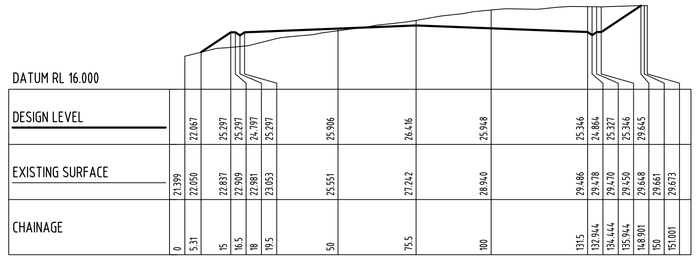

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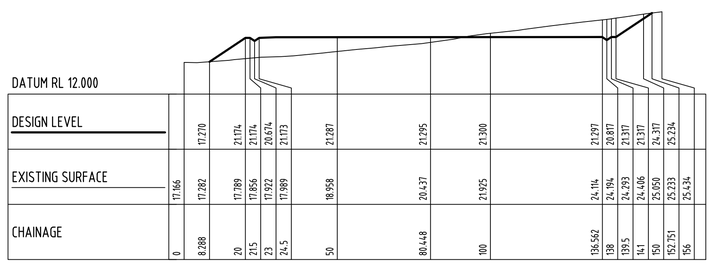

SECTION B3
SCALE 1:1000H 1:500V

DESIGN VOLUME (TO FSL)		
ZONE	CUT m3	FILL m3
AREA 'B'	52295	52044

NOTE: DETENTION BASIN YET TO BE SIZED AND INCLUDED IN VOLUMES

SCALE BAR (m)
HORIZONTAL
20 10 0 20 40

SCALE BAR (m)
VERTICAL
10 5 0 10 20

When sheet printed full size, the scale bar is 100mm.
0 50 100mm

INFORMATION ISSUE
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C	19.02.21	REVISED PRELIMINARY ISSUE	TD	TJM	TJM

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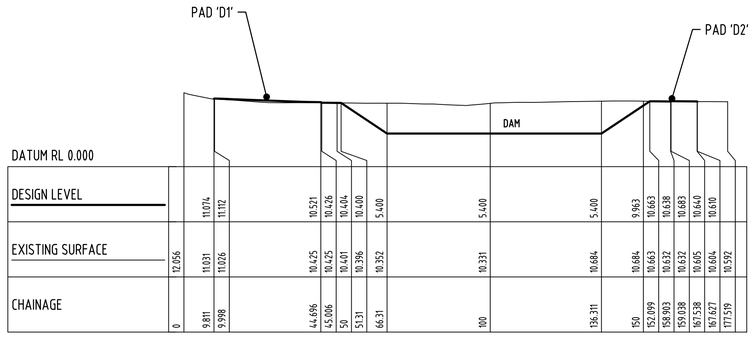
EXISTING ALIGNMENT MODIFICATIONS
SITE B - PRELIMINARY EARTHWORKS

A1 | DOCUMENT NUMBER | Project Number | Sheet No. | Rev.
Design TM | Drawn TD | WGA181404-DR-CC-0011 C



SECTION D1
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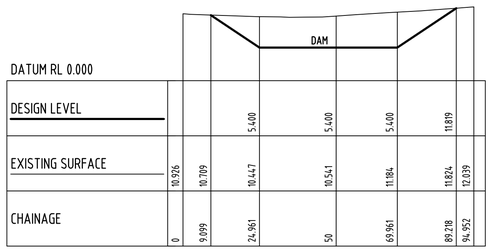

SECTION D2
SCALE 1:1000H 1:500V

DESIGN VOLUME (TO FSL)		
ZONE	CUT m3	FILL m3
AREA 'D'	28347	224

NOTE: DETENTION BASIN YET TO BE SIZED AND INCLUDED IN VOLUMES

SCALE BAR (m)
HORIZONTAL
20 10 0 20 40

SCALE BAR (m)
VERTICAL
10 5 0 10 20

When sheet printed full size, the scale bar is 100mm.
0 50 100mm

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SOUTHERN LAUNCH
WHALERS WAY, SOUTH AUSTRALIA
EXISTING ALIGNMENT MODIFICATIONS
SITE D - PRELIMINARY EARTHWORKS

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Rev.
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Drawn TD
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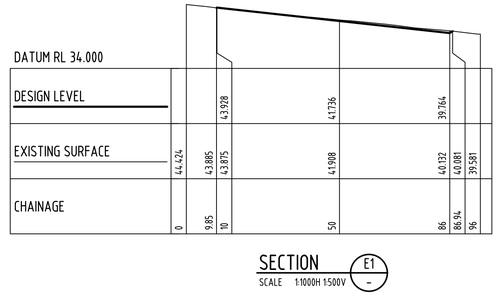

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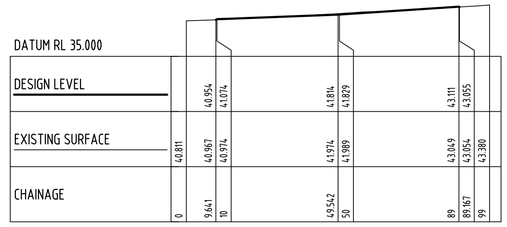

SECTION E2
SCALE 1:1000H 1:500V

DESIGN VOLUME (TO FSL)		
ZONE	CUT m3	FILL m3
AREA 'E'	492	474

NOTE: DETENTION BASIN YET TO BE SIZED AND INCLUDED IN VOLUMES

SCALE BAR (m)
HORIZONTAL
20 10 0 20 40

SCALE BAR (m)
VERTICAL
10 5 0 10 20

When sheet printed full size, the scale bar is 100mm.
0 50 100mm

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SOUTHERN LAUNCH
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SITE E - PRELIMINARY EARTHWORKS

A1
DOCUMENT NUMBER
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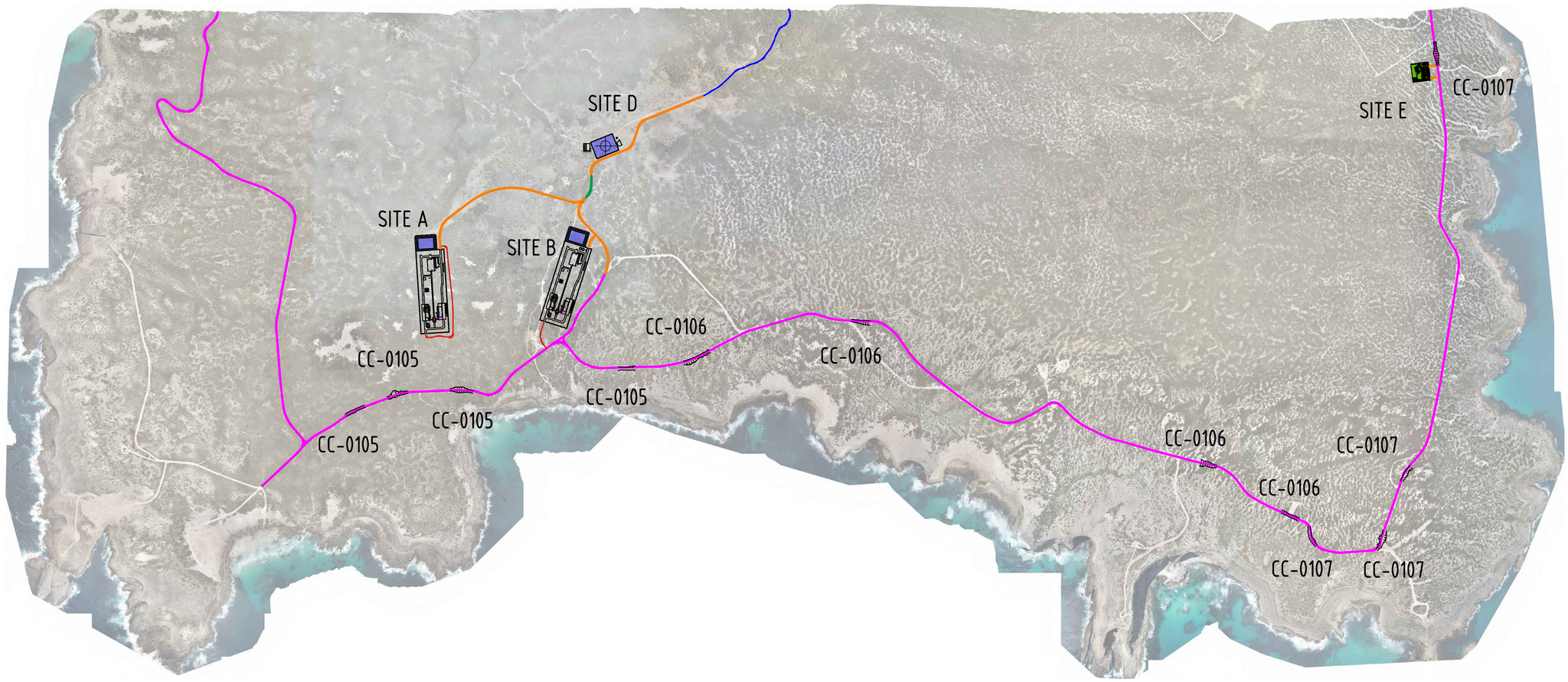
Design TM
Drawn TD
WGA181404-DR-CC-0013 D

SOUTHERN LAUNCH

WHALERS WAY

WHALERS WAY ORBITAL LAUNCH COMPLEX

DRAWING INDEX



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- EXISTING CARRIAGEWAY TO BE WIDENED TO 8.8m
- EXISTING CARRIAGEWAY TO BE WIDENED TO 5.0m
- NEW 8.8m WIDE CARRIAGEWAY
- NEW 4.0m EMERGENCY EGRESS CARRIAGEWAY
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PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	21.08.20	PRELIMINARY ISSUE	LK	TJM	TJM
B	10.12.20	SITE D UPDATED	JJF	TJM	TJM
C	16.02.21	UPDATED ISSUE	LK	TJM	TJM
D	22.11.21	ALTERNATE SITE A	LK	TJM	TJM
E	02.12.21	ALTERNATE SITE A	LK	TJM	TJM
F	11.01.22	SITE 'A' ACCESS ROADS AMENDED	TD	TJM	TJM

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WHALERS WAY
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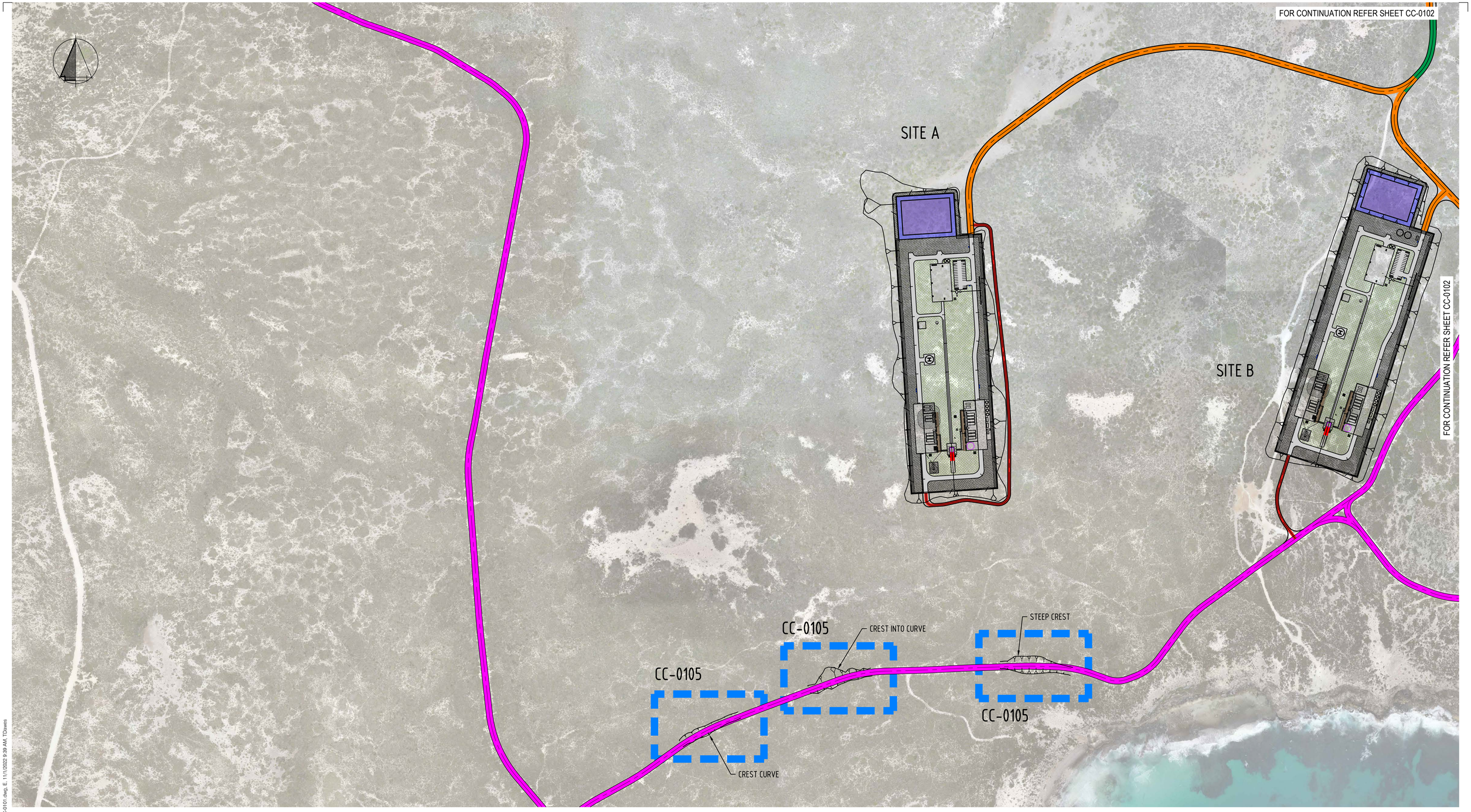
EXISTING ALIGNMENT MODIFICATIONS
LOCALITY PLAN

A1 | DOCUMENT NUMBER | Project Number | Sheet No. | Rev.

Design TM | Drawn DSK | WGA181404-DR-CC-0100 F



PLAN VIEW

SCALE 1:2,500

LEGEND

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- EXISTING CARRIAGEWAY TO BE WIDENED TO 8.8m
- EXISTING CARRIAGEWAY TO BE WIDENED TO 5.0m
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PRELIMINARY ISSUE
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REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	21.08.20	PRELIMINARY ISSUE	LK	TJM	TJM
C	22.11.21	ALTERNATE SITE A	LK	TJM	TJM
D	02.12.21	ALTERNATE SITE A	LK	TJM	TJM
E	11.01.22	SITE 'A' ACCESS ROADS AMENDED	TD	TJM	TJM

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SITE PLAN - SHEET 01

A1 | DOCUMENT NUMBER | Project Number | Sheet No. | Rev.

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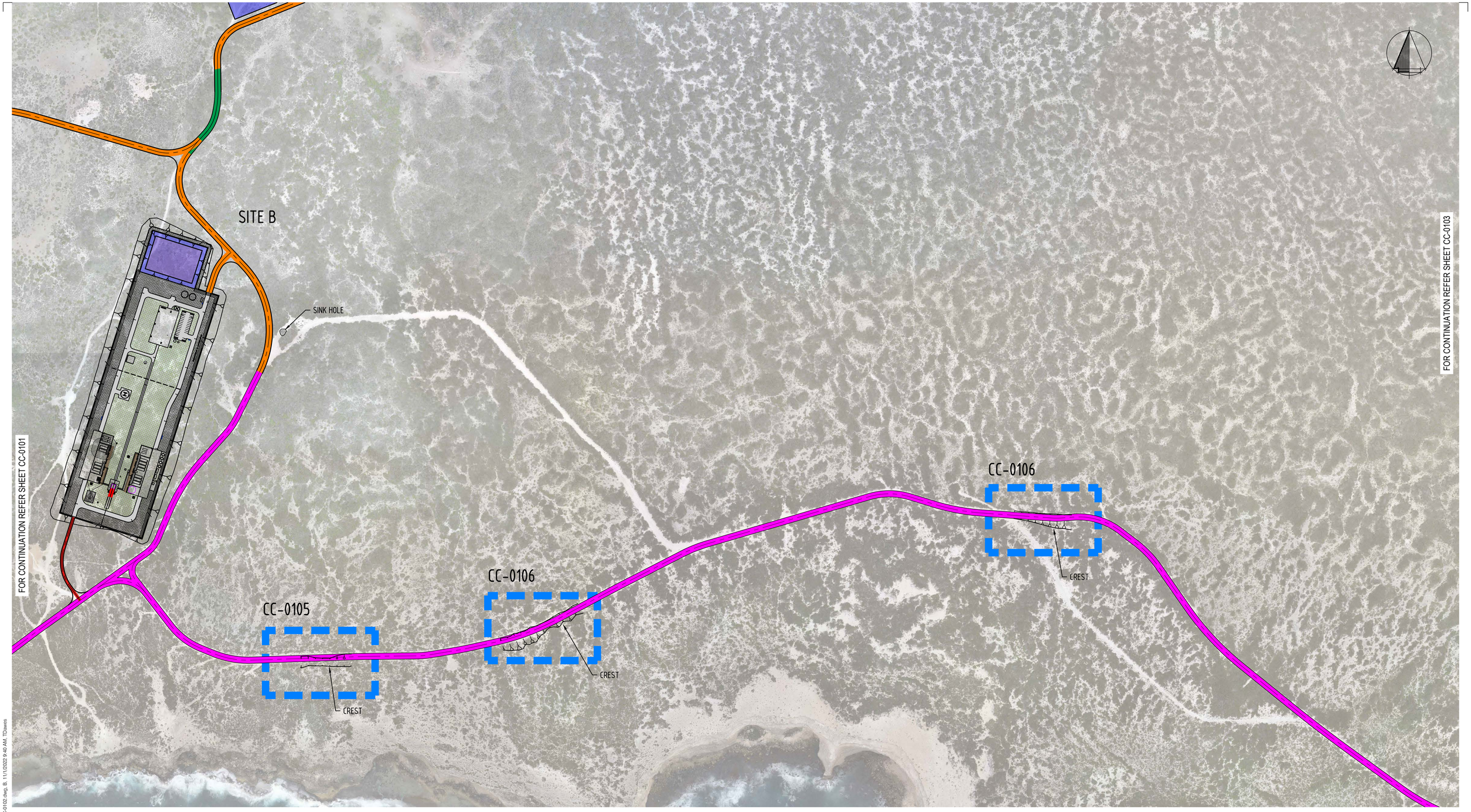

PLAN VIEW

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LEGEND

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B	11.01.22	SITE 'A' ACCESS ROADS AMENDED	TD	TJM	TJM

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WHALERS WAY

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EXISTING ALIGNMENT MODIFICATIONS

SITE PLAN - SHEET 02

A1 | DOCUMENT NUMBER | Project Number | Sheet No. | Rev.

Design TM | Drawn DSK | WGA181404-DR-CC-0102 B

FOR CONTINUATION REFER SHEET CC-0102

FOR CONTINUATION REFER SHEET CC-0104

CC-0106

CREST

CC-0107

CC-0106

CC-0107

PLAN VIEW

SCALE 1:2,500

LEGEND

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A	21.08.20	PRELIMINARY ISSUE	LK	TJM	TJM

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WHALERS WAY
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EXISTING ALIGNMENT MODIFICATIONS
SITE PLAN - SHEET 03

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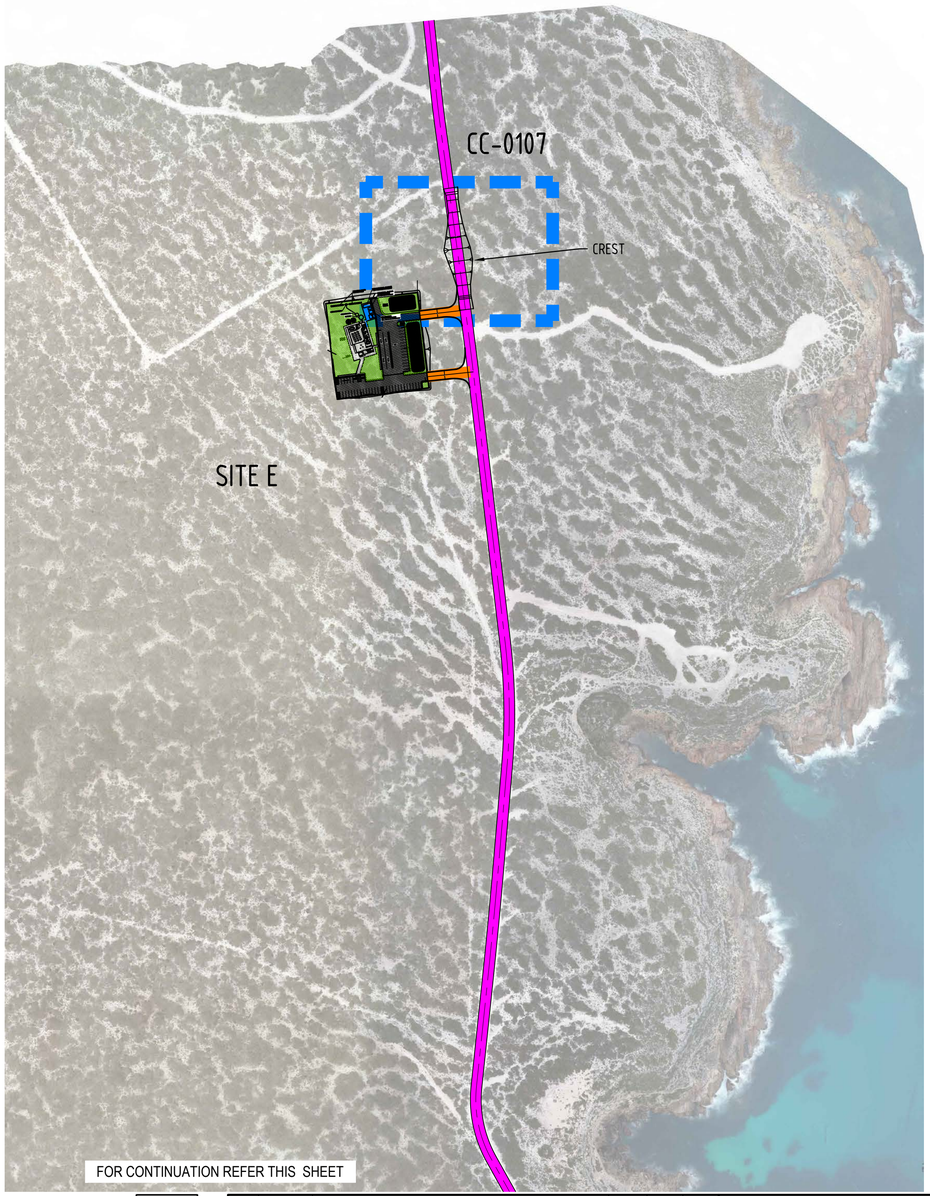
Project Number | Sheet No. | Rev.

Design TM | Drawn DSK

WGA181404-DR-CC-0103 A



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- NEW 4.0m EMERGENCY EGRESS CARRIAGEWAY

PLAN VIEW

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B	16.02.21	UPDATED ISSUE	LK	TJM	TJM

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EXISTING ALIGNMENT MODIFICATIONS
SITE PLAN - SHEET 04

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Sheet No.: B
Rev.

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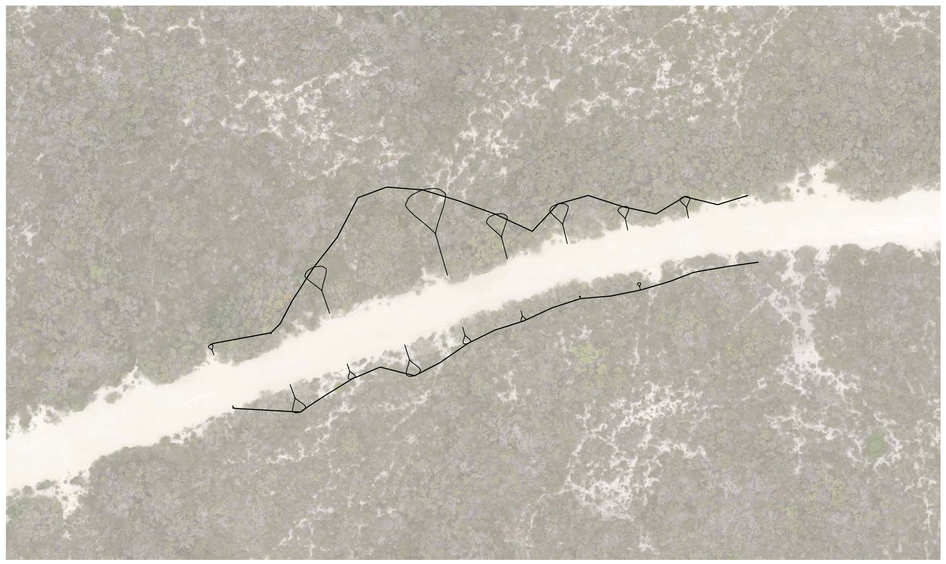

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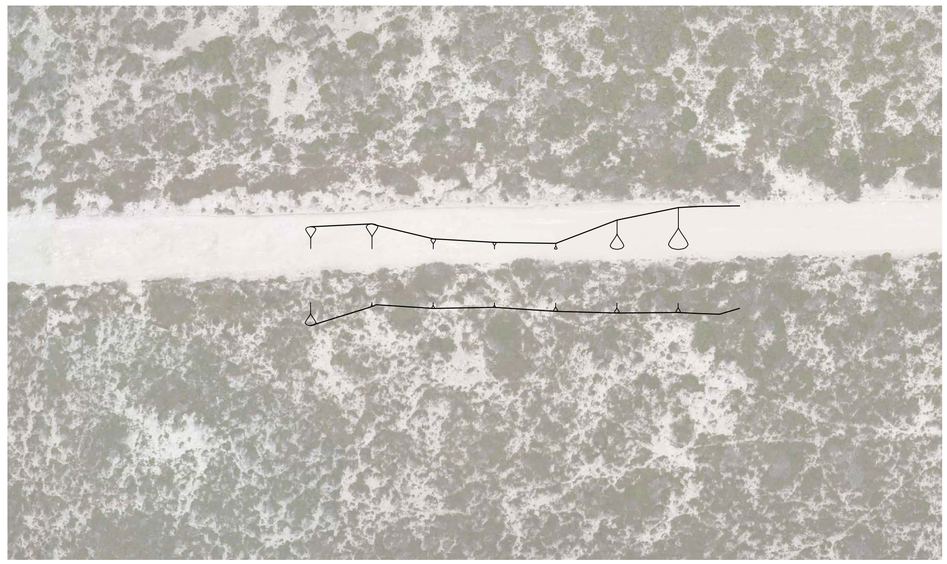

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PLAN VIEW

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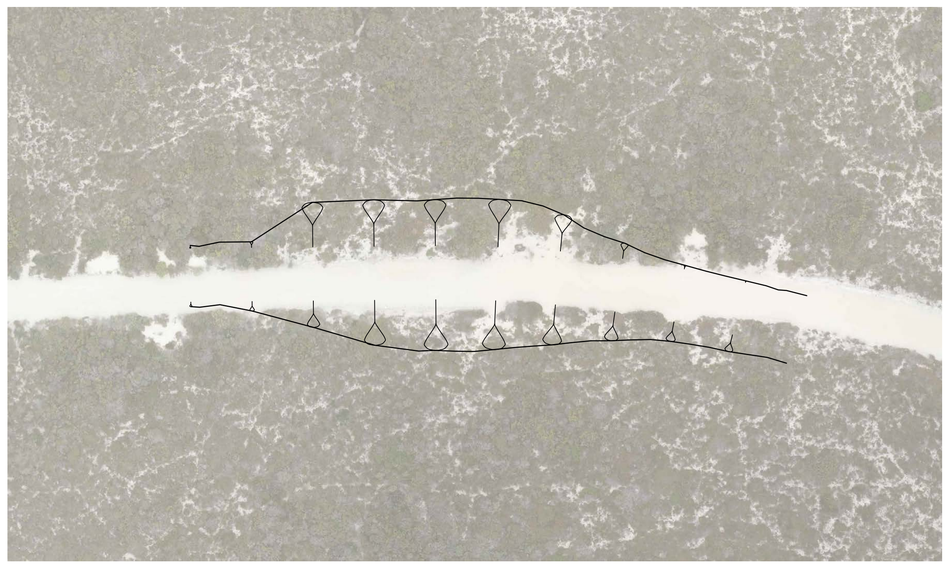

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WHALERS WAY

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EXISTING ALIGNMENT MODIFICATIONS

VERTICAL ALIGNMENT - SHEET 1

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DOCUMENT NUMBER

Project Number | Sheet No. | Rev.

Design TM | Drawn DSK

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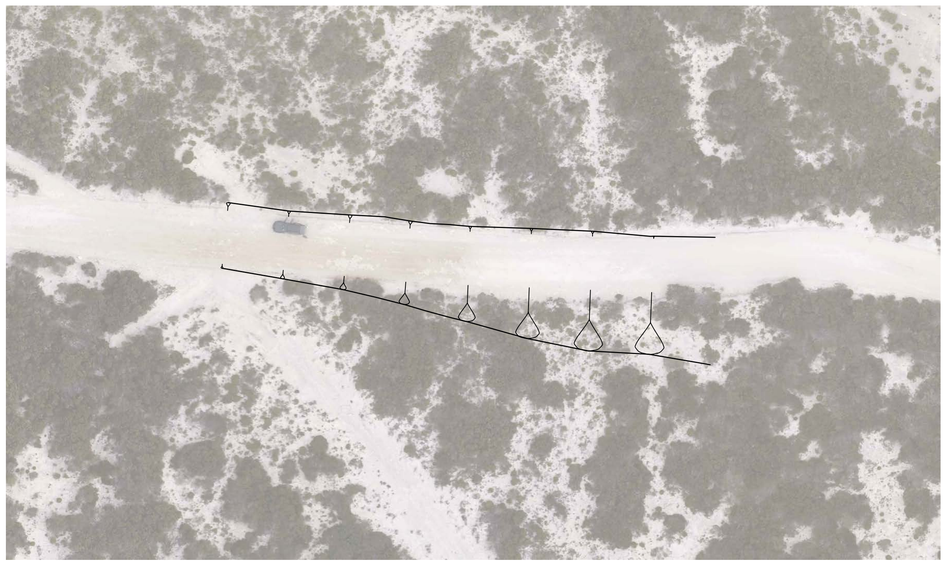

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PLAN VIEW

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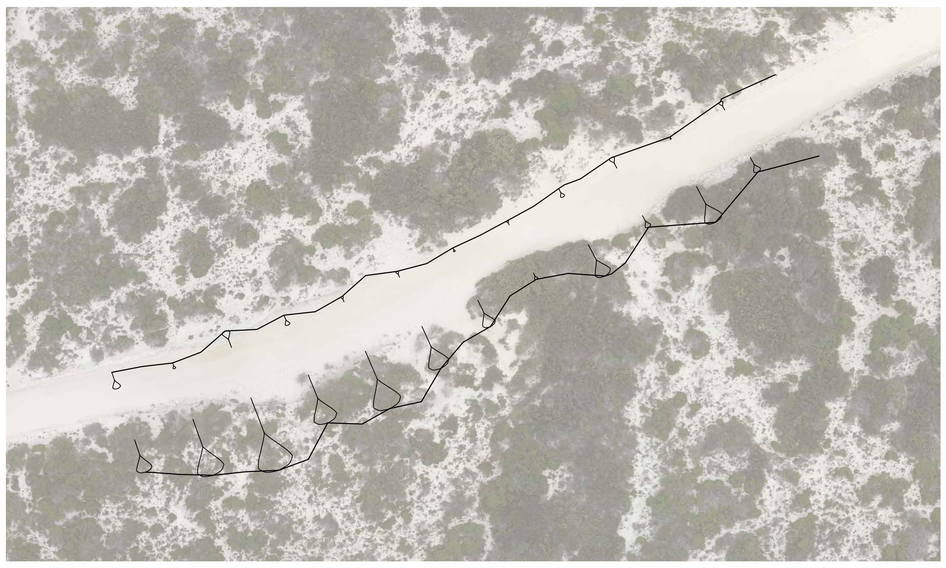

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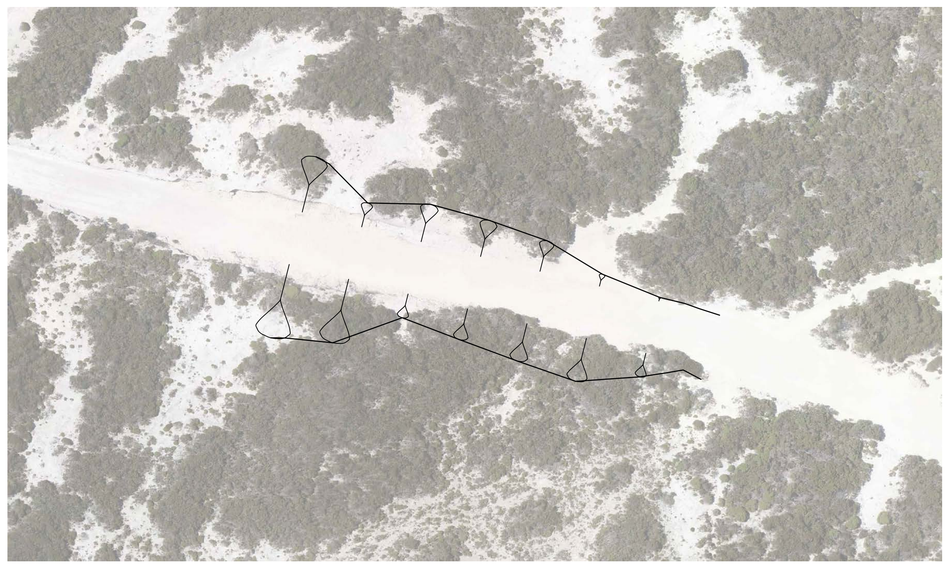

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A	21.08.20	PRELIMINARY ISSUE	LK	TJM	TJM

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WHALERS WAY

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EXISTING ALIGNMENT MODIFICATIONS

VERTICAL ALIGNMENT - SHEET 2

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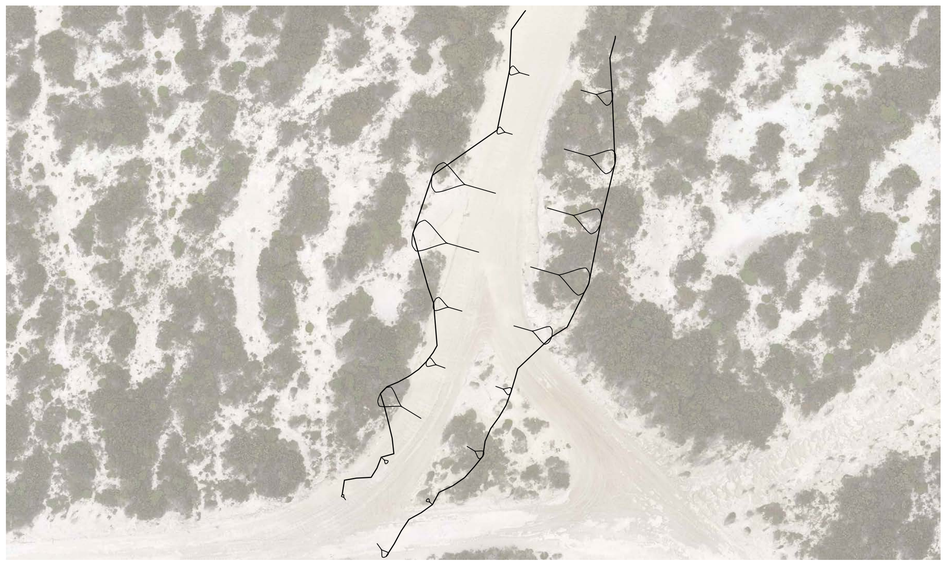

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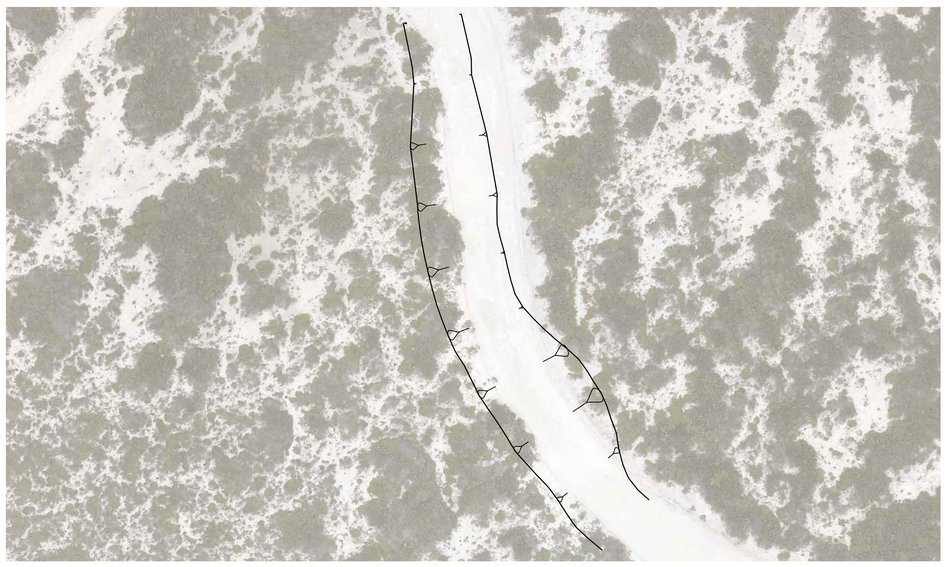

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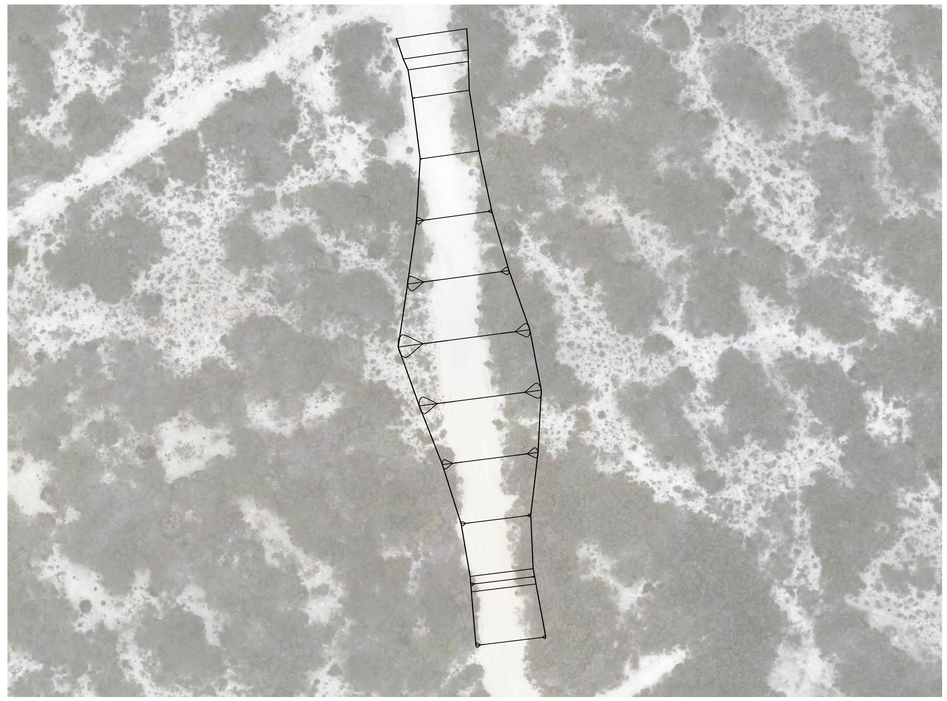

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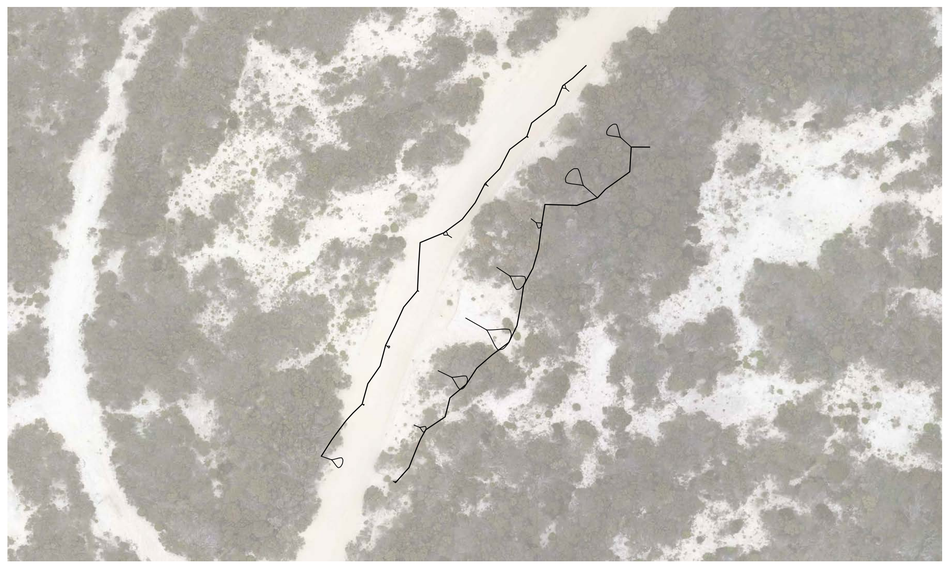

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PRELIMINARY ISSUE
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REV.	DATE	DESCRIPTION	DRAFT	ENG.	CHKD
A	21.08.20	PRELIMINARY ISSUE	LK	TJM	TJM

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WHALERS WAY

WHALERS WAY, SOUTH AUSTRALIA

EXISTING ALIGNMENT MODIFICATIONS

VERTICAL ALIGNMENT - SHEET 3

A1

DOCUMENT NUMBER

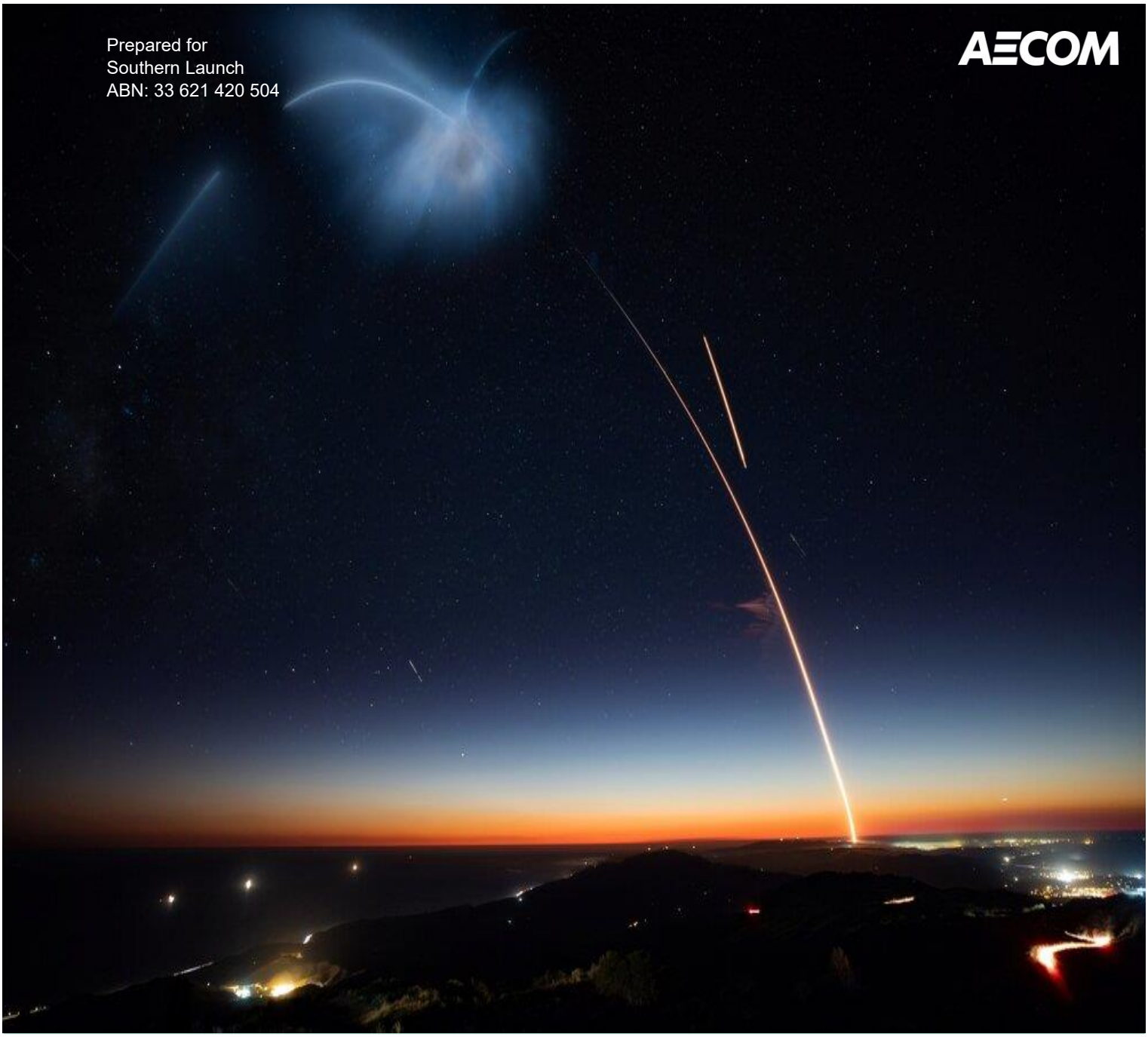
Project Number | Sheet No. | Rev.

Design TM | Drawn DSK

WGA181404-DR-CC-0107 A

B AECOM ACOUSTIC DATA REPORT

Prepared for
Southern Launch
ABN: 33 621 420 504



Whalers Way Orbital Launch Complex - Environmental Assessment Report

Noise and Vibration

28-Apr-2022
Whalers Way Orbital Launch Complex
Doc No. 60627263-AC-RP-0002

aecom.com

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Whalers Way Orbital Launch Complex - Environmental Assessment Report

Noise and Vibration

Client: Southern Launch

ABN: 33 621 420 504

Prepared by

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ABN 20 093 846 925

28-Apr-2022

Job No.: 60627263

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

Quality Information

Document Whalers Way Orbital Launch Complex - Environmental Assessment Report

Ref 60627263

Date 28-Apr-2022

Prepared by Lee Evans

Reviewed by David Peoples

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	20-Apr-2020	Draft for comment	Lee Evans Principal Engineer - Acoustics	
1	24-Jul-2020	Final Draft	David Peoples Technical Director - Acoustics	
2	10-Sep-2020	Final for review	David Peoples Technical Director - Acoustics	
3	08-Dec-2020	Final	David Peoples Technical Director - Acoustics	
4	10-Feb-2022	EIS update draft	David Peoples Technical Director - Acoustics	
5	03-Mar-2022	Final Draft	David Peoples Technical Director - Acoustics	
6	28-Apr-2022	Final	Lee Evans Principal Acoustic Engineer	

Table of Contents

Executive Summary

Southern Launch propose to construct the Whalers Way Orbital Launch Complex (the Project). The Project is located on the southern tip of the Eyre Peninsula in Sleaford and features two launch facilities and supporting infrastructure. An environmental noise and vibration assessment has been undertaken to support project planning and required statutory approvals.

Overview

The assessment included a desktop study to identify the relevant legislature and sensitive receptors near the proposed project footprint, the undertaking of baseline noise measurements, and the development of a construction and operational noise impact assessment.

Legislature

Human amenity impacts from industry are regulated in South Australia by the *Environment Protection Act 1993*, specifically the *Environmental Protection (Noise) Policy 2007* (Noise EPP). These documents do not include specific regulatory requirements for managing noise and vibration impacts from space operations. This information has been sought from international regulatory authorities and scientific publications.

Baseline conditions

The sensitive receptors identified within the Project study area include nearby wildlife (assessed separately) and residences approximately 3.5 kilometres from the closest Project launch site.

The baseline noise environment was measured at five different locations over several days in conjunction with the preliminary ecological fieldwork. The background levels in the study area were considered typical of rural and remote areas with low residential density and little exposure to transportation or industrial noise.

Further baseline monitoring (noise and vibration) was undertaken either side of the Test Launch Campaign in September 2021. Noise levels were comparable to those measured during the initial baseline measurement. Vibration levels were below the level of human perception.

Construction and operational impact assessment

Construction and operation scenarios were based on data provided by Southern Launch and information from projects of a similar nature. These scenarios were used to calculate the potential impacts associated with key project activities. Construction noise was assumed to be concentrated around the Project Areas with notable impacts likely to be limited to regions within 500 to 1000 metres of the works. No residences were noted within this distance from the proposed works.

The proposed launch facility would include buildings and supporting infrastructure that provide office space, workshops and storage areas. The operational noise produced by activities within these spaces is unlikely to impact the neighbouring areas if noisy workshop equipment and plant is adequately mitigated.

Noise from launches and stationary rocket testing are predicted to temporarily alter the quiet setting of the natural environment with noise briefly at times above the measured ambient level at distances further than five kilometres from the launch.

This sudden noise increase is likely to cause a disturbance to residents at nearby properties, particularly if launches were to occur at night. Noise produced by the rocket is expected to be loudest during the initial thrust at ground level (15 – 30 seconds) and gradually reduce as the engines decrease power while the vehicle ascends away from noise sensitive areas (reducing in noise level over following 1 – 2 minutes).

Indicative noise levels during a launch were predicted to be lower than the Day Night Level (DNL) of 65dB(A) that is used by the United States, Federal Aviation Administration (FAA) to assess the significance of noise exposure from aircraft operations at nearby residential properties. However, expected maximum levels of approximately 100 dB at the closest residence indicate that short-term disturbance to communication or sleep could occur, particularly for launches scheduled between 10pm and 7am.

Test Launch

Measured noise levels during the test launch were comparable to the ambient sound pressure levels measured before and after the event. Accordingly, the launch attempt may not have been audible at all monitoring locations and is unlikely to have caused adverse impacts at the nearest residential receptors.

Vibration measurements during the period of the launch indicate that the vibration was slightly above the measured average baseline levels. Levels at the magnitudes measure indicate that vibration-induced structural damage is unlikely to be a notable risk at residential receptors.

Further measurements will be undertaken during the next stages of the Test Launch Campaign to continue the development of the verification database.

Mitigation measures

Engineered source mitigation includes a noise suppressing water deluge system and blast walls to channel the rocket exhaust away from the pad and sensitive receptors.

Southern Launch will also develop a stakeholder engagement plan to inform residents prior to launch activities and a monitoring plan that would include the measurement of noise during launches to verify the effectiveness of onsite mitigation measures.

It is expected that noise from Southern Launch activities can be managed through the combination of engineering and administrative controls.

1.0 Introduction

1.1 Project Overview

AECOM Australia Pty Ltd (AECOM) were engaged by SouthernLaunch.Space Pty Ltd (Southern Launch) to undertake a terrestrial biodiversity assessment for the Whalers Way Orbital Launch Complex (WWOLC) (the Project). Southern Launch is proposing to establish a multi-user rocket launch facility that will service the growing demand for the launch of domestic and international vehicles for Polar and Sun Synchronous orbit satellite insertion.

The complex will be designed to launch the latest technology 'smallsat' satellites which are typically weighted between several kilograms ('cubesat') to a maximum of several hundred kilograms. Consequently, the launch vehicles (rockets) will also be relatively small (in comparison to earlier satellite launch vehicles and heavy-lift rockets), typically being in the range of 10 to 30 m tall.

It is expected the of operation of the WWOLC will accommodate in the order of one rocket launch per two months, increasing over time to one rocket launch per fortnight to a maximum of 36 launches per year. Whilst several weeks of preparation will be involved in preparing for a launch, the actual launch itself, from ignition to orbit, will take approximately 45 minutes. Of this time, the launch will only result in impacts on the terrestrial site and locality for a period of up to three minutes.

The WWOLC is proposed to be developed in stages over time in response to emerging market opportunities and conditions.

The current proposal represents the initial development of the complex and is the subject of the Environmental Impact Statement (EIS) at the state level for the Project. It comprises two separate rocket launching sites and supporting infrastructure (noting Site A launch site was relocated 700 metres to the north-east of the previous site following the initial EIS submission.

The Project comprises of the following key components, which hereinafter will be referred to as the Project Area (see Figure 1):

- Launch Site A
- Launch Site B
- Infrastructure Site D
- Range Control Facility Site E
- Access Upgrades
- General Site Infrastructure.

The key components are further detailed in Table 1. The supporting infrastructure and temporary facilitates required during construction will be located within the relevant Project Area footprint either being the launch site, infrastructure site or range control facility detailed above.

Two launch sites are proposed containing a range of elements and structures and will provide integrated, and largely self-contained facilities for the assembly, preparation, staging, fuelling and the launch of the various vehicles to be launched from the WWOLC.

Table 1 Project Key Components

ELEMENT	Description	TIMING
Launch Site – Site B	A rocket launch facility sited and designed to support small lift launch vehicles with sizes from micro to small conventional (less than 10 tonnes up to approximately 60 tonnes).	Stage 1 - 2022
Range Control Facility – Site E	A permanent range control facility which will provide facilities for launch control, range control, security, office, administration, and visitor facilities.	Stage 2 – 2022/2024

ELEMENT	Description	TIMING
Infrastructure Site – Site D	Infrastructure facilities including a dam, magazine, and ancillary storage facilities.	Stage 3 – 2022/2024
Launch Site – Site A	A rocket launch facility which will predominantly be utilised for larger launch vehicles (greater than 30 tonnes to up to approximately 100 tonnes).	Stage 4 – 2024/2025
Access Upgrades	Existing access tracks will be upgraded as required to provide appropriate, all-weather access to each of the sites. New access connections will be provided to connect the sites to the existing and upgraded access tracks.	Progressively from the commencement of the Project.
Supporting Infrastructure	Diesel and/or Hydrogen Fuel Cell Powered Generators. Helicopter Pad(s). Water Tanks. Water Capture and Treatment Systems associated with each site. 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. Construction of internal access roads. Visitor viewing area and interpretative facilities. Signage Lighting Noise monitoring equipment Radar and telemetry equipment Safety and security related upgrades including fencing, gates, cameras and sensors.	Progressively from commencement of project as each launch site is developed.
Temporary facilities required during construction	• Temporary concrete batching plant. • Temporary site and construction offices and facilities. • Temporary water storage • Temporary laydown areas. • Temporary access tracks.	At the commencement of each stage of construction.

For further details of the construction and operation aspects of the Project refer to the Project Description within the EIS.

The Project was declared a Major Development under the South Australian *Development Act 1993* (Development Act) by the Minister for Planning on 22 August 2019. As such, an EIS is required to support the Major Development Application that Southern Launch is preparing.

The Project has been referred to the Commonwealth Department of Agriculture, Water and Environment (DAWE) under the EPBC Act (EPBC Ref: 2021/9013). On 10 September 2021, a delegate of the Minister for the Environment decided that the proposed action is a controlled action and that it will be assessed by preliminary documentation.

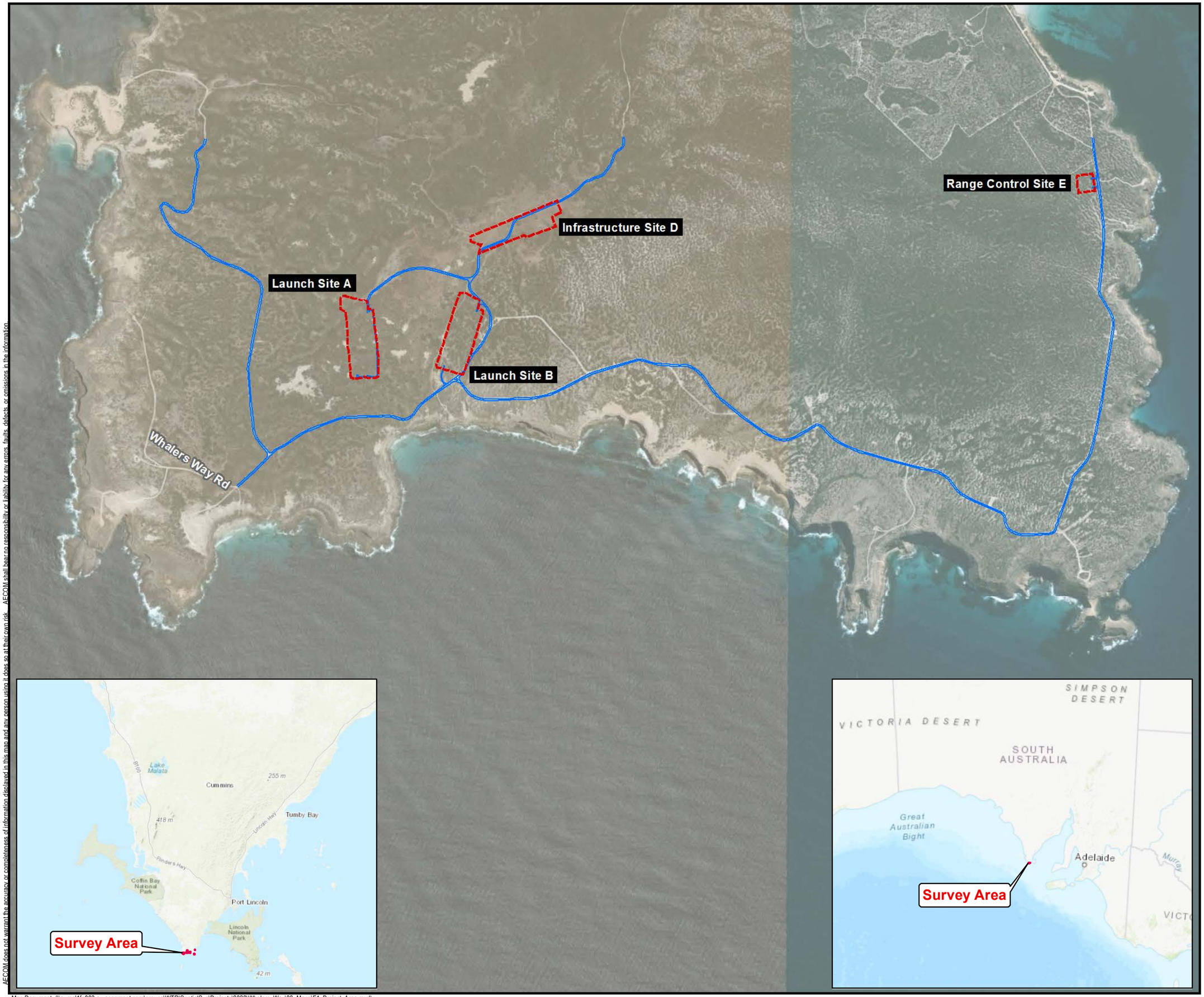
1.2 Location

The Project Area is located at the southern tip of the Eyre Peninsula in Sleaford, commonly known as Whalers Way (see Figure 1). It is approximately 25 km southwest of Port Lincoln in South Australia (SA), in the District Council of Lower Eyre Peninsula and comprises a portion of the allotment identified in Table 2. The land is owned by Theakstone Property Pty Ltd. Southern Launch have entered into a Commercial Access License ('the License') with Theakstone Property Pty Ltd for specified purposes associated with the Project.

The Project Area has access from Right Whale Road at the north-eastern corner of the land. Access to the Project Area from Port Lincoln follows Proper Bay Road, Fishery Bay Road to Right Whale Road before entering the site and continuing via private access track commonly known as Whalers Way Road.

Table 2 Certificate of Title of Project Location

Allotment	Plan	Hundred	Volume	Folio
101	71437	Sleaford	5993	374



PROJECT ID 60627263
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LAST MODIFIED brierej 07 FEB 2022

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Coordinate System: GDA 1994 MGA Zone 53

0 250 500 1,000
metres

1:20,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones

Project Area

Southern Launch Whalers Way

Flora and Fauna Assessment

Whaklers Way, SA

Figure
F1

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F1_Project_Area.mxd)

1.3 Objectives

The State Planning Commission (SPC) has prepared Assessment Guidelines (dated 23 July 2020) for the preparation of an Environmental Impact Statement (EIS) for the WWOLC.

These guidelines outline items that are relevant to the assessment of noise and vibration impacts from the Project Area, including:

- Identification of sensitive receptors
- Description of the existing environment and site conditions
- Assessment of the worst case predicted noise from the construction, non-launch operational activities, and any on site rocket engine testing and launches
- Confirmation of consistency and compliance with relevant regulatory requirements
- Description of what reasonable and practicable mitigation measures will be adopted to minimise impacts at nearby sensitive receptors

The contents of this report been developed in consultation with the South Australian Environment Protection Authority (EPA) and the Department for Environment and Water (DEW). Both departments have provided feedback on this assessment that has subsequently been considered when updating this report.

Further updates have also been made in response comments received from both the public and key government stakeholder during the public exhibition period of the EIS, to include the results from Test Launch 1 of the Project's Test Launch Campaign.

1.4 Assessment context

Noise and vibration have the potential to adversely affect wildlife, humans, heritage structures, sensitive habitat and infrastructure located near construction activities. Noise pollution is sound at a level which is annoying, disruptive or physically harmful to people and wildlife.

In humans, noise impacts can include annoyance, sleep disturbance, productivity loss and negative health effects. In wildlife, impacts may include changes in behaviour and physical harm, which have the potential to adversely impact sensitive wildlife populations.

Activities that are associated with the construction, non-launch operational activities, and any on site rocket engine testing and launches have the potential to generate noise and vibration impacts on the surrounding environment.

These include the following work phases and activities:

- Construction
    - Site preparation
    - Utility construction
    - Development of foundations
    - Structural works
    - Testing and commissioning
    - Roads, landscaping and reinstatement
- Operation:
    - Power generation
    - Workshop activities
    - Vehicle movements
    - Launch activities

Impacts from the above items have been addressed within this report.

Note that the noise and vibration impacts to wildlife have not been discussed in this report. Impacts relevant to wildlife have been described within the report - *Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report*. Further clarifications relevant to this assessment are listed in Section 4.5.

2.0 Legislative Framework

An overview of the Commonwealth and State legislation that is relevant to environmental aspects of this assessment is presented in Table 3.

Table 3 Legislation description and relevance to the Project

Legislation	Description and Project Relevance
Commonwealth	
Space (Launches and Returns) Act 2018	The Space (Launches and Returns) Act 2018 and Space (Launches and Returns) (General) Rules 2019 provide a framework and criteria that is relevant to the approval of space activities in Australia. This includes the information required to support the application relevant to environmental impacts and approvals. The general rules state that applicants consider the impact of their intended activity on the environment and provide information on how any adverse effects on the environment are to be monitored and mitigated. However, specific acoustic values to be considered and protected during the planning of a Project are not detailed.
South Australia	
Planning, Development Infrastructure Act 2016	The *Planning, Development Infrastructure Act 2016* (PDI Act) provides for planning and regulates development in the State, to regulate the use and management of land and buildings and the design and construction of buildings. Subject to this Act, no development may be undertaken unless the development is an approved development. A development is an approved development if, and only if, a relevant authority has assessed the development against, and granted consent in respect of the provisions of an appropriate Development Plan. The PDI Act establishes a new planning and development scheme to replace the current scheme operating under the Development Act.
South Australian Environment Protection Act 1993	The South Australian Environment Protection Authority (EPA) provides noise criteria for noise sources in order to satisfy the General Environmental Duty, as defined under the South Australian *Environment Protection Act 1993*. The noise criteria are set by the *Environment Protection (Noise) Policy 2007* (Noise EPP).
Environment Protection (Noise) Policy 2007 (Noise EPP)	The Noise EPP provides noise goals for operational and construction noise sources in order to satisfy the general environmental duty as defined by Section 25 of the South Australian *Environmental Protection Act 1993*. Noise goals are determined based on the land uses for the noise sources and receptor, as promoted by the relevant development plan.

Notes:

- Airports Act 1996 and the Australian Noise Exposure Forecast (ANEF) requirements (AS2021:2015 *Acoustics—Aircraft noise intrusion—Building siting and construction*) are not applicable to space operations and have not been referenced in this assessment.
- Schedule 1—Noise excluded from policy (clause 6) of the Noise EPP lists aircraft and aerodromes. It is assumed that space launch operations would also be excluded.

Criteria used to assess the impacts from the project have been presented in Section 4.2.

3.0 State Assessment Requirements

The Project was declared a Major Development by the South Australian Minister for Planning on 22 August 2019. The Application was referred to the independent statutory authority the State Planning Commission (SPC). The SPC considered the application and identified the key social, environmental and economic issues relevant to the assessment of the proposed development and determined that it would be assessed as an EIS.

The SPC considered the scale of each of these issues and determined whether they represented either standard, medium or critical issues or opportunities. The SPC found that proposed launch operations will involve the creation of significant noise and vibration and consequently rated the level of assessment as medium:

> *Where work is required to address the issue but the risk is likely to be manageable with additional information then the risk assessment is classed as 'medium'.*

This was because:

> *The proposed development has the potential to disturb fauna, nearby residents and visitors through the creation of noise and vibration impacts.*

The requirements detailed for the noise and vibration impact assessment are presented in Table 4 with cross references to the section of the report that responds to each requirement.

Table 4 Assessment requirements for noise and vibration impact assessment

Assessment requirement	Refer
6.1 Detail the predicted levels of environmental noise and vibration associated with construction and operation of the proposed development, identifying all potential noise and vibration sources and assessing the impact upon sensitive receivers in the immediate and wider locality (including residents, visitors, marine fauna, terrestrial native animals and livestock, and avifauna including migratory species).	Section 6.0 (Impact assessment) Refer to *Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report*.
6.2 Provide information on the anticipated frequency of launch events, initially and into the future. *Include information regarding individual launch events and predicted noise and vibration impacts to be generated.*	Section 4.2.3 Section 6.3
6.3 The location of noise and vibration sensitive receivers should be identified on an appropriately scaled plan.	Section 5.2

Assessment requirement	Refer
6.4 Information, including noise contours from a suitable acoustic model, should be provided for all significant noise generating activities when operating under worst case meteorological conditions.	Appendix C
6.5 Describe current background noise and vibration levels at sensitive receivers and changes to these levels as a result of the project (during both the construction, maintenance and operational phases). *Sufficient data should be gathered to provide baseline information for comparison with any future monitoring undertaken during the construction and operational phases. Details of any noise or vibration monitoring undertaken should be incorporated.*	Section 5.0 (Baseline conditions) Section 6.0 (Impact assessment)
6.6 Detail the predicted noise levels against the Environment Protection (Noise) Policy 2007 and section 25 of the Environment Protection Act 1993 at the nearest noise sensitive receivers when operating under worst case meteorological conditions.	Section 6.0 (Impact assessment)
6.7 Identify what reasonable and practicable measures will be used to minimise impacts from noise and vibration and assess their effectiveness. Details of how any such measures will be monitored, audited and managed should be included.	Section 7.0
6.8 Identify the potential impact of noise and vibrations on native fauna (terrestrial and marine), and the mitigation and monitoring strategies during both construction and maintenance.	Refer to *Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report and Marine Technical Report*

4.0 Methodology and assumptions

This section describes the methodology for undertaking this assessment. An approach has been applied to take account of the existing environment, potential impacts of the Project and how to avoid, minimise or manage the risk of impact.

The key stages of the assessment have been listed below:

- **Baseline conditions:** Overview of the project study area, sensitive receptor locations and baseline noise levels.
- **Assessment criteria:** A summary of the noise and vibration criteria used to assess the acoustic impact on the identified sensitive receptors.
- **Impact assessment:** Desktop assessment to establish construction and operational impacts.
- **Mitigation measures:** Description of additional mitigation measures where impacts are predicted to exceed the criteria.

4.1 Baseline conditions

The aim of the existing conditions assessment is to identify where sensitive receptors are located relative to the proposed Project Area and to characterise the existing acoustic environment.

It is important to establish the existing noise environment throughout the Project study area to:

- To verify the known contributions from existing noise and vibration sources prior to the impact assessment
- Develop appropriate criteria and limits that would guide the impact assessment.

4.1.1 Study area

The majority of the land located adjacent to the Project is sparsely-populated rural land. This type of land use is typically quieter than suburban areas and is usually more sensitive to the introduction of a new commercial noise source.

A study area up to five kilometres from the Project, including the nearest residential locations, was considered appropriate to assess the noise and vibration impacts in this environment.

4.1.2 Classification of sensitive receptors

The identification and classification of sensitive receptors was undertaken via site investigations and a desktop study using available aerial imagery and geospatial data.

Sensitive wildlife receptors were identified in the *Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report* (AECOM, 2020).

4.1.3 Measurement of existing noise environment

Baseline noise monitoring was used to quantify the existing noise environment at sensitive receptors near the proposed Project Area. Noise monitoring consisted of unattended measurements at five measurement locations.

Existing noise levels were monitored and reported with reference to the following descriptors:

- **L_{A90} noise level**: The dB(A) noise level that is exceeded for 90 per cent of a specified period. Commonly referred to as the *background* noise level.
- **L_{Aeq} noise level**: The L_{Aeq} reflects all noise occurring during the measurement period. It approximately equates to the average level for many typical environmental noise scenarios. L_{Aeq} is typically used to quantify industrial noise, and to assess environmental noise impacts.

The existing noise levels were measured with reference to *AS 1055:2018 - Acoustics - Description and measurement of environmental noise.*

Unattended noise monitoring was undertaken at each location for up to two weeks. Equipment was set up in a free field location with the microphone at least 3.5m from all reflecting surfaces and away from

extraneous noise sources. All noise monitoring equipment had current laboratory calibration status at the time of the measurements. Monitoring results and locations are summarised in the tables and maps shown in Section 5.2.

A summary of the monitoring locations, including equipment details and the duration of the monitoring is shown in Table 5. Field calibration was conducted before and after monitoring to check that there were no variations in calibration throughout the monitoring period.

Table 5 Measurement locations, duration and equipment details for unattended background noise monitoring

Site ID	GPS coordinates		Noise monitoring			Laboratory calibration expiry[1]
	Latitude	Longitude	Serial number	Start	End	
1	34°56'22.98"S	135°40'53.40"E	765699	17/03/2020 1015h	19/03/2020 1502h	11/10/2020
2	34°55'54.59"S	135°39'23.72"E	187447	17/03/2020 1030h	19/03/2020 1455h	28/05/2021
3	34°55'55.78"S	135°38'48.77"E	409167	17/03/2020 1040h	19/03/2020 1450h	13/08/2021
4	34°55'31.61"S	135°38'52.48"E	409174	17/03/2020 1050h	19/03/2020 1440h	13/08/2021
5	34°56'18.21"S	135°37'35.58"E	465445	17/03/2020 1000h	19/03/2020 1430h	12/10/2020

1. Note: Sound level meter calibration is valid for two years from the calibration date.

Baseline unattended noise monitoring locations are shown in Figure 2. Further details of the monitoring methodology, results and derivation of criteria are provided in Section 4.1.

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DATUM GDA 1994, PROJECTION MGA ZONE 53

0 500 1,000

Meters
(when printed at A3)

Legend

- Monitoring Locations
- Residential Locations
- Southern Launch Infrastructure

UNATTENDED NOISE MONITORING LOCATIONS AND RESIDENTIAL RECEPTORS

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
2

A3 size

4.1.4 Test launch

Southern Launch gained approval from State Government to undertake three test launches using the non-explosive Hapith I rocket to gather empirical data to be used to validate modelled data and to determine the impact of launches on the environment through specific observation before, during and after the three test launches. The proposed Test Launch Campaign aims to capture data that can be used to aid the South Australian Government's Major Development Assessment on the proposed WWOLC.

The noise and vibration monitoring undertaken for the first launch undertaken on 16 September 2021 has been presented in this report. The monitoring instrumentation used during the launch is summarised in Table 6 and shown in Figure 3.

Table 6 Monitoring locations

Site	Installation date	Data capture	Coordinates (lat/long)	Noise Monitor	Vibration Monitor
1	31/08/2021 4:45 PM	Monitor stolen	-34.923138, 135.683747	01dB Cube (S/N 10773)	N/A
2	1/09/2021 11:00 AM	19 days	-34.932823, 135.652537	01dB Cube (S/N 10813)	Instantel Minimate (BE14514)
3	1/09/2021 3:50 PM	Corrupted	-34.340906, 135.681443	01dB DUO (S/N 12609)	N/A
4	1/09/2021 4:50 PM	19 days	-34.937797, 135.625154	01dB DUO (S/N 12608)	Instantel Minimate (BE12586)
5	2/09/2021 11:00 AM	17 days	-34.908478, 135.659101	01dB DUO (S/N 10388)	Instantel Minimate (BE14510)
6	2/09/2021 11:30 AM	Monitor stolen	-34.920812, 135.653911	01dB DUO (S/N 10390)	N/A
7	2/09/2021 12:30 PM	18 days	-34.919278, 135.626450	01dB DUO (S/N 10788)	Instantel Minimate (BE14069)
8	9/09/2021 4:00 PM	11 days	-34.985663, 135.624973	01dB Cube (S/N 10771)	N/A

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DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1,250 2,500

Meters
(when printed at A3)

Legend

- Test Launch Monitoring
- Residential Locations
- Southern Launch Infrastructure

TEST LAUNCH MONITORING LOCATIONS

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
3

A3 size

4.2 Assessment criteria and context

Potential impacts to humans during the construction and operation phases of the Project may be caused by a disturbance of the acoustic environment. Accordingly, a review of local regulations and international standards was undertaken to seek guidance on the suitable noise and vibration objectives for the project.

4.2.1 Construction noise

The Noise EPP provides specific criteria for construction noise under *Part 6 – Special noise control provisions – Division 1 – Construction noise*.

Under the Policy, construction activity with an adverse impact on amenity must not occur on a Sunday or public holiday, and on any other day except between 7.00am and 7.00pm. The criteria are applicable at noise-affected premises for determining whether construction activities result in noise with an adverse impact on amenity. These criteria are presented in Table 7.

Table 7 Summary of construction noise criteria

Time	Noise Criteria
Monday to Saturday, 7:00 am to 7:00pm	No specific construction noise limit. Minimise construction noise where possible.
All other times, and public holidays	$L_{Aeq,\ 15min}$ should not exceed 45 dB(A). L_{Amax} should not exceed 60 dB(A).

It is assumed that construction works would occur between Mondays and Saturdays within the 7:00am to 7:00pm time period. Within these hours, there is no specific construction noise limit, although construction noise should be minimised where possible.

4.2.2 Operational noise (Office and workshop activities)

The noise from a noise source complies with the Noise Policy requirements if:

- it does not exceed the relevant indicative noise level as measured at a noise affected premises, or
- it is not higher than 5 dB(A) above the background noise level as measured at the noise affected premises.

Residential areas in the vicinity of the project are in the suburb of Sleaford within the Lower Eyre Peninsula council area. The planning zone and overlay information available from the South Australian Property and Planning Atlas (SAPPA) indicated that the residents are located within a Conservation Zone that neighbours nearby Rural Zones.

It is considered reasonable that the residential land could be categorised as Rural Living for the purpose of this assessment.

The *background plus 5 dB* criteria at the nearest noise affected premises have been approximated using the average background levels shown in Section 5.2.1.2. The levels relevant to this assessment are presented in Table 8. Note that only one of the following tests needs to be met to satisfy the requirements of the Noise Policy.

Table 8 Noise criteria summary

Description	Noise goals [$L_{eq(15\text{-}min)}$, dB(A)]	
	Day	Night
Indicative noise factor for Rural Living	47	40
Background plus 5 dB	29	36

In accordance with the noise policy "*the predicted source noise level (continuous) for the development should not exceed the relevant indicative noise level less 5 dB(A)"*.

As such, the criteria for the project would be:

- $L_{eq(15\text{-}min)}$ 42 dB(A) - Daytime hours (7:00am and 10:00pm on the same day)
- $L_{eq(15\text{-}min)}$ 35 dB(A) - Night-time hours (10:00pm on one day and 7:00am on the following day)

The operational impact assessment for noise sources assessed in accordance with this policy is presented in Section 4.3.2.1.

4.2.3 Operational noise (Rocket launch or testing)

A desktop study was undertaken of relevant scientific research that describes the impacts of rocket noise on humans. This step was considered important as there are no standards, regulation and guidelines available for assessing airborne noise and ground vibration from rocket launch activities in Australia.

It was found that all of the noise assessments undertaken for new and modified launch facilities referenced the United States Federal Aviation Administration (FAA) Order 1050.1F. This policy specifies Day-Night Average Sound Level (DNL) as the standard metric for community noise impact analysis of rocket launch facilities

The DNL describes the daily noise energy exposure based on annual aviation activities. The metric incorporates a 10-dB penalty for noise at night to account for increased human sensitivity to noise between 10pm and 7am.

FAA defines a "significant impact" due to aviation noise as a sensitive location exposed to noise greater than a DNL of 65 dB(A) (FAA, 2018). The criterion is presented in Table 9.

Table 9 Preliminary operational noise criterion - human amenity

Activity	Operational noise criteria
Rocket launch and testing	DNL 65 dB(A)

The FAA notes that the application of this criterion should be considered carefully when determining the noise impact in areas of low existing noise levels. Accordingly, additional noise metrics have been considered to help identify the potential impacts in a quiet rural environment.

Where noise sources are in motion, for example, aircraft/ rocket, the noise level changes over time. For a rocket launch, the maximum A-weighted sound pressure level (L_{Amax}) is used to describe the maximum level that would be produced during a launch. The L_{Amax} can be a helpful metric for describing the possible disturbance to conversation, sleep, or other common activities due to a noise event.

The Sound Exposure Level (LAE) has also been identified as another suitable metric as it represents the intensity and duration (total acoustic energy transmitted to the listener) of a single noise event. This parameter can also be used to calculate other energy-based acoustic metrics (e.g., $L_{Aeq(15min)}$) using a single logarithmic subtraction.

An indicative histogram for the noise metrics over the time of a launch has been shown in Figure 4. The initial thrust produced by the launch vehicle is expected to produce high levels of noise starting a few milliseconds after ignition. The greatest noise produced is expected to occur when the rocket is at maximum thrust close to the ground. The levels are expected to radiate omnidirectionally away from the launch site as the rocket elevates.

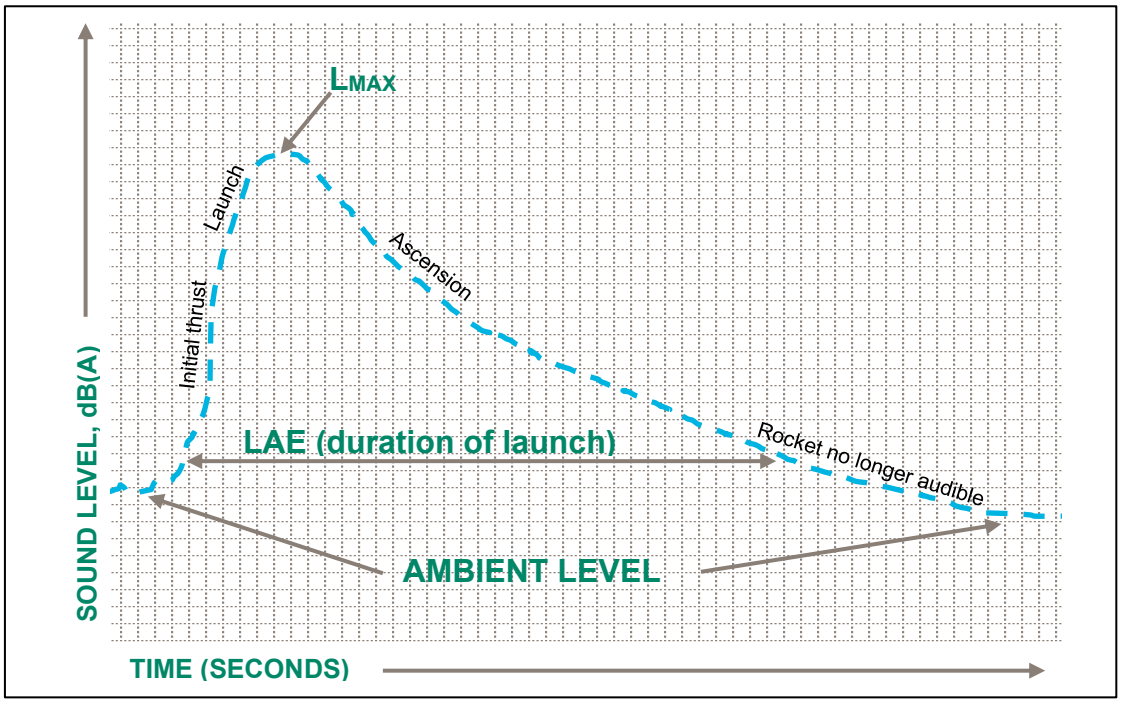


Figure 4 Noise level from a nominal launch over time

The DNL is not shown above as it is calculated using a person's cumulative exposure to sound over a 24-hour period, expressed as the noise level for the average day of the year on the basis of annual operations[1].

Results from the assessment of launch operations are presented in Section 6.3.

4.2.4 Ground vibration

DIN 4150-3 outlines 'safe limits' as Peak Particle Velocity (PPV) levels up to which no damage due to vibration effects have been observed for particular classes of buildings. Damage is defined as anything from minor non-structural effects such as superficial cracking in cement render to the separation of partitions or intermediate walls from load bearing walls. Safe limits applicable to vibration levels of a short duration are summarised in Table 10.

Table 10 Structural damage 'safe limits' for construction-induced short-term vibration on structures (DIN 4150-3)

Group	Type of structure	Peak particle velocity (PPV) in millimetres per second (mm/s)		
		At foundation at a frequency of:		
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that because of their particular sensitivity to vibration, do not correspond to	3	3 to 8	8 to 10

[1] https://www.faa.gov/regulations_policies/policy_guidance/noise/basics/

Group	Type of structure	Peak particle velocity (PPV) in millimetres per second (mm/s)		
		At foundation at a frequency of:		
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]
	those listed in Lines 1 or 2 and have intrinsic value (e.g. heritage-listed)			

4.2.5 Air overpressure

Structural damage to nearby buildings and human disturbance can be caused by high levels of air overpressure. High levels of air overpressure can often be perceived by humans as vibration as it can cause windows to rattle and other building elements to shake.

A literature review was undertaken to determine the most-appropriate criteria to apply to air overpressure produced by rocket launches. It was found that a maintaining a level below 133 dB (linear) peak would minimise the chance of damage to buildings and other structures.

This is consistent with the level applied to blasting activities within the Australian Standard AS 2187.2-2006 *Explosives – Storage and use Part 2: Use of explosives.*

The assessment of potential damage has been based on the predicted Maximum Unweighted Sound Level (L_{max}) for the largest rocket type modelled.

4.2.6 In-air noise criteria for wildlife

A desktop study was undertaken of relevant scientific research identify criteria and guidance for to support the terrestrial and marine mammal impact assessments. Wildlife impacts have not been presented in this report however a summary of the relevant information identified for criteria development has been presented in Appendix D.

4.3 Impact assessment

This study assesses the noise and vibration impacts of activities in the construction and operational phases of the Project. The general approach to the impact assessment for both construction and operational activities includes the following steps:

- Identify sensitive receptors likely to be impacted within the study area
- Determine the source, location, duration and timing for each activity that may cause an impact
- Calculate the level of noise or vibration produced by each activity at the identified sensitive receptors
- Compare predicted levels to the assessment criteria relevant to each activity
- Recommend conceptual mitigation for managing noise and vibration impacts that are predicted to exceed the assessment criteria.

The methodology and assumptions used for the impact assessment have been documented in the following sections.

4.3.1 Construction impact assessment

Details of the facilities being proposed for Southern Launch are summarised in Section 1.1. The Project activities that may produce noise or vibration that could cause negative impacts to the nearby sensitive receptors are listed in Table 11. Most noise and vibration would be produced within the designated sites shown in Figure 1 with exception of vehicles accessing the sites, and any necessary roadworks for the construction of access roads.

Table 11 Description of Project activities associated with construction and operation

Project Activity	Description of activities
Site preparation	Vegetation clearing
	Topsoil stripping
	Excavation for the construction of a quarry then to be transformed into a 30 ML dam
	Construction of temporary site compounds including concrete batching plant
	Installation of hardstands, offices etc
	Stockpiling
Utility construction	Excavation
	Trenching
	Installation of utilities and associated infrastructure
Drainage	Culvert installation
Structures	Construction and installation of infrastructure and buildings associated with launch pad facilities including: • assembly buildings (temporary and permanent) • range control facilities • diesel and / or hydrogen fuel cell powered generators • helicopter pad(s) • solar arrays • 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 • excavation and construction of flame trench and the installation of a water deluge system.
Civil and Road Works	Construction of access roads
	Cutting construction
	Drainage controls

4.3.1.1 Proposed working hours and schedule

Construction works would only be conducted during the daytime, and it is assumed that these would comply with the recommended construction hours defined by the Noise EPP, described in Section 4.2.

The proposed schedule at the time of this report is summarised in Table 1.

4.3.1.2 Construction activities and equipment

Indicative construction stages have been developed based on the description of the project components in Section 1.1 and the project activities listed in Table 11. Worst -case scenarios have been developed based on all fixed and mobile plant equipment operating simultaneously over the relevant assessment period for the activities presented in Table 12.

Table 12 Assumed facility construction activities

Activity reference	Activity	Description
C1	Site preparation	Site set-up within the construction footprint is required to provide a safe and efficient area for construction activities.
C2	Utility construction	Existing ground levels would be excavated/built up and levelled to allow for the installation of utilities and associated infrastructure.
C3	Foundations	Steel reinforced concrete foundations and footings would be installed which the permanent buildings, equipment and supports would sit on and be fixed to.
C4	Structural works	Construction and installation of infrastructure and buildings.
C5	Testing and commissioning	Mechanical and electrical equipment are also mechanically and electrically tested to make sure they have been installed correctly and are ready for commissioning. Commissioning involves fine tuning of equipment and instrumentation by running the facilities through various operating ranges. Once the facility passes all checks per the commissioning plan, it is ready to be handed over to Operations.
C6	Roads, landscaping and reinstatement	The final facility will have some permanent roads, kerbs, pavement, landscaping and permanent fencing.

4.3.1.3 Construction equipment sound power levels

Indicative sound power levels for the construction equipment that may be used for the above staging are presented in Table 13.

Table 13 Assumed construction plant and equipment for assessment

Equipment	Equipment sound power level [L_{eq}, dB(A)]	Operation time (% of a 15- minute period)	Assumed facility construction scenarios					
			C1	C2	C3	C4	C5	C6
Air compressor	91	50%				1	1	
Angle grinder	107	100%			2			
Asphalt Paver	104	70%						1
Circular bitumen saw	115	100%			2			
Compactor	122	100%		2				
Concrete batching plant	115	100%	1	1	1	1		

Equipment	Equipment sound power level [L_{eq}, dB(A)]	Operation time (% of a 15- minute period)	Assumed facility construction scenarios					
			C1	C2	C3	C4	C5	C6
Concrete truck	107	100%			2			1
Crane	98	100%			1		1	
Dozer 20T	109	100%						
Drill	88	50%				3		
Excavator 30T	103	100%	1	2				
Franna crane 20T	99	100%				1		
Generators	102	100%	2			4	1	
Grader	115	100%						1
Mulcher	114	100%	1					
Roller	102	100%	1	1				1
Semi-trailer	108	100%			1	2		
Skid steer	97	100%	1		2	2		
Tipper 12T	108	100%	1					
Truck, 10T	108	50%						1
Truck, dump	109	100%	1	2				1
Ute 4x4	101	25%	2	2	2	2	2	2
Water truck 10,000L	115	100%		1				
Welding machine	101	50%				1		
Activity Sound Power Level [L_{eq}, dB(A)]			**120**	**125**	**120**	**117**	**115**	**119**

4.3.1.4 Construction equipment vibration source levels

Table 14 presents the vibration levels of various construction equipment that could be used during the construction stage of the project, as provided in:

BS5228-2, *Code of practice for noise and vibration control on construction and open sites. Vibration*

FTA document, the Department for Environment Food and Rural Affairs (DEFRA) document *Update of Noise Database for Prediction of Noise on Construction and Open Sites 2005*

Department for Infrastructure and Transport (DIT) *Guideline for the Management of Noise and Vibration: Construction and Maintenance Activities* EHTM Attachment 7D, October 2021

These vibration levels have been used to identify potential impacts at sensitive receptor locations.

Table 14 Typical vibration levels from construction activates (various sources)

Activity	Typical Levels of Ground Vibration (PPV, mm/s)
Vibratory Roller[1]	1.5 mm/s at 25 m
Hydraulic Rock Breakers (levels typical of a large rock breaker in hard sandstone)	4.5 mm/s at 5 m 1.3 mm/s at 10 m 0.4 mm/s at 20 m 0.1 mm/s at 50 m
Excavator Excavator – 12-18T hammer Excavator – 18-34T hammer	0.2 mm/s at 40 m 1.09 mm/s at 40 m 6.11 mm/s at 40 m
Grader	2.5 mm/s at 5 m
Truck traffic (over maintained road surfaces)	0.2 mm/s at 10 m
Truck traffic (over irregular surfaces)	2 mm/s at 10 m
Impact pile driving	≤ 15 mm/s at distances of 15 m ≤ 9 mm/s at distances greater than 25 m Typically below 3mm/s at 50m
Continuous Flight Auger (CFA) piling	Negligible vibration at distances greater than 20 m from the piling
Jackhammer	1 mm/s at 10 m
Asphalt profiler	0.15 mm/s at 5 m

Notes:

1. Higher levels could occur at closer distances depending on local conditions and the roller operation. Vibration levels may vary between continuous pass-by and start/stop (changing direction).

4.3.1.5 Calculation of impacts

Noise propagation from the proposed construction activities has been calculated assuming simple geometric spreading of sound from each noise source. This method has been used to highlight if there are sensitive receptors located within a distance from the works that could be impacted.

Ground-borne vibration levels produced by equipment operating within the vicinity of sensitive buildings were predicted using empirical formulae that accounts for the distance between vibration source and receptor.

4.3.2 Operational impact assessment

Operational noise levels have been assessed for following activities:

- Launch complex supporting infrastructure, including buildings, dams and workshops.
- A rocket launch or testing.

The methodology for predicting operational noise impacts is further discussed in the following sections.

4.3.2.1 Supporting infrastructure assumptions

Noise from the operation of the launch facility would include industrial noise from the Project Area including generator noise, vehicle movements and other typical operational noise.

Supporting infrastructure has been modelled as operating separately for the assessment. Noise emissions from key plant and activities were based on international standards and the AECOM noise source database.

Typical values for winching cranes and generators were obtained from British Standard *BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*.

Noise propagation calculations were performed assuming simple geometric spreading of sound from each noise source. Assumptions have been made where necessary in terms of estimations of the noise level, location, and expected operation of noise sources.

The following assumptions have been made to assess the typical operational noise levels of the launch complex:

- Day to day operation of the facility would require generators supporting office buildings, dams, workshops and launch facilities.
- Workshop activities would be similar to those at a mechanical workshop.
- Noise from the launch vehicle erector has been assumed to be similar to that of a large mobile crane.

The following table provides a breakdown of the proposed noise sources, estimated sound power levels, and the duration of each activity within a seven-day period.

Table 15 Expected operation scenarios and duration

Activity	Duration of activity within a 7-day period	Estimated sound power level
General office activity and vehicle movements	5 days	L_{Aeq} 97 dB
Auto mechanic noise	Up to 2 days	L_{Aeq} 114 dB inside workshop
Launch vehicle erector (similar to a mobile crane winch)	10 minutes	L_{Aeq} 98 dB

4.3.2.2 Rocket launch and rocket testing assumptions

The main noise sources associated with a rocket launch or test can be attributed to the engine and exhaust. Environmental noise levels produced by these sources during rocket launch and testing events were predicted using the RUMBLE 3.0 computer modelling package developed in the United States by Blue Ridge Research and Consulting.

This modelling package is used evaluate the far-field environmental noise impact associated with inflight and static operations of subsonic commercial launch vehicles. The software is approved by the United States Federal Aviation Administration and considered suitable to use during the development stage of the Project. It has been recently used for environmental assessments including the SpaceX DragonFly Vehicle at the McGregor test site in Texas.

RUMBLE 3.0 includes several updates that improve the functionally of the software over the version of the software used for the draft EIS (RUMBLE 2.0).

This includes:

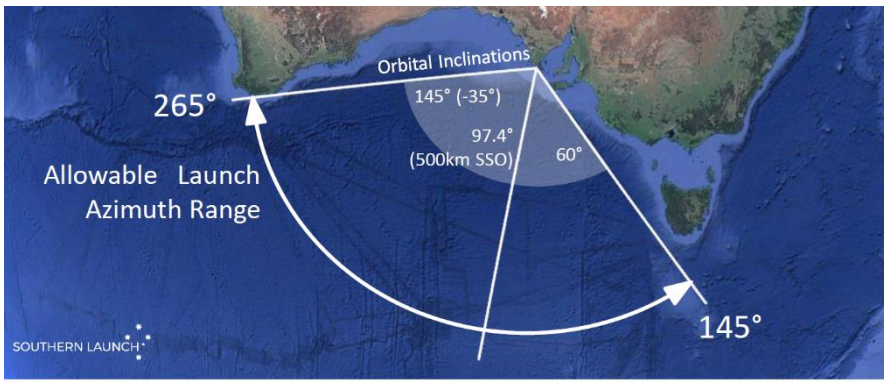
- An expanded database of default rockets available for modelling
- Updates to the rocket noise source levels and characteristics
- Bug fixes and general improvements

The software update has resulted in changes to the modelled noise level when compared to the draft EIS. A majority of the levels presented are slightly higher (up to 3 dB) than those previously presented for the Falcon 9 rocket. The exception being the calculated SEL that is notably higher (more than 10 dB) for the updated assessment. This has been attributed to the improvements to the software calculation module for this rocket.

The modelling assumptions input into the RUMBLE 3.0 model are summarised in Table 16.

Table 16 Noise modelling assumptions

<table>
<tr><th>Item</th><th>Assumption</th></tr>
<tr><td>Launch sites</td><td>-34.932804, 135.637994 (Site A)
-34.933906, 135.643307 (Site B)</td></tr>
<tr><td>Azimuth</td><td>The maximum range of azimuths that the site is likely to support is from 145 deg to 265 deg:

A single scenario of a launch with a trajectory in a southerly direction has been assumed. This is considered a reasonable approach as vertical launches have been assumed to produce a similar noise impact at ground level regardless of the azimuth.</td></tr>
<tr><td>Nominal Trajectory</td><td>
<table>
<tr><th>Stage</th><th>Trajectory and speed</th></tr>
<tr><td>Lift off</td><td>Notional speed: 0 km/h
Notional altitude: 0 m
Notional downrange distance: 0 m</td></tr>
<tr><td>10 seconds after lift-off</td><td>Notional speed: 106 km/h
Notional altitude: 192 m
Notional downrange distance: 0 m</td></tr>
<tr><td>30 seconds after lift-off</td><td>Notional speed: 389 km/h
Notional altitude: 1520 m
Notional downrange distance: 20 m</td></tr>
<tr><td>1 minute after lift-off</td><td>Notional speed: 1042 km/h
Notional altitude: 7,200 m
Notional downrange distance: 780 m</td></tr>
<tr><td>2 minutes after lift-off</td><td>Notional speed: 3,880 km/h
Notional altitude: 38,000 m
Notional downrange distance: 17,600m</td></tr>
<tr><td>2.5 minutes after lift-off</td><td>The first stage of the launch vehicle separates</td></tr>
</table>
Notes:
Notional Speed: Notional velocity of launch vehicle
Notional altitude: Notional altitude of launch vehicle above initial launch height
Notional downrange distance: Notional offset distance from initial launch location within range of azimuths</td></tr>
<tr><td>Potential Rockets</td><td>• Medium size solid
• Small size liquid
• Small solid sounding rocket</td></tr>
</table>

Item	Assumption
Maximum sound power of rocket	Notional sound power level of 140 dB(A) based on Southern Launch specifications.
Launch vehicle	Maximum thrust at lift-off of launch vehicle of ~1,200KN is assumed. The Falcon 9 launch vehicle was selected from the RUMBLE database due to the similar levels of thrust to the maximum assumed. This is considered as the worst-case scenario as Southern Launch would typically launch much smaller rockets. A sub-orbital rocket (Blue Origin's New Shepard) has also been modelled to provide a scenario for a rocket that is smaller and has a lower thrust than the Falcon 9 for comparison.
Number of launches	Maximum of one launch per week with up to 42 per year. A launch could be undertaken during day or night-time hours. Accordingly, assumed launch numbers have been assumed to be spread between day (7am to 10pm) and night (10pm to 7am), i.e., 11 launches during the day and 10 at night for each launch site. In practice, Southern Launch would not expect to undertake these many launches at night.
Launch testing (Site A)	Typically, prior to each launch of a liquid propellant rocket there would be single a "stack test" involving the first stage engine firing for approximately 10 to 15 seconds. This would take place with the rocket clamped down on the pad and the water sound suppression system operating. Solid rockets would not have any pre-launch firing tests. It has been assumed that rocket testing would be undertaken up to 10 times per year between 7am and 10pm only.

Predicted noise levels due to rocket launch and testing operations have been described using the following acoustic descriptors:

- Day-Night Average Sound Level (DNL)
- Maximum A-weighted Sound Level (L_{Amax})
- Maximum unweighted Sound Level (L_{max})
- A-weighted Sound Exposure Level (L_{AE})
- Unweighted Sound Exposure Level (L_E) (included to support wildlife assessments)

These descriptors are relevant to the assessment criteria presented in Section 4.2. Grid noise maps showing the predicted noise levels were mapped at 5-dB intervals (see Appendix C).

4.3.2.3 Sonic booms

Air overpressure would be produced by sonic booms when the rocket reaches a velocity faster than the speed of sound (supersonic). Extreme impacts from large sonic booms can result in an adverse behavioural or physiological response.

A literature review of similar launch facilities has been conducted to identify the risk of impact from sonic boom based on the location and proposed direction of launch.

4.4 Initial mitigation and management measures

The project design, construction methodology and operation strategies were progressed at the commencement of this impact assessment. Accordingly, mitigation measures that were already incorporated in the project planning have been considered within the assessment.

These initial mitigation and control measures are summarised in Table 17.

Table 17 Planned mitigation and management measures

Design aspect	Mitigation and management measures
Construction noise management	If a construction activity results in noise with an adverse impact on amenity, all reasonable and practicable measures must be taken to minimise noise resulting from the activity in order to minimise the impact. This includes (but is not limited to) the following measures to the extent that is practicable: Scheduling particularly noisy activities to commence after 9.00am where reasonable and practicable to do so. Locating noisy equipment (such as masonry saws) or processes so that their impact on neighbouring premises is minimised (whether by maximising the distance to the premises, using structures or elevations to create barriers or otherwise). Shutting or throttling equipment down whenever it is not in actual use. Ensuring that noise reduction devices such as mufflers are fitted and operating effectively. Ensuring that equipment displaying wear-induced noise characteristics is repaired or maintained prior to use. Operating equipment and handling materials so as to minimise impact noise. Using off-site or other alternative processes that eliminate or lessen resulting noise.
Water deluge system	Water deluge systems reduce noise impact by producing water droplets that interact with the generated sound waves. The sound energy is converted into heat energy through the water being turned to steam. This reduces emission of engine and booster noise from the launch pad. Water-based acoustic suppression systems are in common usage on launch pads, where they offer typical noise reductions of 3-5dB
Blast wave bunding	Blast walls are to be constructed to channel the rocket exhaust away from the pad.

Mitigation measures in addition to those outlined in Table 17 would be developed where emissions are predicted to be non-compliant with the criteria in Section 4.2, or where it is considered necessary to preserve the existing acoustic environment (Section 25 of the Environment Protection Act 1993).

4.5 Report clarifications

Note the following points of clarification with respect to the assessment presented in this report:

- Assumptions have been made using typical construction activities and equipment for each documented work stage.
- Helicopter movements to and from the site are for emergency purposes only and have not been assessed as part of typical operations.
- The impacts due to sonic booms have not been calculated using computer modelling.
- Occupational health and safety of staff working at Southern Launch (including those using the viewing areas) has not been considered and would be managed separately.
- Vibroacoustic impacts of a rocket launch in the near field, i.e., structures and buildings constructed to support the launch vehicle, have not been considered in this assessment.
- Wildlife impacts have not been presented in this report.

- The underwater impact of jettisoned material from space vehicle launches has not been considered.
- The underwater acoustic modelling has not been undertaken for this assessment (see Section 6.3.2).

5.0 Baseline conditions

5.1 Sensitive receptors

There are no dwellings immediately adjacent to the proposed Project Area. There are a number of (approximately three) residential dwellings located to the north-east of the study area in the vicinity of Fishery Beach (See Figure 2).

The distance to the nearest residential noise sensitive receptors to the launch and infrastructure sites are shown in Table 18.

Table 18 Sensitive receptors near launch activities

Location	Residential
Site A	~3.8km
Site B	~3.5km

5.2 Measurement results

Unattended background noise monitoring was undertaken at five locations between Tuesday 17th March and Friday 19th March 2020. Monitoring equipment was installed during the preliminary flora and fauna study.

Each monitoring location was described in terms of the vegetation present in the area as outlined in Table 19. Notes included in this table provide an indication of the typical noise environment of each monitoring location.

Table 19 Measurement locations and site descriptions

Site ID	Site description	Environment notes
1	Eucalyptus angulosa, low mixed Mallee	Low Mallee, average height approximately 1.5m tall. Some leaf rustle noise. No sea noise noted.
2	Eucalyptus angulosa, low mixed Mallee	Noise logger placed in semi open area where breaks in dense bush. No sea noise noted.
3	Eucalyptus diversifolia, mixed low Mallee	Noise logger placed in semi open area where breaks in dense bush, quite large areas of low heath breaks within patches. No sea noise noted.
4	Degraded leucopogon parvifolius, Open shrubland	Noise logger located approximately 300 metres away from windmill. No sea noise noted.
5	Beyeria lechenaultia, very low shrubland	Gentle sea noise audible at western end. Very low levels of shrub noise, with very low shrubland average height of 0.5m.

5.2.1.1 Weather conditions

The meteorological data captured from Port Lincoln weather station and obtained through the Bureau of Meteorology was used to identify periods where measured noise levels should be adjusted or removed due to extraneous weather.

Adverse weather conditions were considered where wind speeds were noted to be greater than 5 m/s and/or rainfall was measured to be greater than 0.3 millimetres in an hour. The data from each site was investigated and data was omitted where adverse weather conditions, or extraneous noise events, affected the measurements.

5.2.1.2 Average background noise levels (L_{A90})

A summary of the measured background noise levels is provided in Table 20.

Table 20 Background noise monitoring results (average measured L_{A90} noise level)

Site	Description	Measured L_{A90} Noise Level, dB(A)	
		Day	Night
1	Low mixed Mallee	24	32
2	Low mixed Mallee	23	30
3	Low mixed Mallee	23	26
4	Open shrubland	27	35
5	Very low shrubland	24	30

5.2.1.3 Ambient noise levels (L_{Aeq})

The average measured ambient noise level for the day-time, evening and night-time periods at each unattended monitoring location is shown in Table 21.

Table 21 Ambient noise monitoring results (average measured L_{Aeq} noise levels)

Site	Description	Measured L_{Aeq} Noise Level, dB(A)	
		Day	Night
1	Low mixed Mallee	42	37
2	Low mixed Mallee	38	33
3	Low mixed Mallee	39	30
4	Open shrubland	46	41
5	Very low shrubland	51	48

5.2.1.4 Observations

Key observations from the existing conditions noise monitoring include:

- Overall, background noise levels in the study area were low. This is typical of rural and remote areas with low residential density and little to no exposure to transportation or industrial noise.
- The night-time background noise levels are greater than the day-time background noise levels at all locations. Reasons for this have not been established, however, it is possible for this to be caused by insects or birds.

Human presence near the proposed launch sites is assumed to be limited to permitted tourist activities. Accordingly, anthropogenic noise would likely be limited to intermittent light vehicles and light aircraft.

The local acoustic environment was observed to be predominantly influenced by weather-induced noise, such as wind interaction with nearby vegetation. This is confirmed by the measured sound pressure levels that are consistent with rural and remote areas with low residential density and little to no exposure to transportation or industrial noise.

It is expected that the residences identified in Section 4.1 would likely experience similar background noise levels to those measured at the five monitoring locations. This has subsequently been confirmed by the baseline measurements captured at Site 5 as part of the test launch campaign (see Table 6).

5.3 Additional baseline measurements (Test launch)

Each of the noise monitors at the five locations measured for at least seven days before and two to three days after the test launch on 16 September 2021. Vibration levels were also measured at four locations. This information has been included to supplement the baseline monitoring presented in Section 5.2.

Noise from the test launch activities are not expected to contribute to the overall ambient or background levels due to the short duration of launch events (typically less than 30 seconds). However, the information has been included to help understand whether noise from the launch was louder than other environmental noise sources at the time.

Weather conditions on the afternoon of the launch included a moderate north easterly breeze (20 to 28 km/h) with gusts of wind up to 44 km/h. No rain was noted within 24 hours of the test launch.

5.3.1 Measured ambient sound pressure levels

Daily summaries of the ambient (L_{Aeq}) and background (L_{A90}) levels for Day (7am to 10pm) and Night (10pm to 7am) periods are summarised in the following tables. Details of the levels measured during the test launch are presented in Section 6.4.

Table 22 Baseline noise monitoring results (Site 2)

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Wed 1/09/2021	63	40	-	-
Thu 2/09/2021	72	44	55	38
Fri 3/09/2021	66	41	60	44
Sat 4/09/2021	55	41	53	40
Sun 5/09/2021	55	39	41	36
Mon 6/09/2021	47	37	42	36
Tue 7/09/2021	43	35	55	36
Wed 8/09/2021	67	39	70	40
Thu 9/09/2021	78	40	49	38
Fri 10/09/2021	73	48	60	40
Sat 11/09/2021	71	45	73	51
Sun 12/09/2021	74	52	63	43
Mon 13/09/2021	51	38	39	35
Tue 14/09/2021	47	35	44	36
Wed 15/09/2021	49	36	56	39
Thu 16/09/2021	64	44	55	37
Fri 17/09/2021	74	52	71	48
Sat 18/09/2021	70	48	70	51
Sun 19/09/2021	75	56	-	-

Table 23 Baseline noise monitoring results (Site 4)

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Wed 1/09/2021	50	48	58	50
Thu 2/09/2021	53	43	43	39
Fri 3/09/2021	48	42	45	42
Sat 4/09/2021	41	38	40	38
Sun 5/09/2021	40	36	35	31
Mon 6/09/2021	34	26	37	32
Tue 7/09/2021	38	28	45	42
Wed 8/09/2021	49	39	47	40
Thu 9/09/2021	57	35	45	37
Fri 10/09/2021	52	45	44	41
Sat 11/09/2021	53	42	59	51
Sun 12/09/2021	60	50	47	42
Mon 13/09/2021	40	35	37	32
Tue 14/09/2021	41	35	43	38
Wed 15/09/2021	44	39	50	41
Thu 16/09/2021	55	49	50	34
Fri 17/09/2021	60	49	60	54
Sat 18/09/2021	55	49	56	51
Sun 19/09/2021	58	52		

Table 24 Baseline noise monitoring results (Site 5)

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Fri 3/09/2021	43	28	43	27
Sat 4/09/2021	39	24	40	22
Sun 5/09/2021	39	21	43	18
Mon 6/09/2021	43	18	40	20
Tue 7/09/2021	38	26	43	34
Wed 8/09/2021	45	29	41	31
Thu 9/09/2021	50	29	42	29
Fri 10/09/2021	45	35	43	28
Sat 11/09/2021	43	31	45	33
Sun 12/09/2021	48	38	41	31
Mon 13/09/2021	38	25	40	22
Tue 14/09/2021	38	27	40	26

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Wed 15/09/2021	39	27	40	27
Thu 16/09/2021	42	34	41	26
Fri 17/09/2021	49	39	46	34
Sat 18/09/2021	44	33	43	31
Sun 19/09/2021	52	37	-	-

Table 25 Baseline noise monitoring results (Site 7)

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Thu 2/09/2021	52	43	47	43
Fri 3/09/2021	47	44	46	41
Sat 4/09/2021	43	39	45	40
Sun 5/09/2021	42	38	42	37
Mon 6/09/2021	39	32	44	38
Tue 7/09/2021	42	30	50	46
Wed 8/09/2021	47	43	48	46
Thu 9/09/2021	50	43	50	44
Fri 10/09/2021	50	46	47	42
Sat 11/09/2021	47	43	51	45
Sun 12/09/2021	52	45	45	41
Mon 13/09/2021	40	32	44	27
Tue 14/09/2021	37	26	42	27
Wed 15/09/2021	38	29	44	36
Thu 16/09/2021	46	38	45	39
Fri 17/09/2021	53	45	52	48
Sat 18/09/2021	50	46	51	47
Sun 19/09/2021	53	48	-	-

Table 26 Baseline noise monitoring results (Site 8)

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Thu 9/09/2021	55	50	48	50
Fri 10/09/2021	57	53	53	53
Sat 11/09/2021	59	55	53	55
Sun 12/09/2021	63	60	58	60
Mon 13/09/2021	60	57	58	57

Date	Day (7am-10pm)		Night (10pm-7am)	
	L_{Aeq}, dB	L_{A90}, dB	L_{Aeq}, dB	L_{A90}, dB
Tue 14/09/2021	60	58	57	58
Wed 15/09/2021	60	59	57	59
Thu 16/09/2021	55	49	58	49
Fri 17/09/2021	57	54	48	54
Sat 18/09/2021	58	55	54	55

5.3.2 Measured vibration levels

A summary of baseline vibration levels is presented in Table 27. These levels represent the Peak Particle Velocity (PPV) levels in absence of rocket launch activities.

Table 27 External vibration measurements

Location	Measured Peak Particle Velocity (PPV, mm/s)	
	Average	Maximum
Site 2	0.1	1.2
Site 4	0.1	1.8
Site 5	0.1	1.0
Site 7	0.1	2.3

The average measured Peak Particle Velocity (PPV, mm/s) for each site was generally below the threshold that can be felt by humans.

The source of vibration above perceptible levels (approximately 0 to 0.3 mm/s) was not confirmed. It is expected to be attributed to local disturbance of the vibration sensor caused by wildlife and human activity.

6.0 Impact assessment

Noise generated by construction and the operational stage of the project has the potential to temporarily change the existing acoustic environment. This section presents predicted noise levels associated with the noisiest project activities and the assessment of the potential noise impacts to human amenity.

6.1 Construction noise

6.1.1 Construction noise levels at distance

Noise levels at various distances from the indicative construction scenarios are shown in Table 28.

Table 28 Noise impact set back distances

Activity reference	Construction works	Sound pressure level, L_{Aeq}, dB(A), at distances from source						
		25m	50m	100m	200m	500m	1000m	2000m
C1	Site preparation	78	72	66	60	54	48	42
C2	Utility construction	83	77	71	65	59	53	47
C3	Foundations	78	72	66	60	54	48	42
C4	Structural works	75	69	63	57	51	45	39
C5	Testing and commissioning	73	67	61	55	49	43	37
C6	Roads, landscaping and reinstatement	77	71	65	59	53	47	41

6.1.1 Construction safe working levels at distance from vibration

Table 29 presents the safe working distances which relate to cosmetic/structural damage and adverse human response for vibration-intensive construction equipment, in relation to the vibration criteria outlined in Section 4.2.

Table 29 Construction safe working levels

Plant	Rating / description	Cosmetic damage safe working distances (m)			Human response safe working distances[1] (m)
		Heritage	Residential	Industrial	
Drop hammer	3t Enclosed (30kJ per blow assumed)	40	23	6	100
Drop hammer	25 kJ per blow	40	23	6	100
Drop hammer	5 kJ per blow	17	10	3	35
Excavation	-	2 [1]	1 [1]	<1	Avoid contact with structure
Hydraulic jacking rig	-	3	1.5	<1	Avoid contact with structure
Jackhammer	Handheld	1 [1]	1 [1]	<1	Avoid contact with structure
Large hydraulic hammer	(1,600 kg – 18-34t excavator)	34	22	7	73

Plant	Rating / description	Cosmetic damage safe working distances (m)			Human response safe working distances[1] (m)
		Heritage	Residential	Industrial	
Medium hydraulic hammer	(900 kg – 12-18t excavator)	12	7	2	23
Pile boring	≤ 800 mm	3	2	<1	N/A
Small hydraulic hammer	(300 kg – 5-12t excavator)	4	2	<1	7
Vibratory rig	50 kJ per cycle	50	30	8	100
Vibratory rig	10 kJ per cycle	23	15	3.5	100
Vibratory roller	< 50 kN (typically 1-2t)	8	5	2	15-20
	< 100 kN (typically 2-4t)	10	6	2	20
	< 200 kN (typically 4-6t)	20	12	3	40
	< 300 kN (typically 7-13t)	25	15	4	100
	> 300 kN (typically 13-18t)	30	20	6	100

1 Based on Table 1 in BS6472-1:2008

6.1.2 Discussion

The construction noise level is calculated to be 53 dB(A) at the nearest residence for the worst-case construction scenario (during utility construction at the range control, activity reference C2). This calculated worst case level is deemed compliant with the assessment criteria as there are no specific noise criteria for construction works occurring between Monday and Saturday, 7.00am to 7.00pm, excluding public holidays.

Although construction noise is likely to be audible at times it is unlikely that construction noise would present a significant impact to the existing acoustic amenity at the closest residential locations if good practice construction methods are adopted. Vibration impacts are also expected to be limited to within 100 metres of the work area and would be unlikely to disturb humans at any stage of construction.

Accordingly, it is recommended that the good practice construction noise management measures listed in Table 17 are incorporated into the applicable environmental management plan.

6.2 Operation of supporting infrastructure

6.2.1 Operational noise levels from office, workshop and crane activity

Assumed operational noise levels and setback distances from generators and supporting launch infrastructure are presented in Table 30.

Table 30 Setback distances and estimated noise levels from typical site facilities and supporting infrastructure

Facility/process	Sound pressure level, dB(A), at distances (in metres) from source						
	25	50	100	200	500	1000	2000
Building generators	62	56	49	40	29	20	<20
Workshop activity	59	53	48	38	25	<20	<20

Facility/process	Sound pressure level, dB(A), at distances (in metres) from source						
	25	50	100	200	500	1000	2000
Lifting crane	61	54	47	37	26	<20	<20

In addition to these fixed operational noise events, up to 16 truck movements per week have been advised. The maximum (L_{Amax}) noise produced by a single truck movement would be approximately 85 dB(A) at 10 metres from a pass by. These above truck movements are expected throughout the day and are not expected to cause significant noise impact.

6.2.2 Discussion

Noise generated from building generators and other supporting launch infrastructure and activities have been predicted to be less than 20 dB(A) at distances greater than one kilometre from the launch facilities.

These noise levels would likely be inaudible at the nearest residential locations at Fishery Bay, which are more than 3.5 kilometres away from any launch facility. It is unlikely that typical operational activities, excluding a rocket launch or testing, would cause disturbance to the inhabitants of nearby residences.

6.3 Operation of launch vehicles

Noise from launches and testing would temporarily alter the quiet setting of the natural environment for one to two minutes during launches and for up to 15 seconds during testing. These events have the potential to disturb nearby residents.

Parameters relevant to the disturbance of humans have been considered when calculating the impacts from the operational noise associated with launch vehicles. Table 31 provides an overview of the parameters and assumptions for each scenario. A full list of assumptions has been included within Section 4.2.3.

Table 31 Modelling scenarios

Parameter, dB(A)	Scenarios and nominal assumptions
L_{Amax} and L_{max}	The maximum instantaneous sound pressure level for a single launch for both Falcon 9 and New Shepard rockets from each proposed launch site.
L_{AE}	The A-weighted Sound Exposure Level for a single Falcon 9 and New Shepard rocket launch assuming this loudest rocket would launch from each proposed launch site.
DNL	The combined future equivalent sound level for a 24-hour period assuming up to 42 launches per year and 10 tests. The following has been modelled for this assessment: • Site A launches: 11 day (7am to 10pm) and 10 night (10pm to 7am) - Falcon 9 and New Shepard launch vehicles • Site B launches:11 day (7am to 10pm) and10 night (10pm to 7am) - Falcon 9 and New Shepard launch vehicles • Site rocket testing: 10 day (7am to 10pm) for a duration of 15 seconds for each test - Falcon 9 launch vehicles only

Note that the above levels have not been produced for the purpose of determining compliance as there are no regulations that specify required levels for the operation of space facilities in Australia. The predicted levels have been compared to those presented in Section 4.2.3 as a reference point for the discussion of impacts with reference to the proponent's general environmental duty[2].

[2] Environment Protection Act 1993

6.3.1 Predicted noise levels

This section presents the predicted noise levels associated with the launch and testing of rockets followed by a discussion outlining how these levels may impact the amenity of nearby residents. Table 32 (Falcon 9) and Table 33 (New Shepard) provide an overview of the predicted levels at each residence.

The noise levels presented are considered a conservative approximation based on the information available at the time of the assessment. Furthermore, the noise reduction from the initial mitigation measures (water deluge and blast walls) captured within the design (See Section 4.4) have not been included within the results presented (limitation of modelling software).

Table 32 Sensitive receptors near launch activities (Falcon 9)

Location	Launch from Site A			Launch from Site B			Day-Night Average Sound Level (DNL)
	L_{Amax}	L_{max}	L_{AE}	L_{Amax}	L_{max}	L_{AE}	
Residence 1	100	121	117	101	122	118	65
Residence 2							
Residence 3							

Table 33 Sensitive receptors near launch activities (New Shepard)

Location	Launch from Site A			Launch from Site B			Day-Night Average Sound Level (DNL)
	L_{Amax}	L_{max}	LAE	L_{Amax}	L_{max}	LAE	
Residence 1	93	104	120	95	105	121	57
Residence 2							
Residence 3							

6.3.2 Discussion

The cumulative noise exposure (DNL) from the proposed ultimate operating scenario (42 yearly launches) is predicted to be equal to the proposed assessment criterion of DNL 65 dB(A) for the worst-case scenario where all rockets are either Falcon 9 (above the maximum thrust of the facility) or the New Shepard rocket (expected to be above the 80th percentile of all launch vehicles at Whalers Way) assumed to be operating is designed to support. For comparison, if only New Shepard rockets were used at Whalers way, the predicted DNL value would be below 60 dB.

Achieving a DNL at or below 65 dB(A) indicates that the overall level and frequency of the planned Southern Launch activities are less likely to cause a significant community response to noise as per FAA recommendations.

This does not mean that a launch would not cause annoyance or disturbance. At this stage of the project it is assumed that a rocket could be launched at any time over a 24-hour period. Consequently, the maximum instantaneous noise produced by an individual rocket launch or static test is likely to cause disturbance at the neighbouring properties, particularly if these activities are undertaken at night.

Maximum external noise levels (L_{Amax}) of up to 101 dB and 95 dB for each scenario were calculated outside the residential properties closest to Launch Site B. Noise at this level is likely to be of short duration (seconds) when a launch vehicle is close to the ground (beginning of a launch). This level would decline after launch due to the gradual decrease in energy output from the rocket and increase in altitude. A lower audible sound associated with the rocket engine may persist after the launch (approximately 1 – 2 minutes) under quiet conditions.

The external levels transferring to the inside of a typical residential building during a launch would likely be high enough to disturb sleep. Noise during a day launch or test may also be at an annoying outdoor level for a brief period (less than one minute) before ambient levels returned to normal. For context, a

comparable level of sound could be experienced by standing close to a train pass by or below an aircraft flyover at low altitude.

Additional mitigation at the source to reduce these levels are not considered to be feasible as the design has already incorporated a water deluge system (example shown in Figure 5) to reduce both near and far field noise impacts and blast walls/bunds to reflect acoustic energy away from the launch vehicle and sensitive areas. These are noted as two of the most effective noise suppressants when a rocket is in a launch position (Lubert, 2017).

Figure 5 Kennedy Space Centres Launch Pad 39A water sound suppression system (NASA - https://www.nasa.gov/missions/shuttle/f_watertest.html)

Administrative measures proposed by Southern Launch would also include a plan to notify residents of upcoming launch activities and to restrict human presence within required set back distances prior to a launch. This may not necessarily reduce the noise level exposure but would prepare residents for a loud acoustic event and inform them about the activities being undertaken on site.

A noise monitoring and reporting program would also be developed to verify noise impacts of launch activity on nearby residents. Details of the ongoing monitoring program are provided in Section 7.2.

It is recommended that further considerations are made during detailed design regarding the scheduling of launches at night as impacts would be greatest during this time.

6.3.3 Sonic booms

The potential impact from sonic booms has been determined by comparing the impact of other launch facilities with a similar planned azimuth, trajectory and rocket size. The audible component of a sonic boom may sound similar to a single distant thunder clap. Exposure to this sound in a quiet environment could cause an unexpected disturbance to sensitive receptors.

Supersonic speeds are assumed to occur approximately three kilometres from the coast during vehicle ascent over the ocean. Sonic booms produced during vehicle ascent are typically directed in front of the vehicle and the entire boom footprint is usually some distance downrange of the launch site (SpaceX, 2020).

Furthermore, the rockets proposed for the Southern Launch facility are also relatively small which would limit the physical size of sonic boom being created. This means that the vehicle is unlikely be big enough or located close enough to land to produce a focused boom that could reach the surface.

Furthermore, impact assessments for suborbital rocket launch facilities in the United States (FAA, 2009) have concluded that sonic booms are less likely to contribute to other noise impacts associated with the launch if they occur over the ocean at a high altitude. Rocket landing events can often result in single or

multiple sonic booms as vehicles return to subsonic speeds however this type of activity is not proposed by Southern Launch.

Hence, the overpressure produced by the sonic boom is not expected to exceed the assessment criterion of 133 dB(L) on land.

6.3.4 Ground vibration

The extent of ground and structural vibration produced by the acoustic environment near the launch vehicle is expected to be limited to the buildings supporting the launch. This consideration is related to the design of the facility and is outside the scope of this assessment.

No evidence of damage or significant disturbance caused by ground vibration during typical launch and testing operations was found when undertaking the literature review in preparation for this assessment.

6.3.5 Air overpressure

The potential for structural damage due to launch events is assessed by comparing the predicted L_{max} values to the overpressure assessment criterion of 133 dB.

The highest predicted L_{max} level is 122 dB for the worst-case rocket launching from Site B. Accordingly, damage due to launch events is not considered to be a significant risk.

6.4 Test launch

At 16:08 hours on the 16th September 2021, TiSpace attempted to launch the experimental VS01 sub orbital rocket from Pad 1 at the Whalers Way Orbital Launch Facility.

During the launch attempt only one of the four engines completed ignition and produced ‘launch’ thrust. With less than full ‘launch’ thrust being produced by all four engines, the lift-off command was not sent to the rocket and all engines were successfully shut down.

Southern Launch’s emergency response system was enacted with standard shut down, and ‘safeing’ procedures started with the nitrous oxidiser released from the onboard tanks. Residual heat from the rocket engines caused a fire to break out in the base of the rocket which damaged the rocket structure, causing it to fall off the rocket launcher.

The fall and fire damaged the first stage oxidiser tank resulting in a pressure-induced explosive rupture of the tank pushing the rocket off the launch pad. Emergency services extinguished the small fire at the launch pad and the area was made safe.

An overview of the of the events at the time of the launch is presented in Table 34. This information was collected by TiSpace and provided for comparison to the measured noise levels during the noted events.

Table 34 Launch events 16 September 2021

Event	Test launch date and time (T)
	16/09/2021 4:08:35 PM
Automatic flight mode	T-31
Activate launcher water deluge system	T-25
Start S2 ignition command	T-14
S2 main valve open*	T-2
Flight termination system abort command	T+1
S2 tank rupture*	T+10m31s

* Loudest noise events as per *AcousticReadingRecords-1516Sept2021.xlsx* (TiSpace)

Noise and vibration measurements were undertaken during this event to verify the levels in the surrounding environment and at residents closest to the site during launch.

6.4.1 Measured levels during test launch

A summary of the noise levels measured during the two key noise events associated with the test launch is presented below. These events were assumed to occur at approximately 4:08 PM and 4:19 PM on the day of the launch.

Site	Approximate distance from launch site	Measured sound pressure level, dB			
		S2 Main Valve Open		S2 Tank Rupture	
		$L_{Aeq(1\text{-}min)}$	L_{Amax}	$L_{Aeq(1\text{-}min)}$	L_{Amax}
2	900 metres	65	71	69	79
4	1.7 kilometres	62	74	64	88
5	3 kilometres	43	49	44	54
7	2.1 kilometres	61	68	56	68
8	6.2 kilometres	62	66	65	69

The levels measured at these locations were used to calculate the sound power level being produced by the test launch events. This level has then been used to calculate the noise levels at other nearby sensitive receptor locations using a three-dimensional noise model.

6.4.1.1 Continuous noise monitors

A summary of the noise levels measured during the two key noise events associated (see Table 34) with the test launch is presented in Table 35. These events were assumed to occur at approximately 4:08 PM and 4:19 PM on the day of the launch.

Weather conditions on the afternoon of the launch included a moderate north easterly breeze (20 to 28 km/h) with gusts of wind up to 44 km/h. No rain was noted within 24 hours of the test launch.

Table 35 Measured sound pressure level

Site	Approximate distance from launch site	Measured sound pressure level, dB			
		S2 Main Valve Open		S2 Tank Rupture	
		$L_{Aeq(1\text{-}min)}$	L_{Amax}	$L_{Aeq(1\text{-}min)}$	L_{Amax}
2	900 metres	65	71	69	79
4	1.7 kilometres	62	74	64	88
5	3 kilometres	43	49	44	54
7	2.1 kilometres	61	68	56	68
8	6.2 kilometres	62	66	65	69

A summary of vibration measurements undertaken are presented in Table 36.

Table 36 Measured vibration levels

Location	Maximum measured Peak Particle Velocity (PPV, mm/s)
	Test launch
Site 4	0.3
Site 7	0.15

6.4.1.2 EPA monitoring

The EPA undertook monitoring a day before the failed launch (15 September 2021) between 2pm and 3:30pm at approximately 100 meters from the launch vehicle. During monitoring, the rocket was able to reach the stage of the igniters firing before aborting before fuel was engaged (at approximately 2.14pm on the 15 September 2021).

The EPA measured 15-minute broadband and spectral levels with instantaneous sound pressure levels also being captured at 100ms intervals.

Sound pressure levels measured during this activity were typically between 90 dBA and 105 dBA with an L_{Amax} of 109 dB.

6.4.1.3 TiSpace monitoring

TiSPACE undertook noise monitoring at the launch pad and inside the vehicle during rocket firing on the 15 September 2021 and during the test launch on the 16 September 2021. The levels recorded represent the highest level measured for each event before and after ignition (T).

Table 37 TiSpace measured levels 15 September 2021

Event	Countdown T- ss	Acoustic Value inside Launcher (dB)	Acoustic Value on right side of Launcher (dB)
Before	~	73	65
Automatic Flight Mode	T-31 to T-25	71	65
Activate Launcher Water Deluge System	T-24 to T14	94	82
Start S2 Ignition Command	T-13 to T-3	108	117
S2 Main Valve Open	T-2 to T+1	108	135
FTS Abort Command	T+2 to T+6	111	137

Table 38 TiSpace measured levels 16 September 2021

Event	Countdown T- ss	Acoustic Value inside Launcher (dB)	Acoustic Value on right side of Launcher (dB)
Before	~	74	63
Automatic Flight Mode	T-31 to T-26	74	64
Activate Launcher Water Deluge System	T-25 to T-15	94	79
Start S2 Ignition Command	T-14 to T-3	89	104
S2 Main Valve Open	T-2 to T-0	109	108
FTS Abort Command	T+1 to T+10m0s	111	112
S2 Tank Rupture	T+10m31s	110	110
After rupture	~	75	82

It is expected that the external monitor was not operating correctly on the 16 September as the levels are expected to be higher than those shown.

6.4.1.4 Observations

Noise measurements during the test launch were comparable to the ambient sound pressure levels measured before and after the event. Accordingly, the launch attempt may not have been audible at all monitoring locations and is unlikely to have caused adverse impact at the nearest residential receptors.

This conclusion was supported by anecdotal commentary from visitors located within the observation area approximately three kilometres from the launch. Visitors at this location reported that the test launch activities could not be heard at this location.

Vibration measurements during the period of the launch indicated that the vibration was slightly above the measured average baseline levels. Levels at the magnitudes measured indicate that vibration-induced structural damage is unlikely to be a notable risk at residential receptors.

Further measurements will be undertaken during operations to continue the development of the database.

6.4.2 Estimated sound power level

The estimated sound power level for the test launch was approximated by considering the following measured sound pressure levels:

- The maximum levels at Site 2 during the S2 Tank Rupture (79 dBA)
- The overall levels measured by the EPA at approximately 100 metres from the rocket ignition (90 to 105 dBA)
- The overall levels at the right side of launcher during the S2 Main Valve Open event on the 15 September 2021 (135 dB)

The octave band levels for the rocket launch have been based on the *maximum predicted acoustic environment* values provided within the SpaceX user's guides.

This information was used to help create an acoustic model that would represent the noise produced during the test launch and allow for noise levels to be calculated for receptors outside of the monitoring locations.

The estimated sound power level and acoustic spectra for the test launch event is presented in Table 39.

Table 39 Estimated sound power level

Item	Octave band frequency (Hz) sound power levels (dB)							Overall SWL dBA
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
Rocket test launch	152	150	148	143	136	132	129	145

Note that the sound power level presented in Table 39 should be considered relevant to the test launch only. As only one of the four engines were operating during the launch attempt.

6.4.3 Calculated noise levels at monitoring locations

Noise emissions were predicted using SoundPLAN version 8.2 environmental noise modelling software and the implementation of ISO 9613-2: 1996 '*Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*'. ISO 9613-2 describes a method for calculating the attenuation of sound from industrial sources and is used to predict noise levels at noise-sensitive receptors.

The ISO 9613-2 methodology was considered acceptable in this instance as the launch vehicle was not airborne at any stage of the testing. Validation of noise from successful launches would utilise rocket noise modelling software such as RUMBLE 3.0.

The following inputs were included in all operational acoustic models:

Terrain was based on elevation contour lines sourced from the Elevation and depth – Foundation Spatial Data (https://elevation.fsdf.org.au/)

Ground Absorptivity was modelled as:

50% acoustic absorptivity within the

Acoustically reflective in ocean areas.

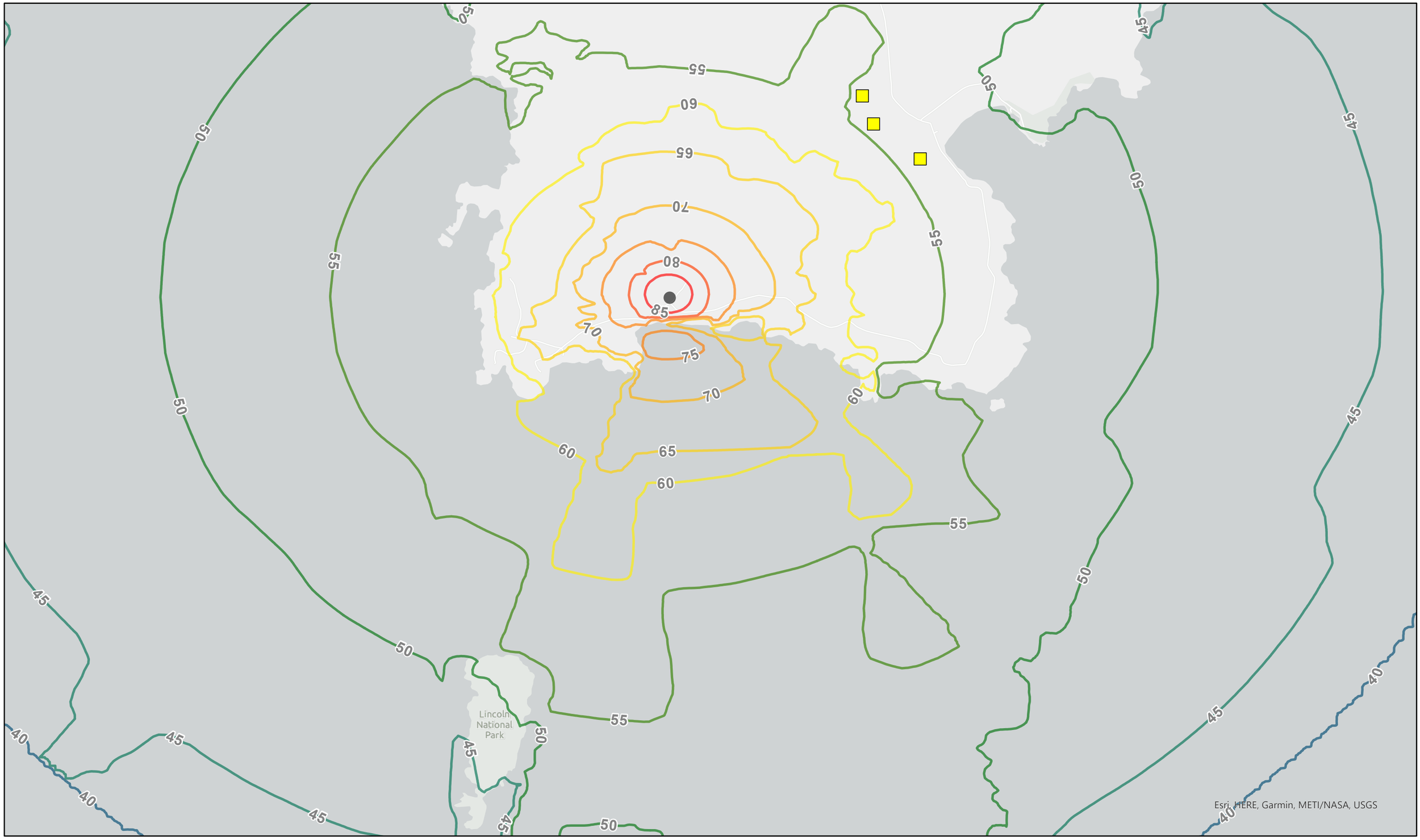
Structures were digitised from site layout files

Noise sources were based on the derived sound power levels using the measured levels during the test launch.

Figure 6 provides and overview of the calculated L_{Amax} sound pressure levels at the noise monitoring locations.

The levels presented are intended to provide a reasonable reproduction of the noise measured at each noise monitoring location. Accordingly, there may be some variation between the measured and modelled level due to complex noise environment at the launch site.

It is expected that noise predictions would continue to be refined using the additional data collected during future launches.



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DATUM GDA 1994, PROJECTION MGA ZONE 53

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Kilometers
(when printed at A3)

L_{Amax} Noise Levels (dB)

- 40 dB
- 45 dB
- 40 dB
- 45 dB
- 40 dB
- 45 dB
- 60 dB
- 65 dB
- 70 dB
- 75 dB
- 80 dB
- 85 dB

Residential Locations

Test Launch Pad

Details within this map are to provide a prediction of the noise propagation from the test launch.

Airborne noise predictions have been carried out using SoundPLAN software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{AMAX} NOISE LEVELS FOR TEST ROCKET LAUNCH AT LAUNCH SITE B

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
6

A3 size

7.0 Mitigation measures

7.1 Construction

Noise impacts from construction activities have not been identified as a significant risk at this stage of the project. Nevertheless, all reasonable and practicable measures must be taken to minimise noise resulting from the construction in order to reduce the chance of an adverse impact on the amenity of nearby residencies.

7.2 Operation

Impacts during typical daily operations were predicted to achieve the noise policy levels. Consequently, a significant impact on the environment is unlikely and additional mitigation has not been recommended.

Testing and launching of rockets have incorporated planned mitigation measures including:

- Using blasting walls or bunds near launch and testing sites
- Operation of a water deluge system
- Details of the above systems will be refined during the detailed design phase of the project.
- In addition to the above it is recommended that the following mitigation measures are considered:
- Scheduling of launch testing during the day only and minimising night launches where feasible to do so.
- Development of a stakeholder engagement plan with procedures for notifying residents in advance of all planned launch events.
- Development of a noise monitoring and reporting program to verify noise impacts of launch activities on nearby residents. This should include the following:
    - Measurement of all launches within the first 12 months of operation at up to three locations with at least one location being the closest residential receptor
    - Measurement of new launch vehicles (not measured in the first 12 months) at up to three locations with at least one location being the closest residential receptor
    - Details of the effectiveness of onsite noise mitigation measures and the verification of the predicted noise levels
    - Reported response from nearby residents.

The above measures should be included within the Operational Environmental Management Plan (OEMP) developed for the Project.

8.0 Conclusion

This report presents a preliminary assessment of the potential noise impacts of the proposed Whalers Way Orbital Launch Complex.

Existing conditions

Noise monitoring of the existing environment throughout the Project study area was used to develop an understanding of the existing background levels.

Background noise levels were considered typical of rural and remote areas with low residential density and little to no exposure to transportation or industrial noise.

Measurements prior to and following the first launch of the test campaign were comparable to the initial baseline levels.

Construction noise impact assessment

The construction works would likely occur between 7am and 5pm, Monday to Friday, excluding public holidays. This would be within the allowable construction hours for the South Australian Noise EPP, where no criteria are applied.

The risk of significant construction noise impacts is considered low based on the scenarios assessed in this report.

Operational noise impact assessment

A desktop study has considered the potential operational noise impacts due to the operation of the proposed Project, as well as noise associated with the launch and testing of two different sub-orbital rockets.

The risk of significant noise impacts due to the typical operation of the launch facilities, including office buildings, workshops and other supporting infrastructure is considered to be low based on the scenarios presented in this report.

Noise levels were predicted to be equal to or below the DNL of 65 dB(A) for residents closest to the launch sites. However, the maximum instantaneous noise produced by an individual rocket launch or static test is likely to cause disturbance at the neighbouring properties, particularly if these activities are undertaken at night.

Mitigation measures

Initial mitigation was incorporated into the construction and operation impact assessments.

The proposed source controls were considered the best practice mitigation measures available to the project for launch and testing activities (water deluge noise suppression system and blast walls).

Stakeholder engagement and administration actions have been recommended to ensure nearby residents are informed about launch activities. Noise monitoring was also recommended to confirm predicted noise levels and the effectiveness of onsite noise mitigation.

9.0 References

Legislation, Australian Policies and Guidelines

Commonwealth *Space (Launches and Returns) Act 2018*

South Australian *Development Act 1993*

South Australian *Environment Protection Act 1993*

South Australia *Environmental Protection (Noise) Policy 2007 (Noise EPP)*

Australian Standards

Australian Standard 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*

Australian Standard AS 2187.2-2006 *Explosives – Storage and use Part 2: Use of explosives*

Overseas and International Standards

FAA, 14 CFR Part 150 - Airport Noise Compatibility Planning

British Standard 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites –Part 1: Noise*

DIN 4150-3, 2016 Edition, December 2016 - *Vibrations in buildings - Part 3: Effects on structures*

Key research and reports

Blue Ridge Research and Consulting. (2017). *RUMBLE Launch Vehicle Acoustic Simulation Model Version 2.0 User Guide.* Asheville.

Bowles, A. E. (2000). *Potential Impact of USAF Atmospheric Interceptor Technology (ait) Launches from the Kodiak Launch Complex, Kodiak Island, Alaska. Monitoring of Noise Levels During the Launch of ait-2.* San Diego: Hubbs-SeaWorld Research Institute.

Caltrans. (2013). *Transportation and Construction Vibration Guidance Manual.* Sacramento: California Department of Transportation.

Dooling, R. J., & Popper, A. N. (2007). *The effects of highway noise on birds.* Sacramento, CA: California Department of Transportation Division of Environmental Analysis.

Dooling, R. J., & Popper, A. N. (2016). *Technical Guidance for Assessment and Mitigation of the Effects of Highway and Road Construction Noise on Birds.* Sacramento, CA: California Department of Transportation, Division of Environmental Analysis.

FAA. (2009). *Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications.*

FAA. (2018). *FAA History of Noise.* FAA.

Lubert, C. P. (2017). *Sixty years of launch vehicle acoustics.* Proc. Mtgs. Acoust. 31.

NMFS. (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts.* Silver Spring: US Dept of Commerce, NOAA.

Southall, B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., . . . Tyack, P. L. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals, 49*(2), 125-232. doi:10.1578/AM.45.2.2019.125

SpaceX. (2019). *Draft Environmental Assessment for the SpaceX Starship and Super Heavy Launch Vehicle at Kennedy Space Centre (KSC).*

SpaceX. (2020). *Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Centre and Cape Canaveral Air Force Station.*

USAF. (1998). *Final Environmental impact Statement - Evolved Expendable Launch Vehicle Program.* U.S. Air Force. 1260 Air Force Pentagon, Washington, D.C.: HQ USAF/ILEVP.

Wyle. (2003). *Noise Basics and the Effect of Aviation Noise on the Environment.* Wyle.

Appendix A

Glossary

Appendix A Glossary

Term	Definition
'A' Weighted	Frequency filter designed to adjust the absolute sound pressure levels to correspond to the subjective response of the human ear. The A-weighting filter emphasises frequencies in the speech range (between 1 kHz and 4 kHz) which the human ear is most sensitive to. When an overall sound level is A-weighted it is expressed in units of dB(A).
Ambient noise	Ambient noise is the all-encompassing noise at a point comprising sound from all noise sources near and far. The equivalent continuous sound pressure level. L_{Aeq}, is typically the descriptor used to describe ambient noise.
Background level (L_{90} *or* L_{A90})	The underlying noise level present in the ambient noise when extraneous noise (such as a lawnmower and dogs barking) is removed. The L_{90} sound pressure level is used to quantify the background level. For a day, evening or night period means the arithmetic average of the L_{A90} levels for each hour of that period for which the commercial, industrial or trade premises under investigation normally operates. The background level shall include all noise sources except noise from commercial, industrial or trade premises which appears to be intrusive at the point where the background level is measured.
Decibel [dB]	The measurement unit of sound.
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A three decibel increase in the sound pressure level corresponds to a doubling in sound energy. An increase or decrease of three decibels is typically considered to be the smallest change in sound level that a listener can detect. A change of five decibels, however, is clearly noticeable. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. This increase is typically perceived to sound twice as loud. The table below shows the sound pressure level that would be typically experienced when exposed to different sources:
	0 dB(A) Threshold of human hearing 30 dB(A) A quiet country park 40 dB(A) Whisper in a library 50 dB(A) Open office space 70 dB(A) Inside a car on a freeway 80 dB(A) Outboard motor 90 dB(A) Heavy truck pass-by 100 dB(A) Jack hammer / subway train 110 dB(A) Rock concert 115 dB(A) Limit of sound permitted in industry 120 dB(A) 747 take off at 250 metres
Frequency [f]	Frequency is measured in Hertz (Hz).

Term	Definition
	The frequency corresponds to the pitch of the sound: a high frequency to a high-pitched sound and a low frequency to a low-pitched sound.
Insertion loss	The reduction in sound pressure level at a receptor by inserting a barrier between the source and considered receptor.
Impulsiveness	A noise is more annoying when it has an impulsive component (such as banging noise). Where a noise source is impulsive, an adjustment is made to allow for the additional annoyance caused by the impulses.
L_{eq}	Equivalent (energy averaged) noise level measured over a time period. This noise descriptor is commonly used in environmental noise policies and assessments. The time period the measurement is averaged over may be included in the subscript, i.e. $L_{Aeq,\ 30min}$.
L_{90}	The noise level exceeded 90% of the measurement period. This descriptor is used to represent the background noise level.
L_{max}	The maximum sound pressure level measured over the measurement period. The A-weighted form is denoted 'L_{Amax}'.
Noise-sensitive area	The SEPP N-1 noise limits and NIRV recommended noise levels are set at noise-sensitive areas. These are mainly residential dwellings, but can include, for example, motels and tourist establishments. They do not include schools. Noise is assessed at the property boundary or within 10 m of a dwelling, whichever is the lesser.
Octave band	The International Standards Organisation has agreed upon preferred frequency bands for sound measurement and the octave band is the widest band for frequency analysis. The upper frequency limit is approximately twice the lower frequency limit and each band is identified by its band centre frequency. Typical Octave Band frequencies for environmental noise assessments are: 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz.
One-third octave band	Where more detailed information about a noise is required, standardised one-third octave band analysis may be used. There are three one-third octave bands for each octave band. (e.g. 25Hz, 31.5Hz, 40Hz one-third octave bands cover the same frequency range as the 31.5Hz octave band).
Sensitive receptor	Areas where the occupants, buildings or land use are potentially susceptible to the adverse effects of exposure to noise and vibration.
Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified receiving point.
Tonality	Noise is subjectively more annoying when it has a tonal component (a perceptible hum or whine). Tonality can be determined by subjective assessment or from one-third octave band analysis of the noise. Where a noise is tonal, an adjustment is made to allow for the additional annoyance caused by the tone.

Appendix B

Baseline monitoring

Appendix B Baseline monitoring

The average measured noise levels by time period are presented at the bottom of each monitoring summary. The methodology for calculating the average, minimum and maximum noise levels for each monitoring location was as follows:

- The $L_{A90\ (day/evening/night)}$ (arithmetic average) and $L_{Aeq\ (day/evening/night)}$ (logarithmic average) was calculated for each single day of the monitoring period.
- The overall minimum, maximum and average noise level was calculated for each time period (day/evening/night) of the monitoring period. These values are presented in the following summary tables. Time periods containing extraneous noise events or inclement were omitted from this calculation.

Details of the monitoring instrumentation and location are presented in Section 5.2 of the report.

Noise Monitoring Data Sheet

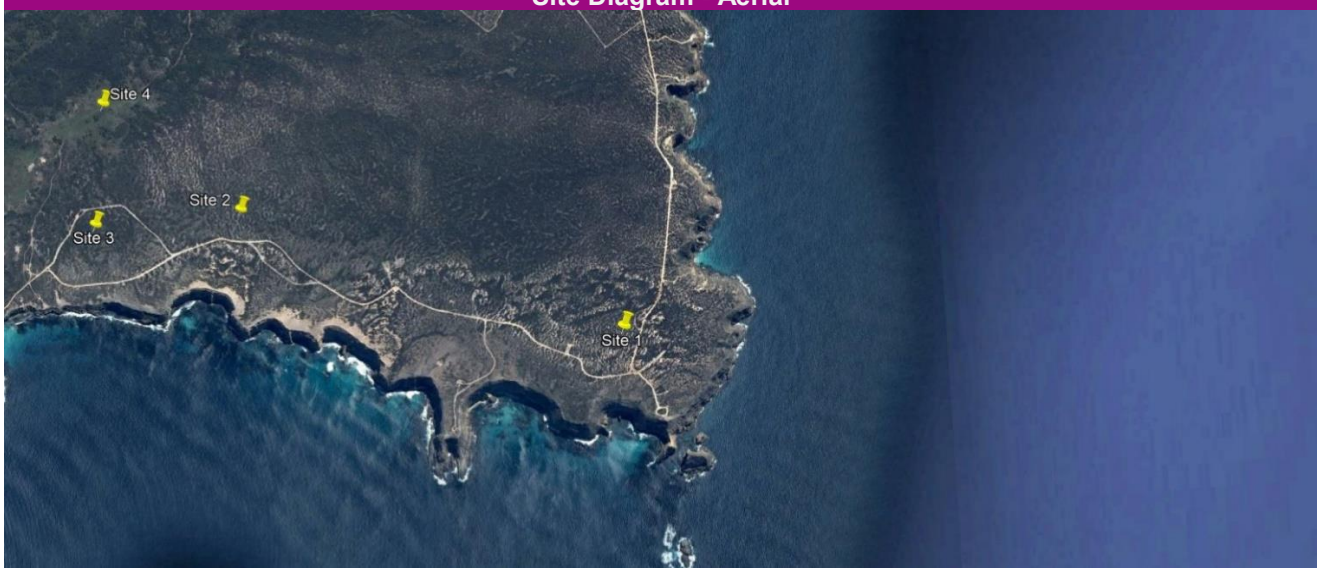
Southern Launch

SITE ID
1

From	17/03/2020 10:30	Mic. Height (m)	1.2 - 1.5 m	Address	Site 1
To	19/03/2020 14:45	Meas. Type	Environmental	Suburb	Whalers Way
Pre Calibration	94.0	Inst. Type	Rion NL-21	District	South Australia
Post Calibration	94.0	Inst. Serial #	187447	Longitude	135°40'53.40"E
Sample Int.	15 min	Operator	AECOM	Latitude	34°56'22.98"S

LA90(Day) (7am-10pm)	24.1 dB(A)	LA90(Night) (10pm-7am)	31.9 dB(A)

Site Diagram - Aerial



Site Photographs

AECOM

Noise Monitoring Data Sheet

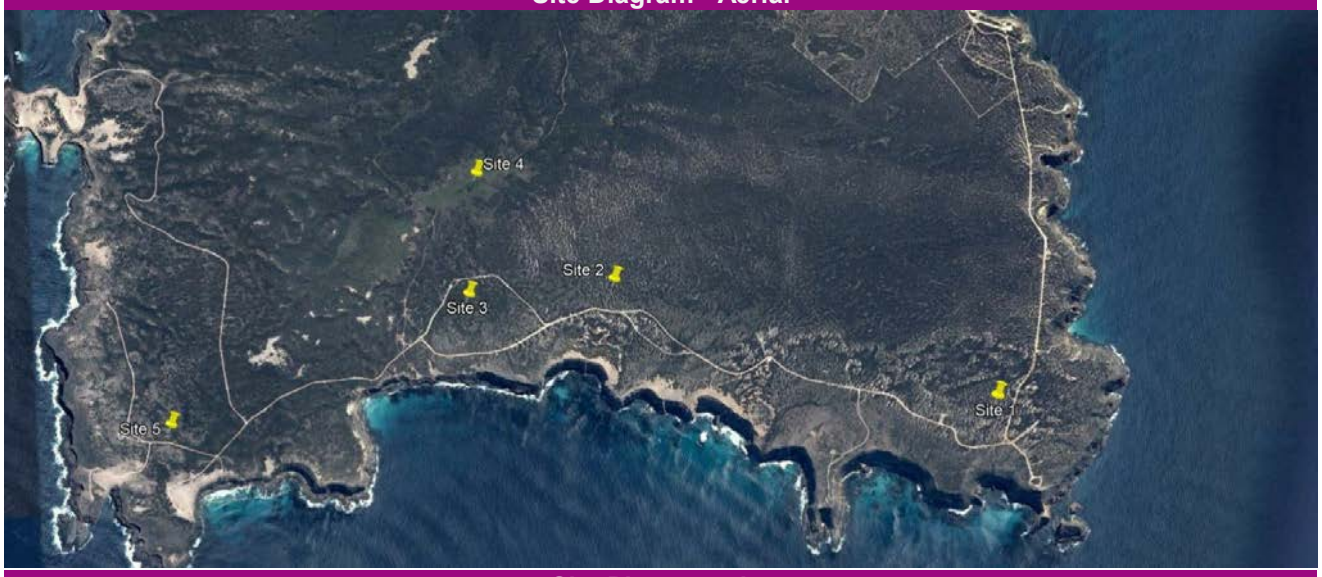
Southern Launch

SITE ID
2

From	17/03/2020 10:45	Mic. Height (m)	1.2 - 1.5 m	Address	Site 2
To	19/03/2020 14:30	Meas. Type	Environmental	Suburb	Whalers Way
Pre Calibration	94.0	Inst. Type	Rion NL-21	District	South Australia
Post Calibration	94.0	Inst. Serial #	409167	Longitude	135°39'23.72"E
Sample Int.	15 min	Operator	AECOM	Latitude	34°55'54.59"S

LA90(Day) (7am-10pm)	23.4 dB(A)	LA90(Night) (10pm-7am)	29.6 dB(A)

Site Diagram - Aerial



Site Photographs

AECOM

Noise Monitoring Data Sheet

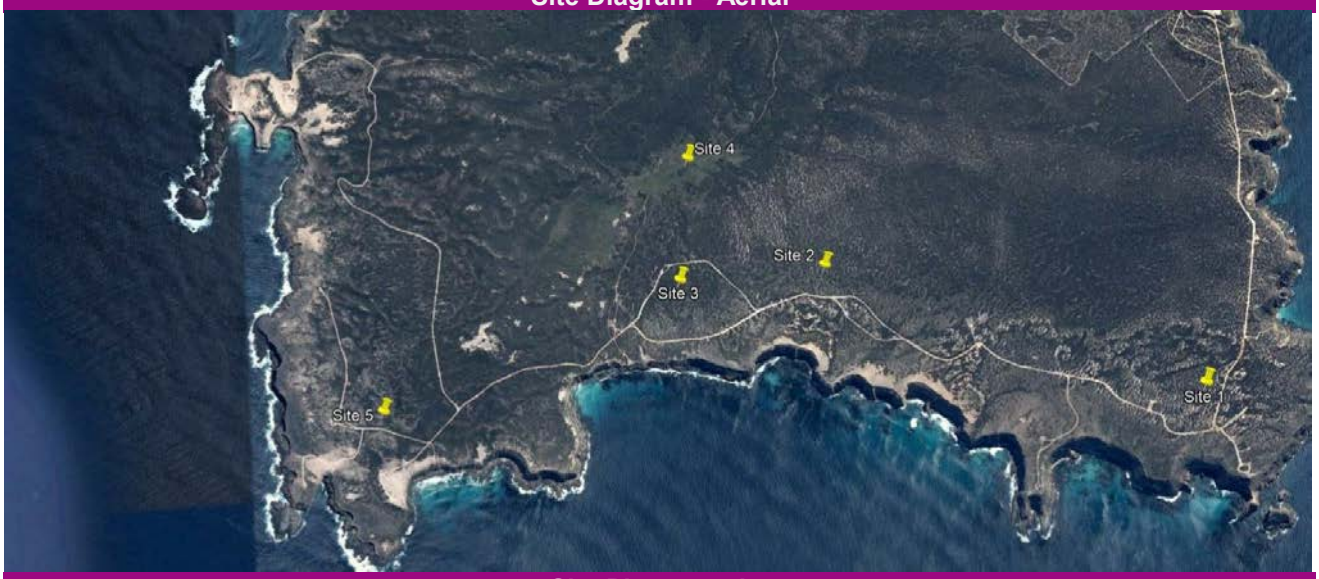
Southern Launch

SITE ID
3

From	17/03/2020 10:45	Mic. Height (m)	1.2 - 1.5 m	Address	Site 3
To	19/03/2020 14:15	Meas. Type	Environmental	Suburb	Whalers Way
Pre Calibration	94.0	Inst. Type	Rion NL-21	District	South Australia
Post Calibration	94.0	Inst. Serial #	409174	Longitude	135°38'48.77"E
Sample Int.	15 min	Operator	AECOM	Latitude	34°55'55.78"S

LA90(Day) (7am-10pm)	22.8 dB(A)	LA90(Night) (10pm-7am)	26.1 dB(A)

Site Diagram - Aerial



Site Photographs

Noise Monitoring Data Sheet

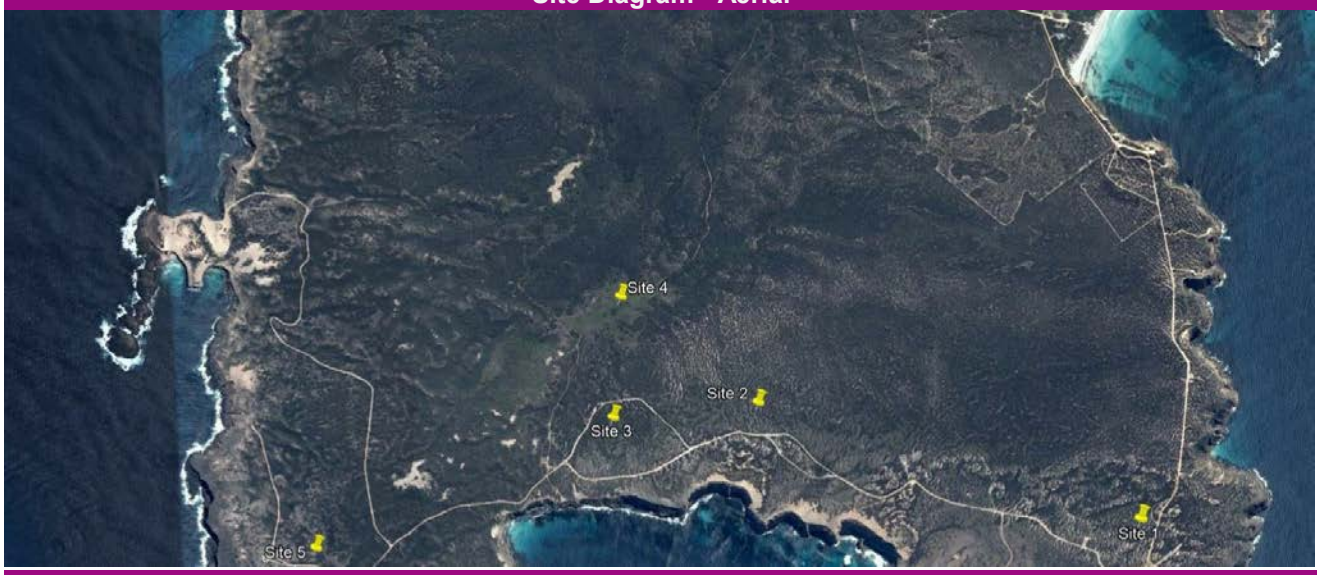
Southern Launch

SITE ID
4

From	15/03/2020 10:00	Mic. Height (m)	1.2 - 1.5 m	Address	Site 4
To	17/03/2020 13:00	Meas. Type	Environmental	Suburb	Whalers Way
Pre Calibration	94.0	Inst. Type	Rion NL-21	District	South Australia
Post Calibration	94.0	Inst. Serial #	465445	Longitude	135°38'52.48"E
Sample Int.	15 min	Operator	AECOM	Latitude	34°55'31.61"S

LA90(Day) (7am-10pm)	27.3 dB(A)	LA90(Night) (10pm-7am)	34.7 dB(A)

Site Diagram - Aerial



Site Photographs

Noise Monitoring Data Sheet

Southern Launch

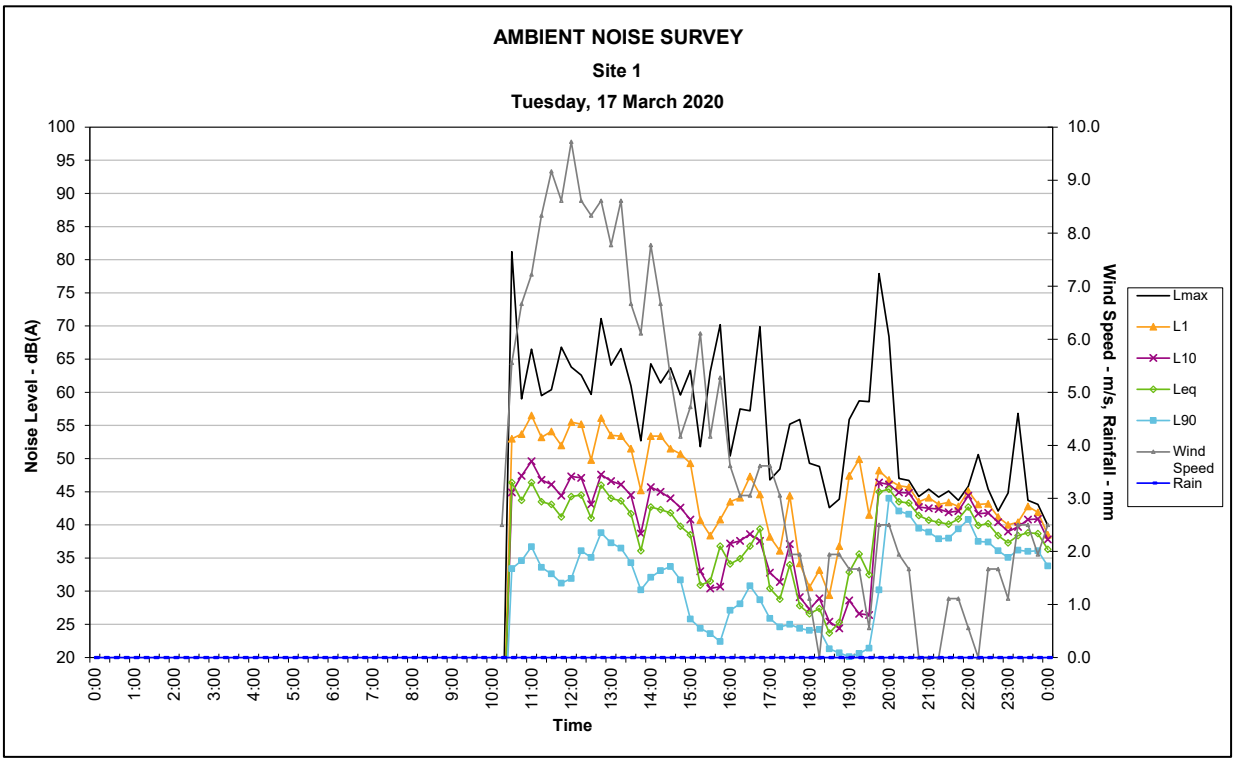
SITE ID
5

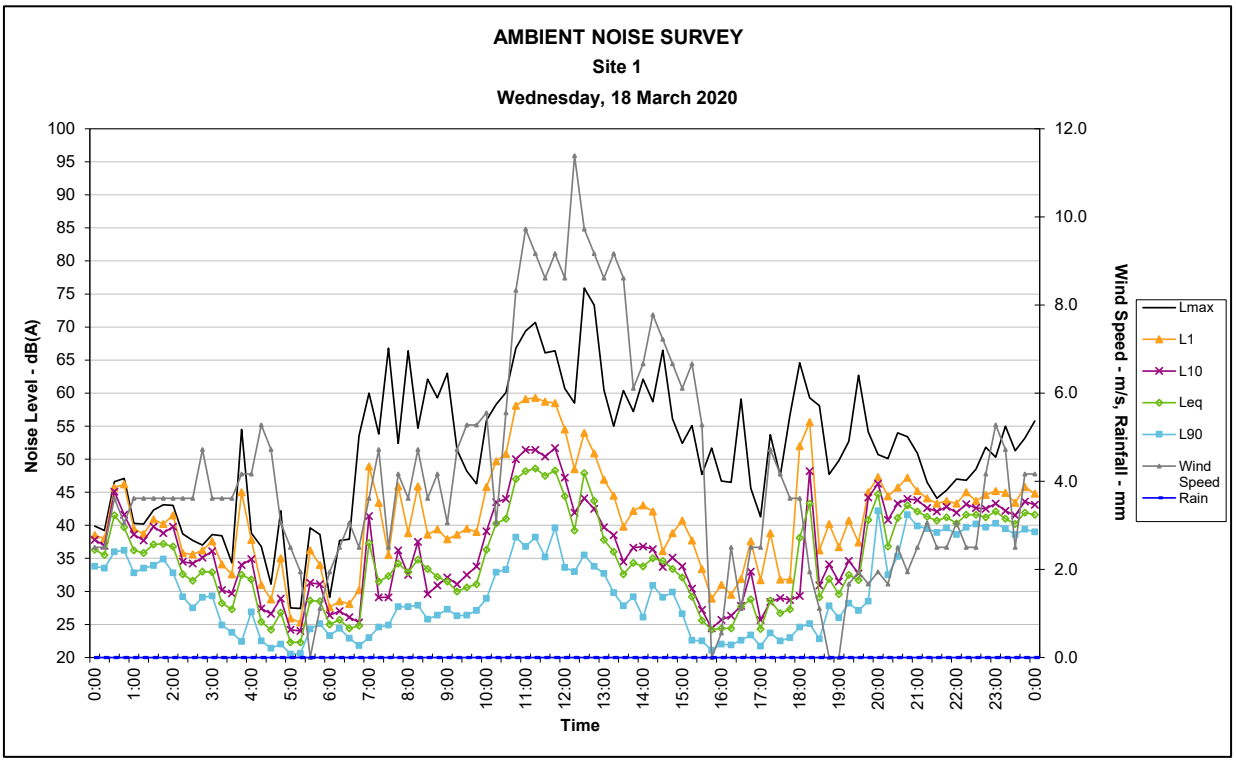
From	13/03/2020 8:00	Mic. Height (m)	1.2 - 1.5 m	Address	Site 5
To	15/03/2020 12:45	Meas. Type	Environmental	Suburb	Whalers Way
Pre Calibration	94.0	Inst. Type	Rion NL-21	District	South Australia
Post Calibration	94.0	Inst. Serial #	765699	Longitude	135°37'35.58"E
Sample Int.	15 min	Operator	AECOM	Latitude	34°56'18.21"S

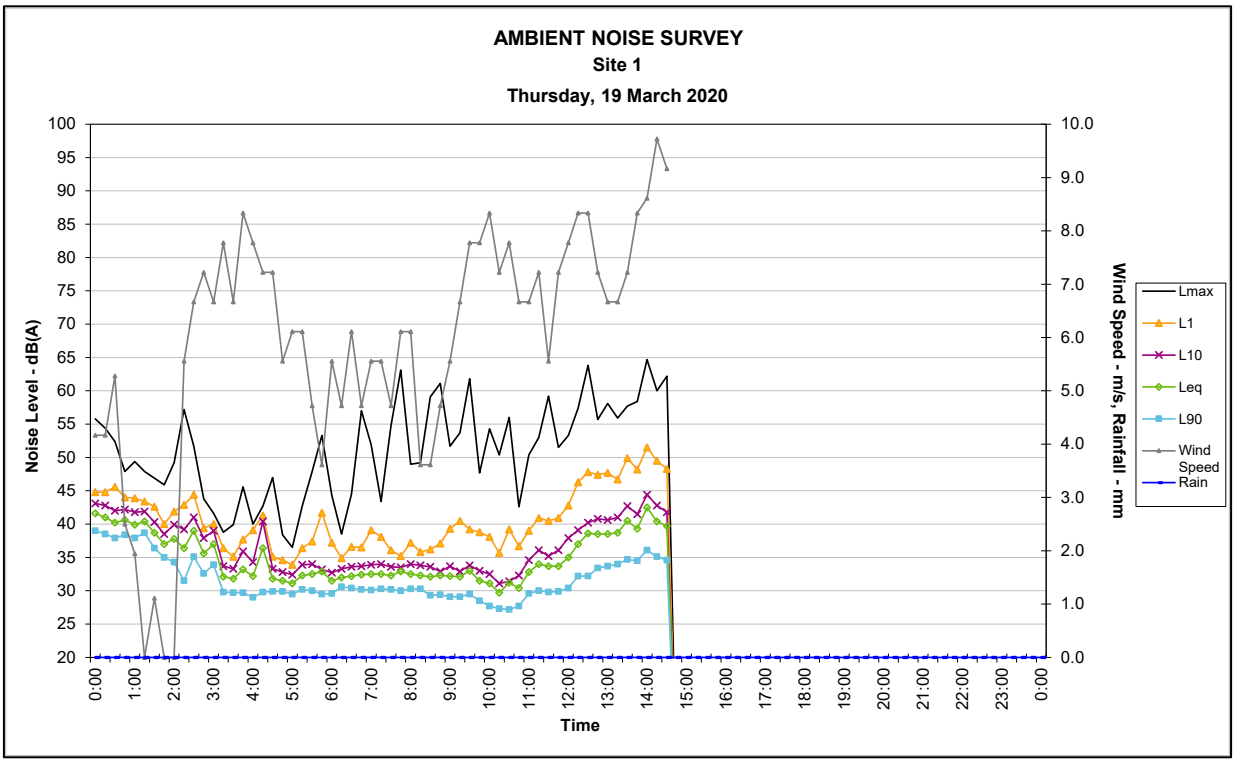
LA90(Day) (7am-10pm)	24.3 dB(A)	LA90(Night) (10pm-7am)	30.0 dB(A)

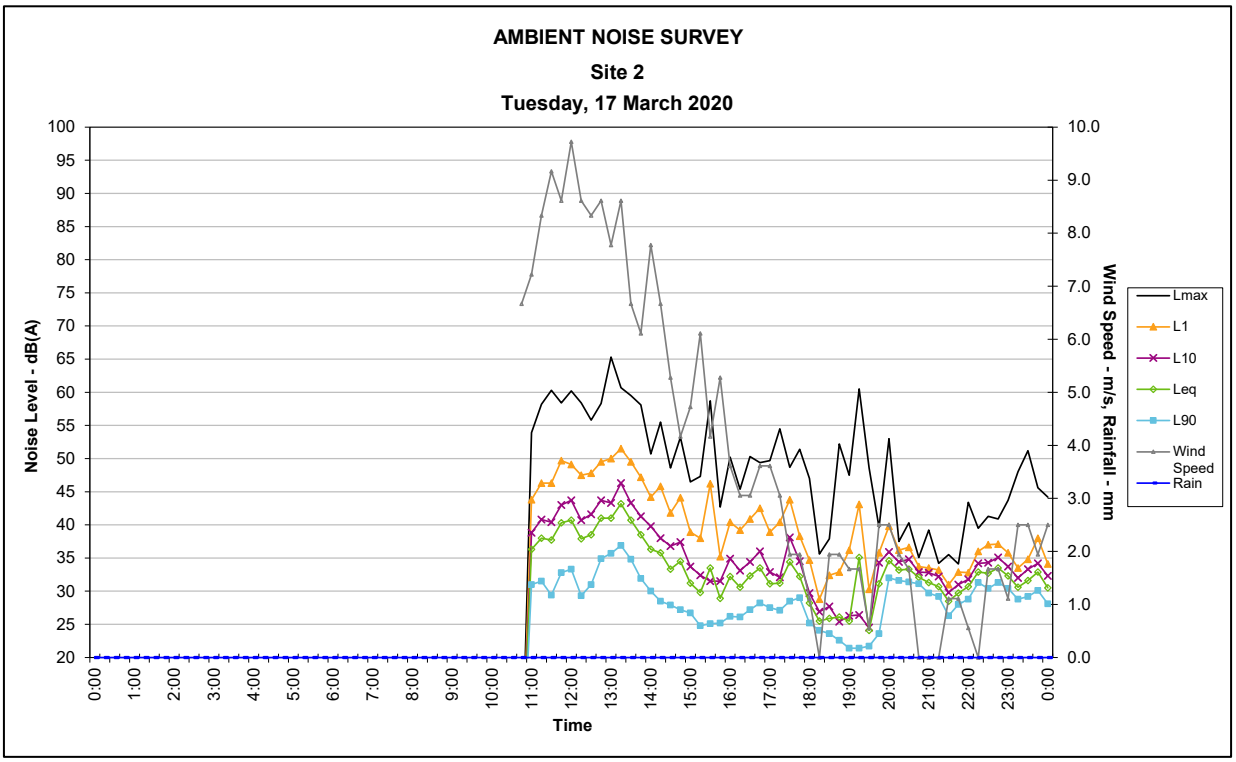
Site Diagram - Aerial

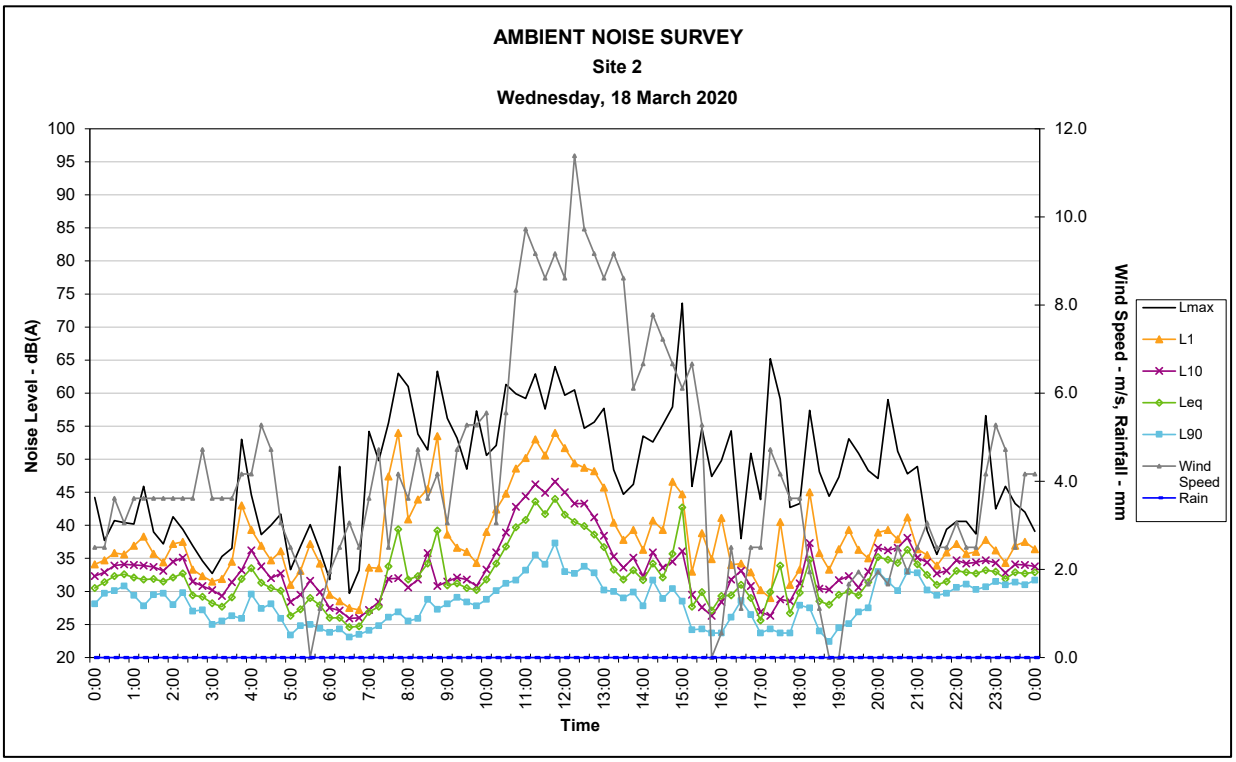
Site Photographs

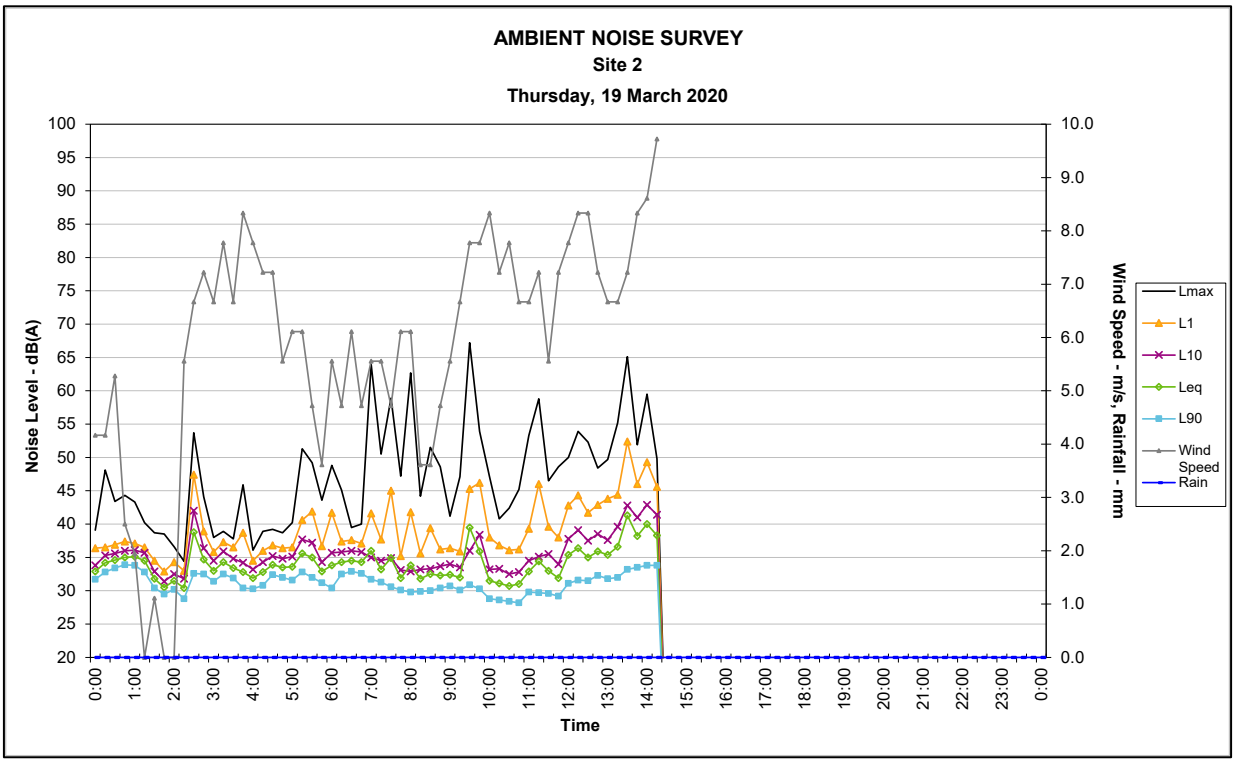

AMBIENT NOISE SURVEY
Site 1
Tuesday, 17 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

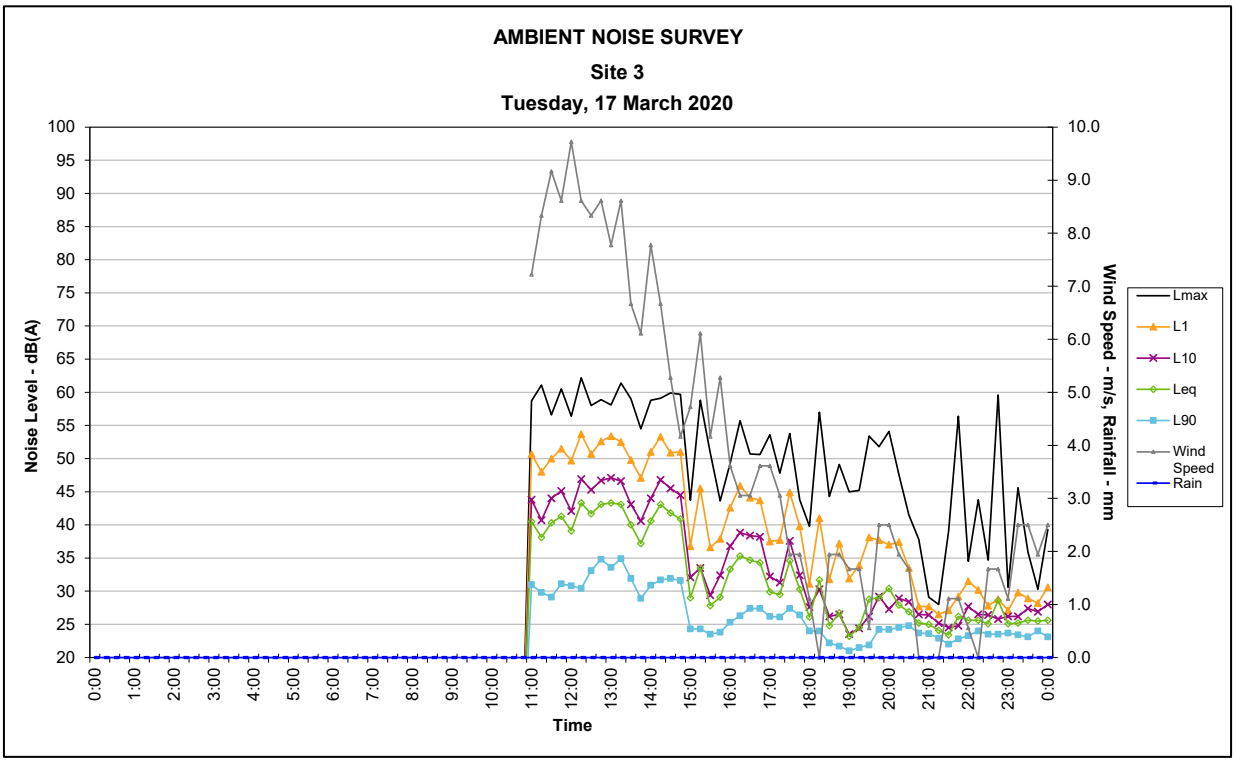

AMBIENT NOISE SURVEY
Site 1
Wednesday, 18 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

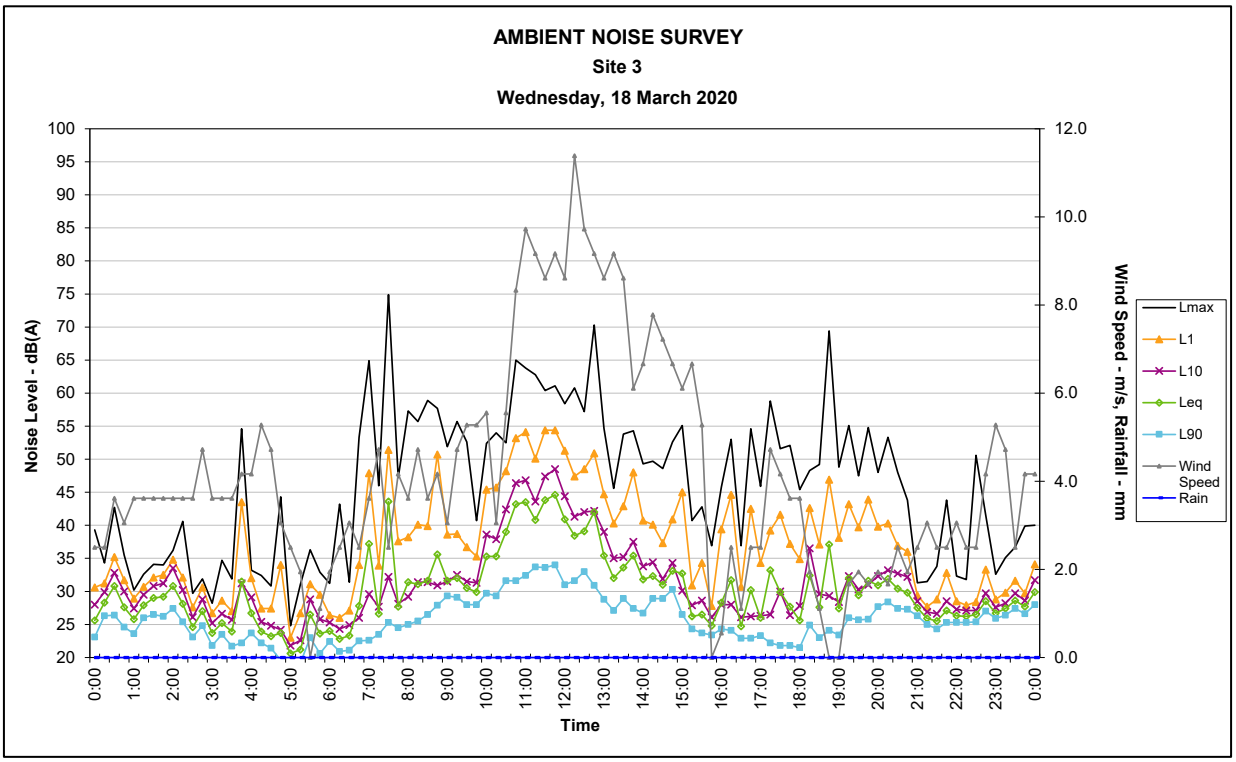

AMBIENT NOISE SURVEY
Site 1
Thursday, 19 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

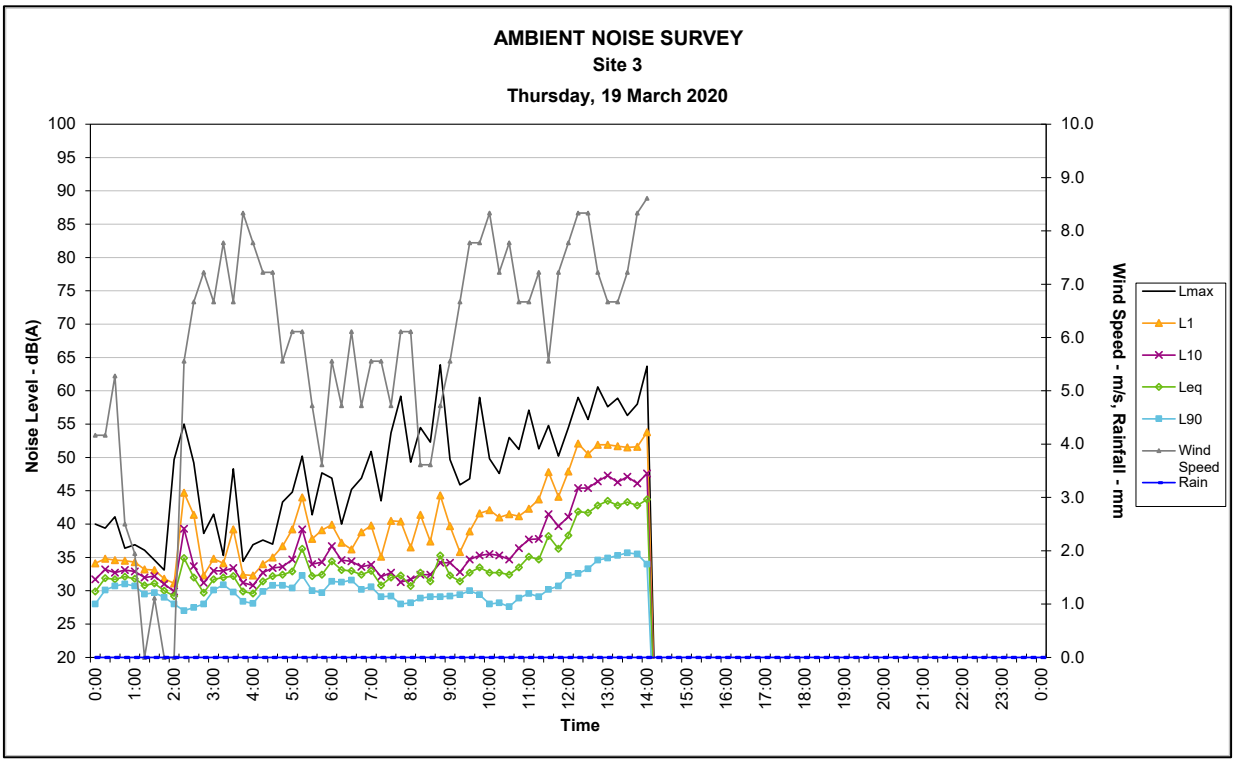

AMBIENT NOISE SURVEY
Site 2
Tuesday, 17 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

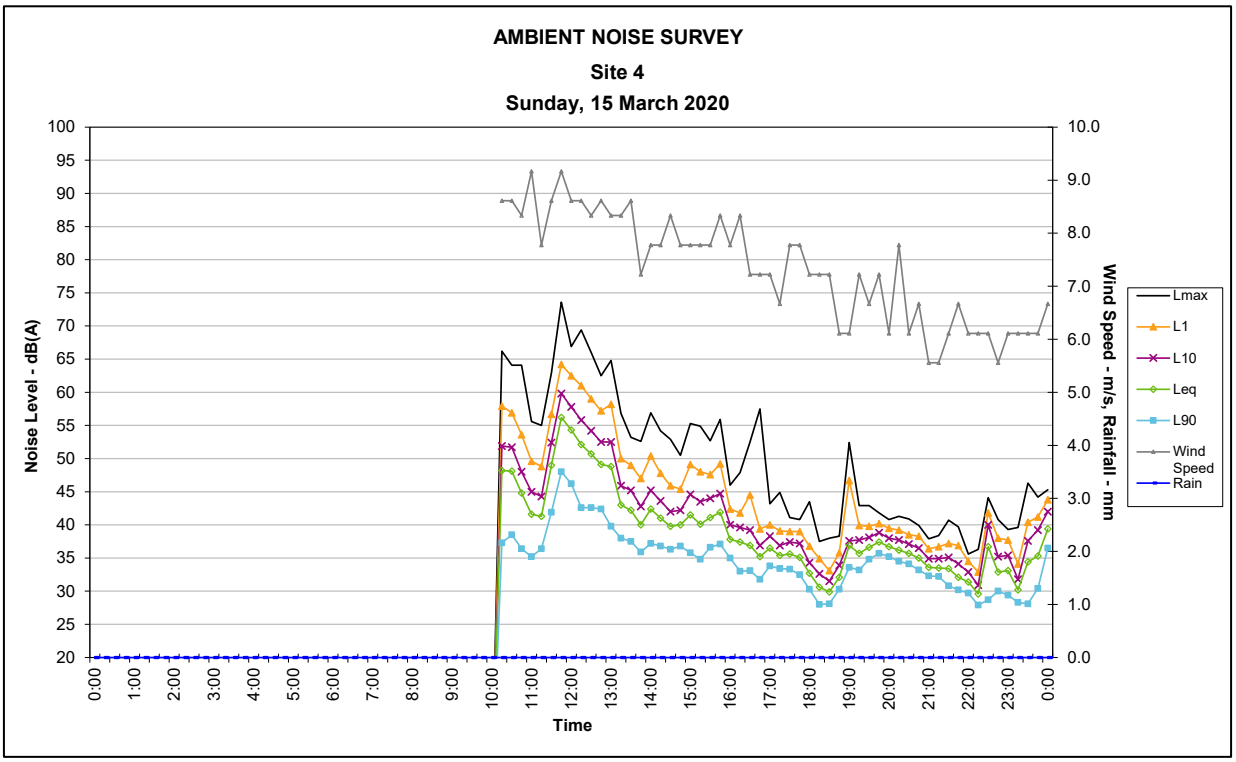

AMBIENT NOISE SURVEY
Site 2
Wednesday, 18 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

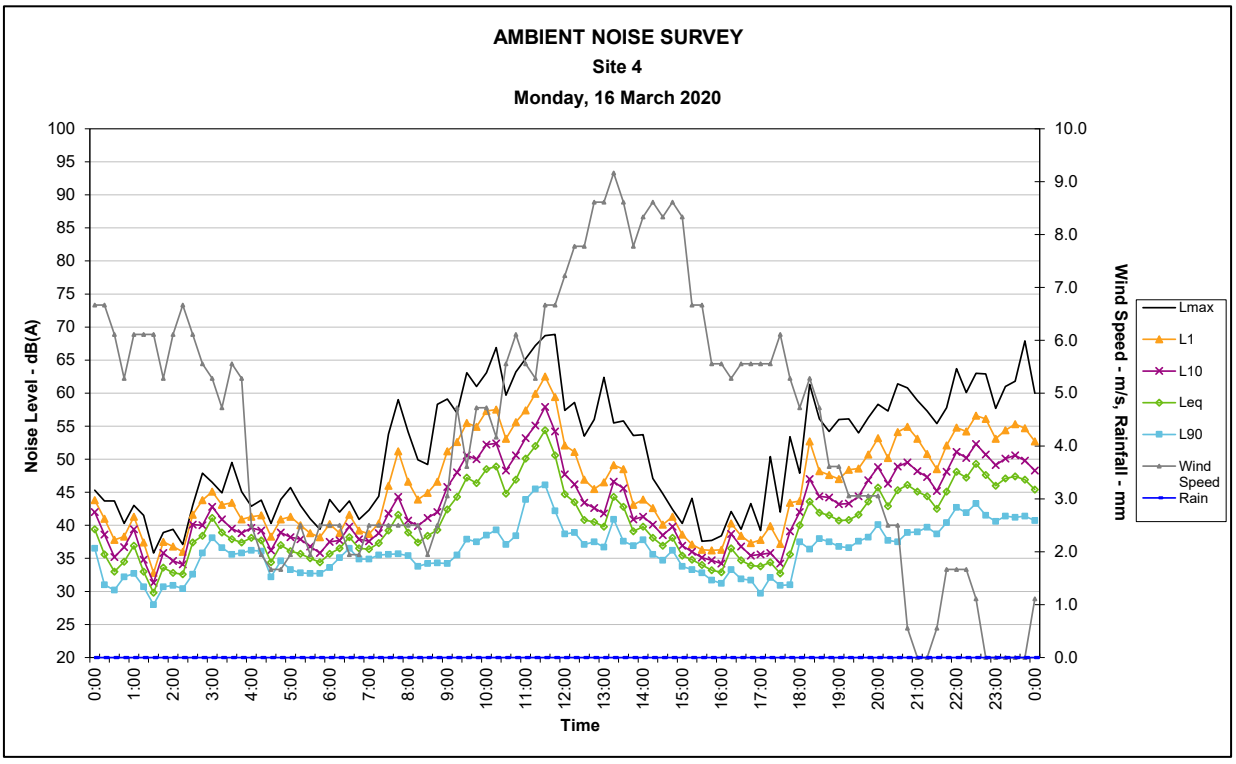

AMBIENT NOISE SURVEY
Site 2
Thursday, 19 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

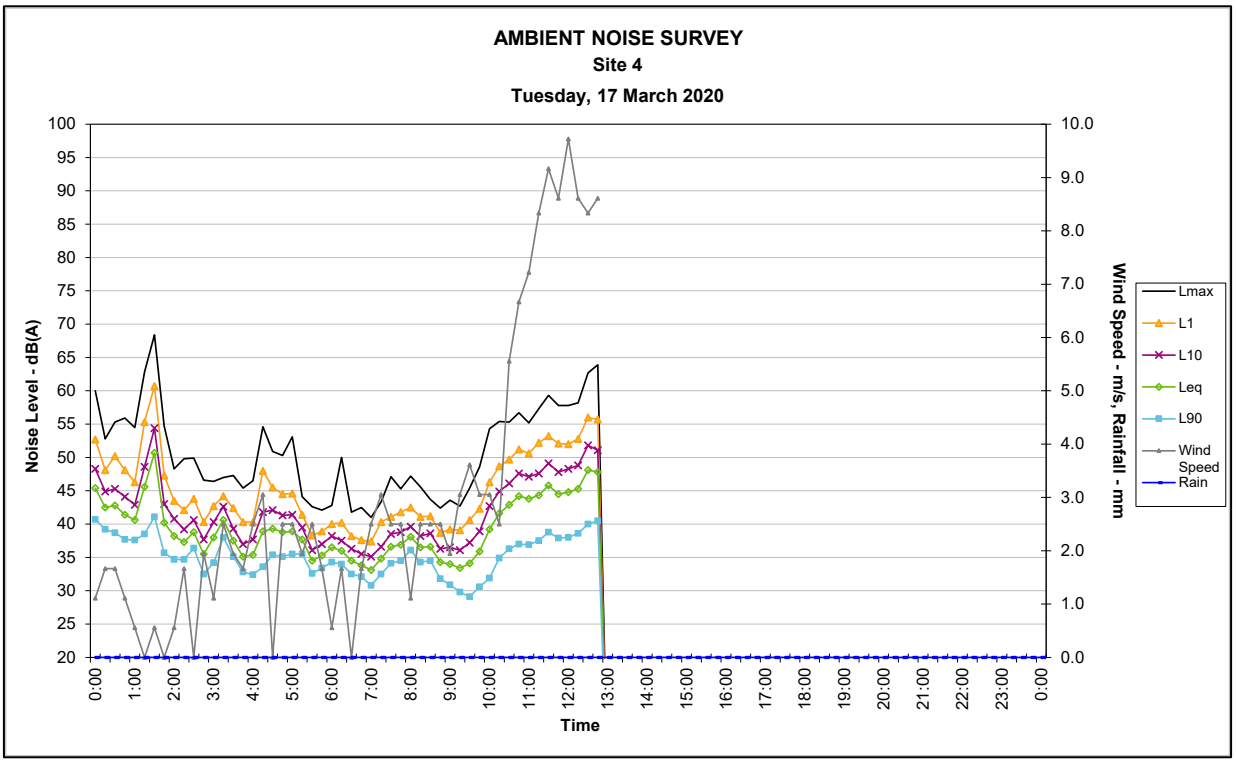

AMBIENT NOISE SURVEY
Site 3
Tuesday, 17 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

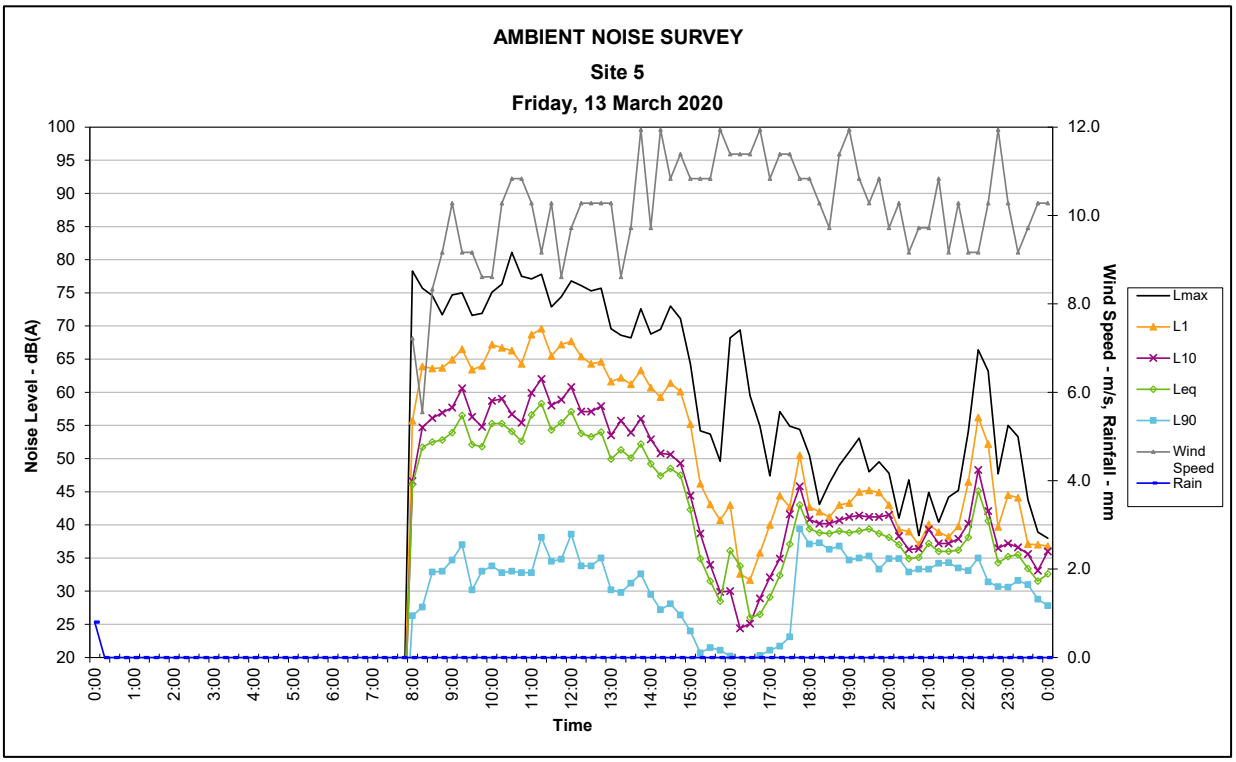

AMBIENT NOISE SURVEY
Site 3
Wednesday, 18 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

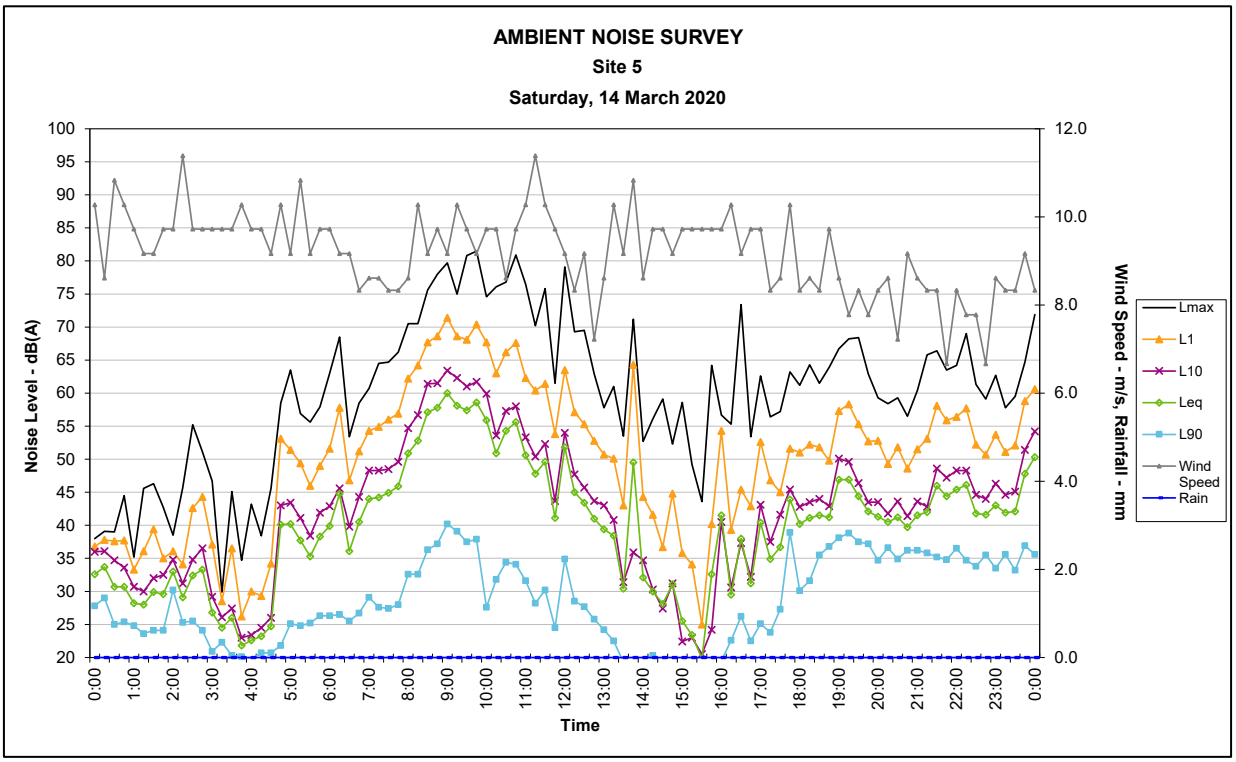

AMBIENT NOISE SURVEY
Site 3
Thursday, 19 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

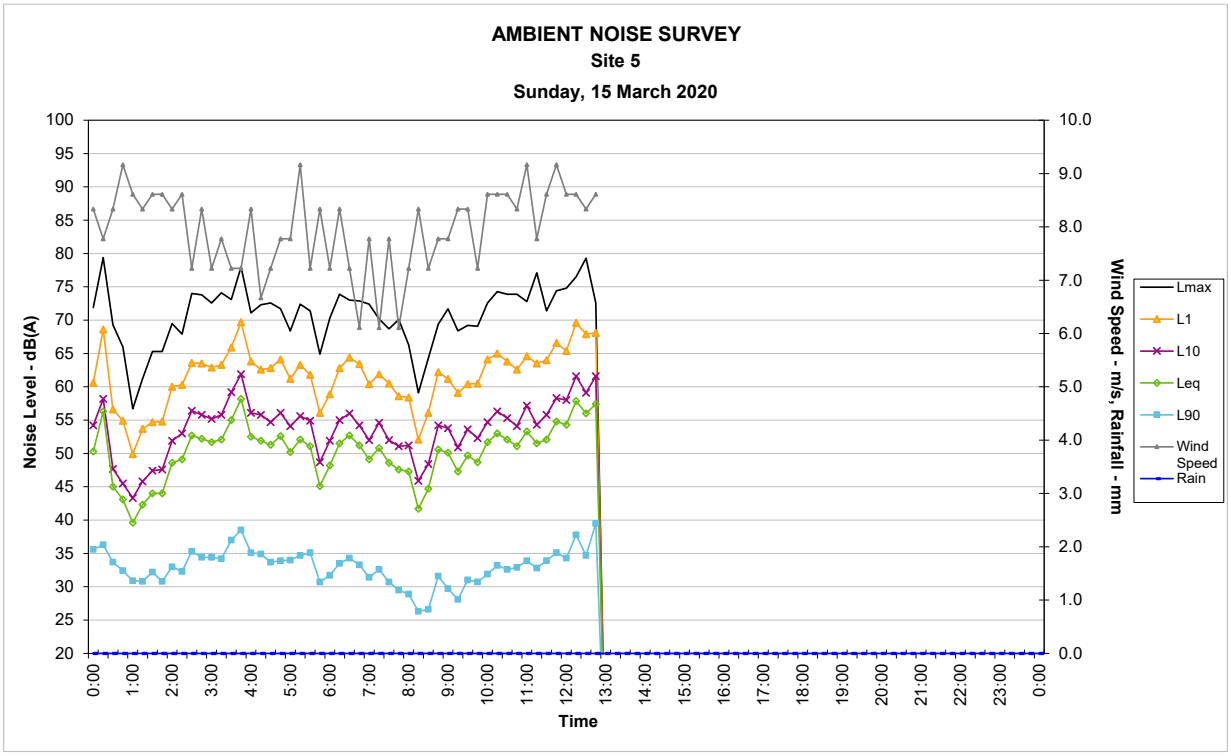

AMBIENT NOISE SURVEY
Site 4
Sunday, 15 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain


AMBIENT NOISE SURVEY
Site 4
Monday, 16 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain


AMBIENT NOISE SURVEY
Site 4
Tuesday, 17 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

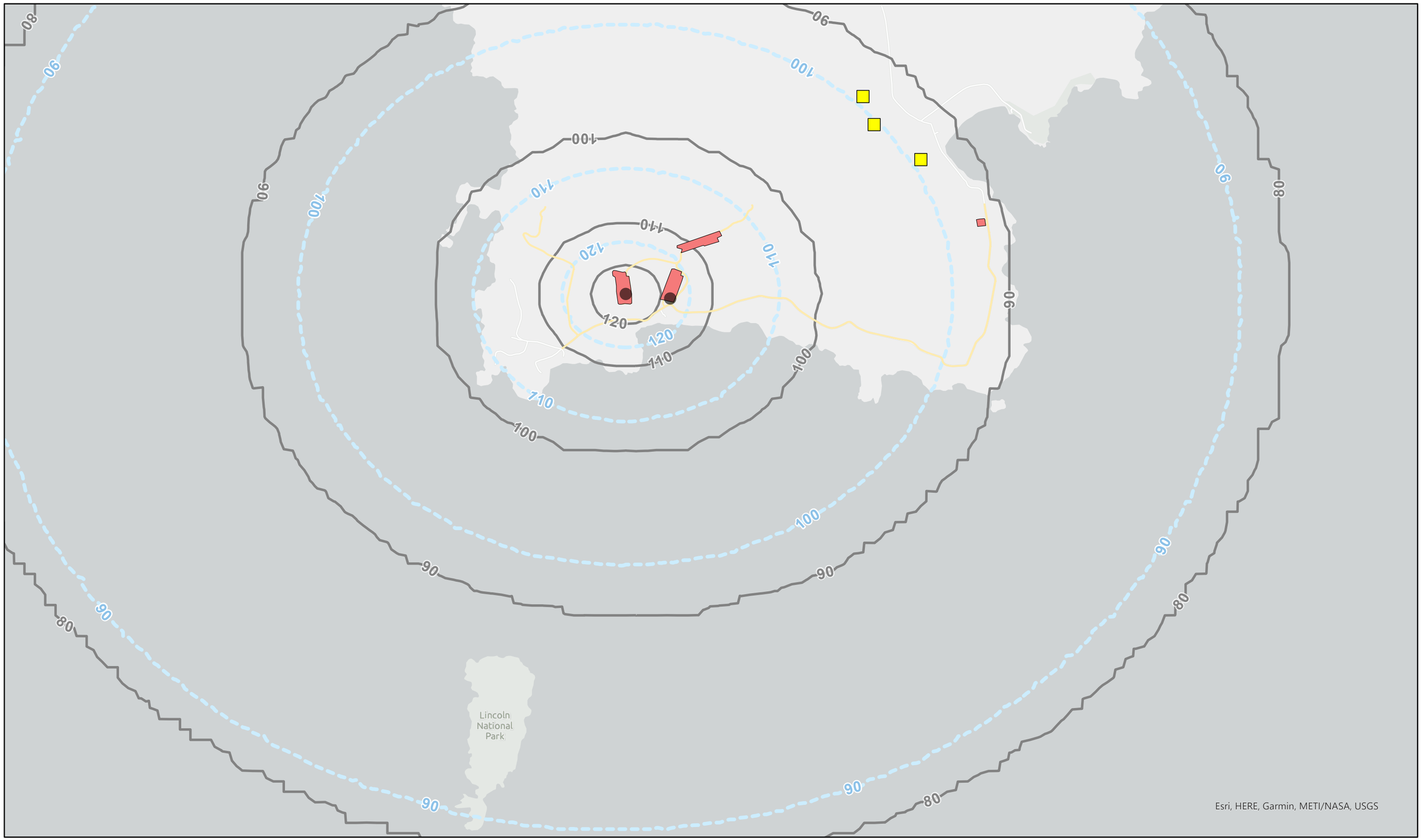

AMBIENT NOISE SURVEY
Site 5
Friday, 13 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain


AMBIENT NOISE SURVEY
Site 5
Saturday, 14 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain


AMBIENT NOISE SURVEY
Site 5
Sunday, 15 March 2020
Noise Level - dB(A)
Wind Speed - m/s, Rainfall - mm
Time
Lmax
L1
L10
Leq
L90
Wind Speed
Rain

Appendix C

Noise Contours



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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_{Amax} Noise Levels (dB)

- Falcon 9 (Site A)
- New Shepard (Site A)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

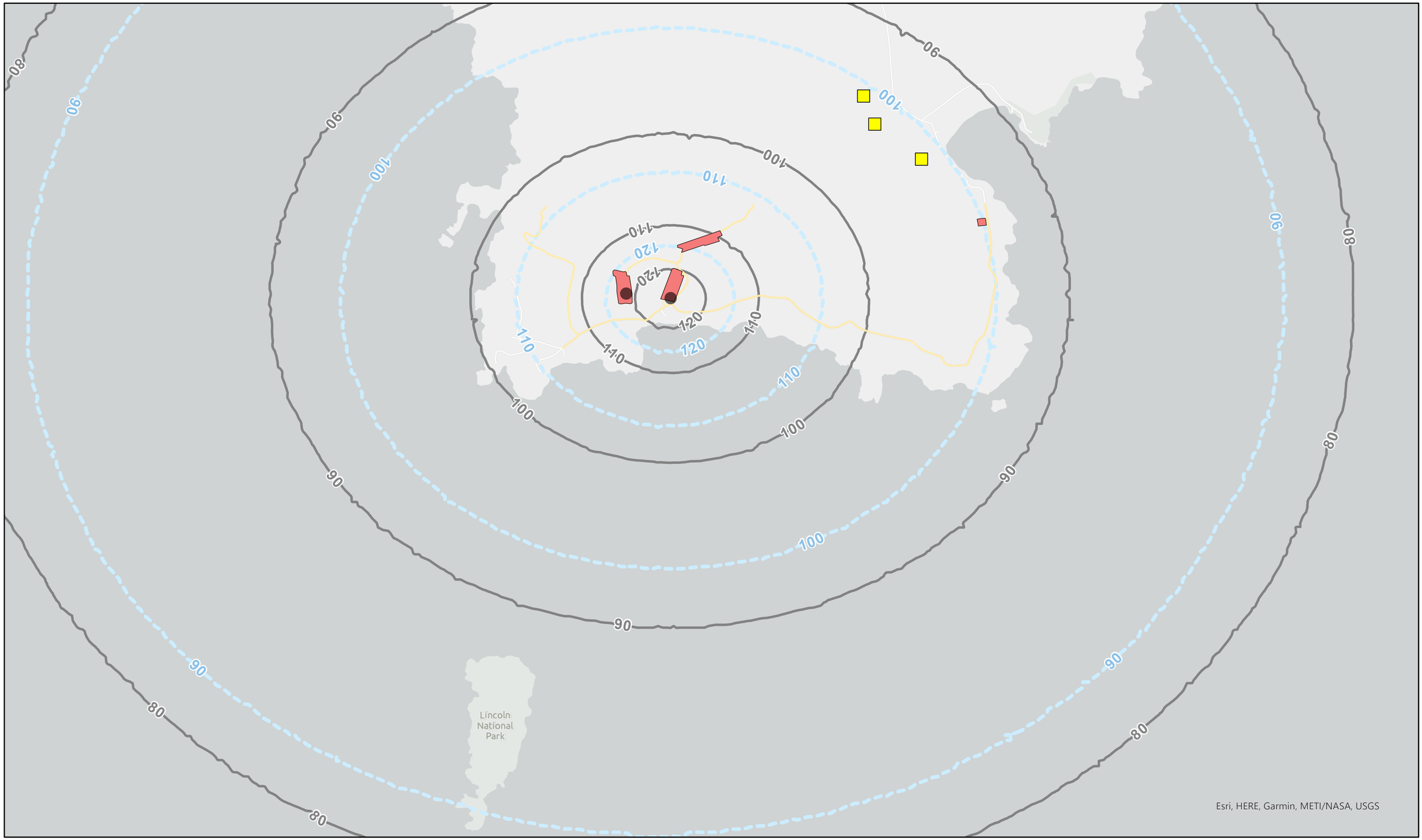
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{AMAX} NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE A

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
A

A3 size



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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_{Amax} Noise Levels (dB)

- Falcon (Site B)
- New Shepard (Site B)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

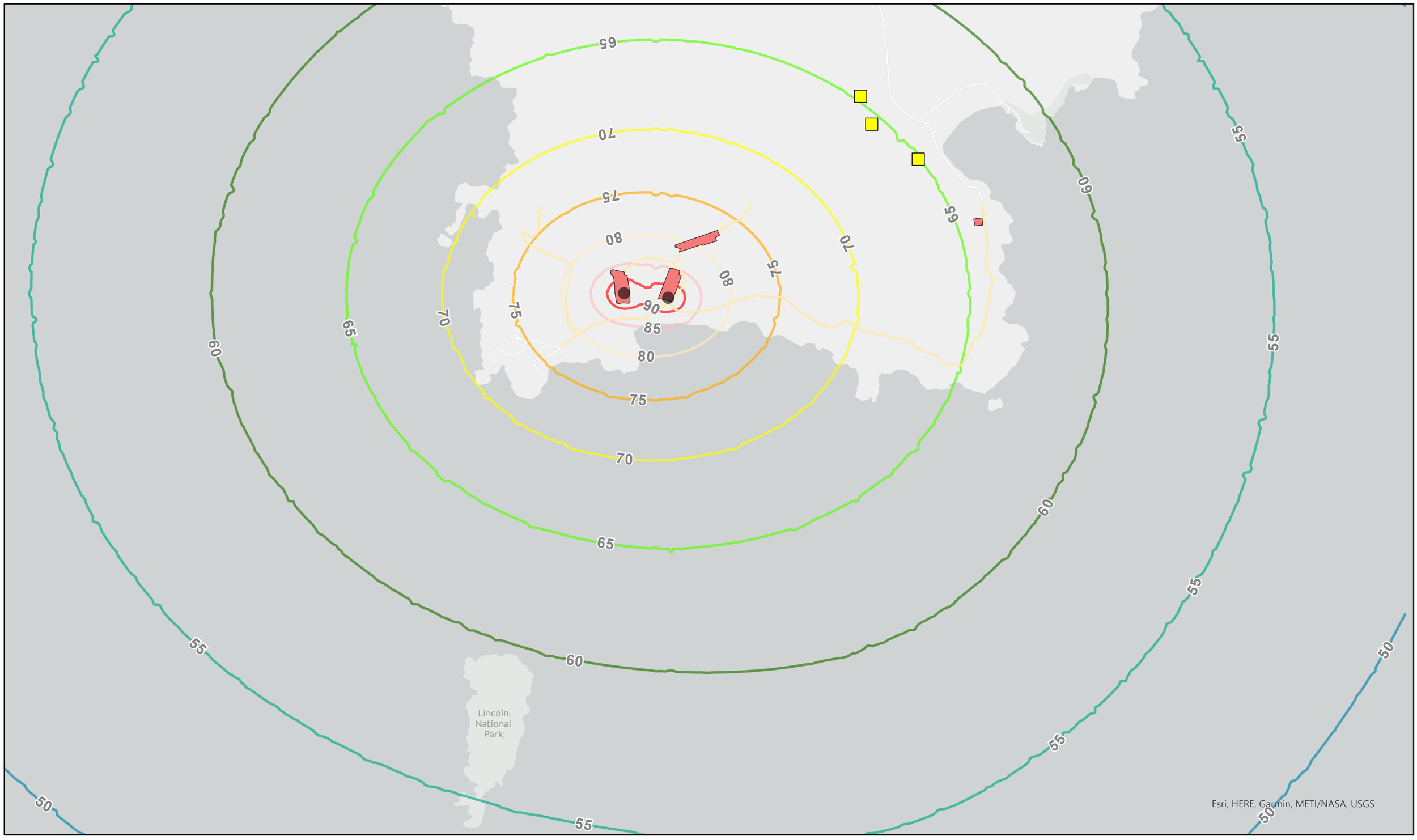
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{AMAX} NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE B

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
B

A3 size



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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3

Kilometers
(when printed at A3)

Day-night sound Level (DNL)

- 50 dB
- 55 dB
- 60 dB
- 65 dB
- 70 dB
- 75 dB
- 80 dB
- 85 dB
- 90 dB

- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

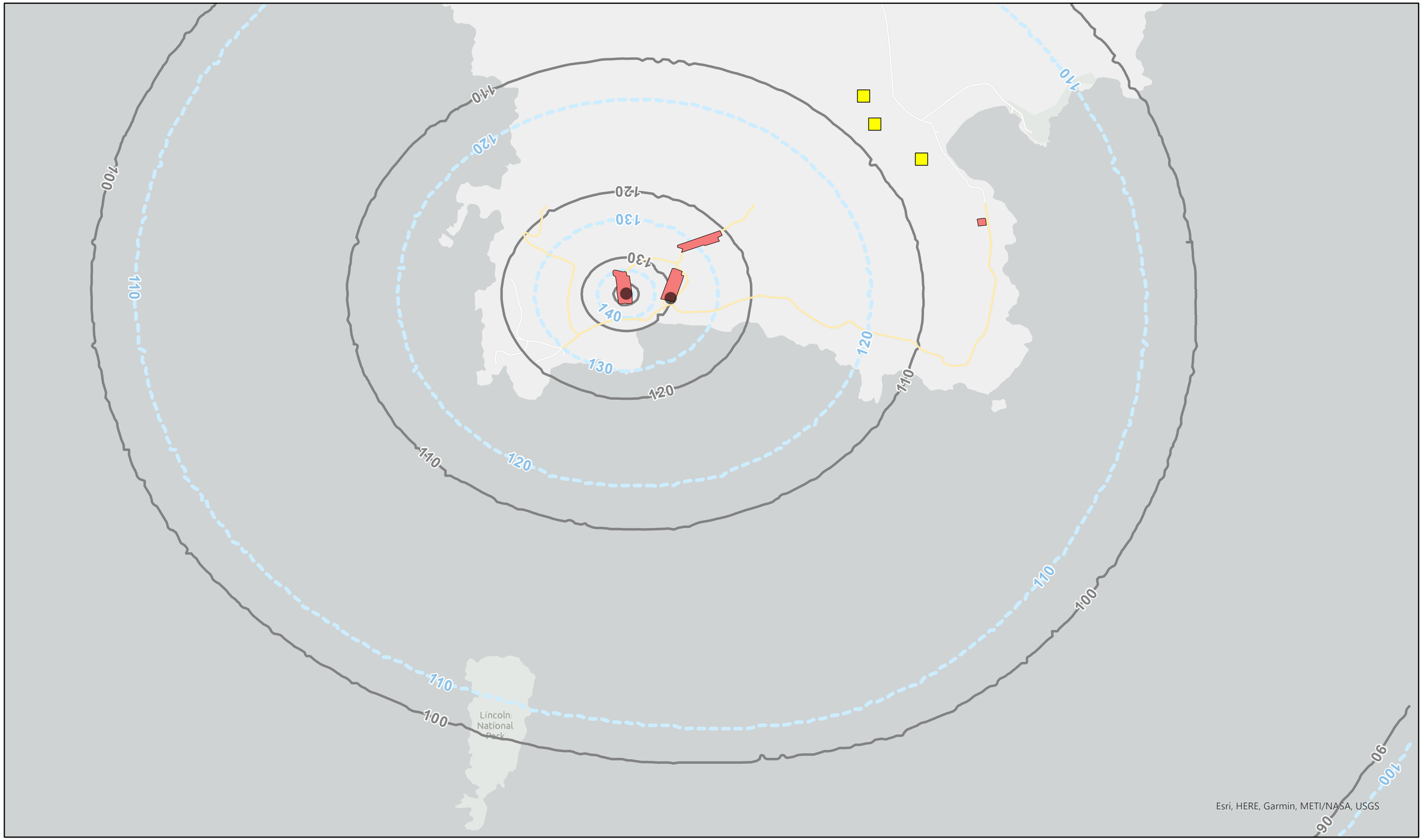
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

COMBINED DNL NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE A, SITE B AND TESTING AT SITE A

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
C

A3 size



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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_{AE} Noise Levels (dB)

- Falcon 9 (Site A)
- New Shepard (Site A)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

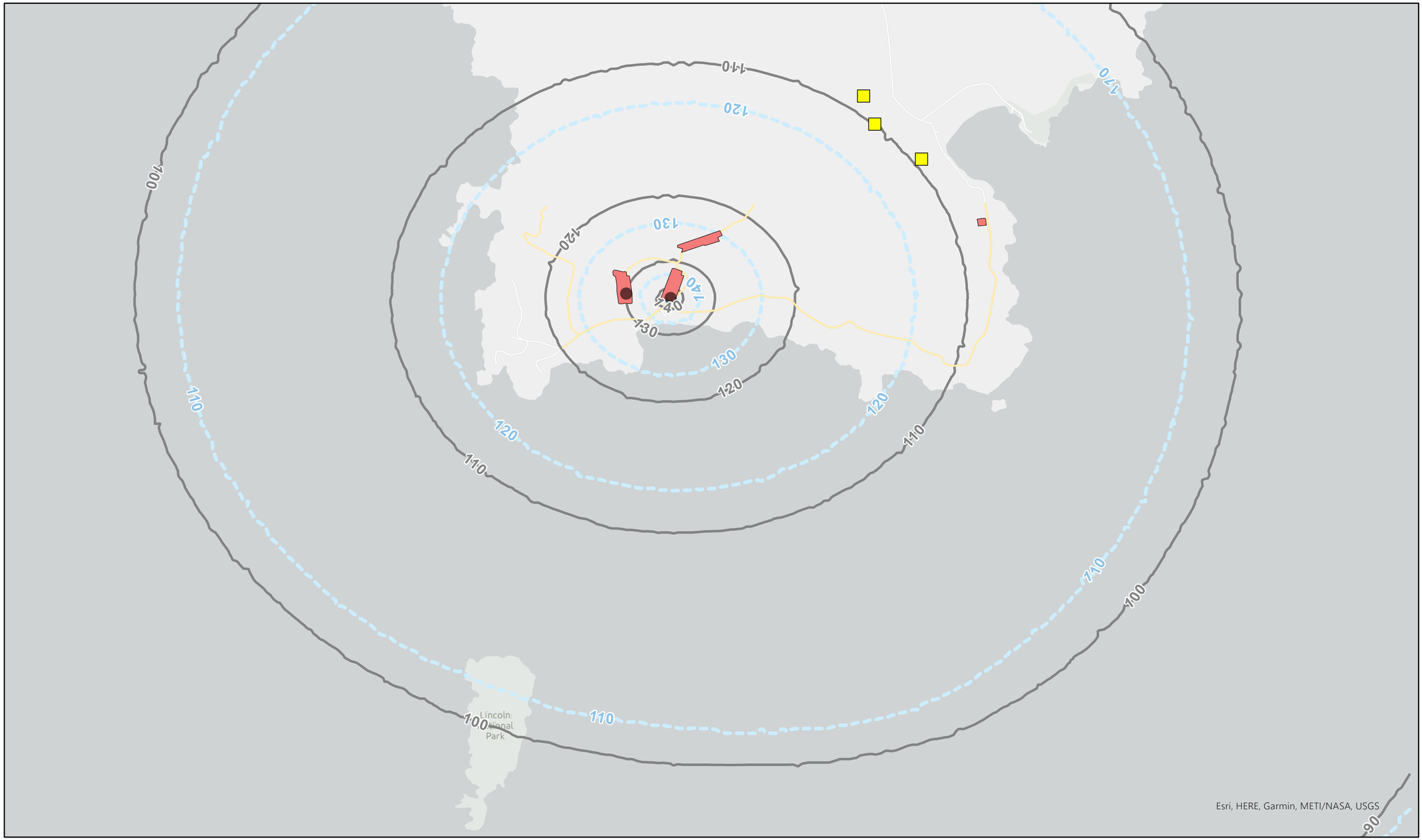
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{AE} NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE A

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
D

A3 size



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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_{AE} Noise Levels (dB)

- Falcon 9 (Site B)
- New Shepard (Site B)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

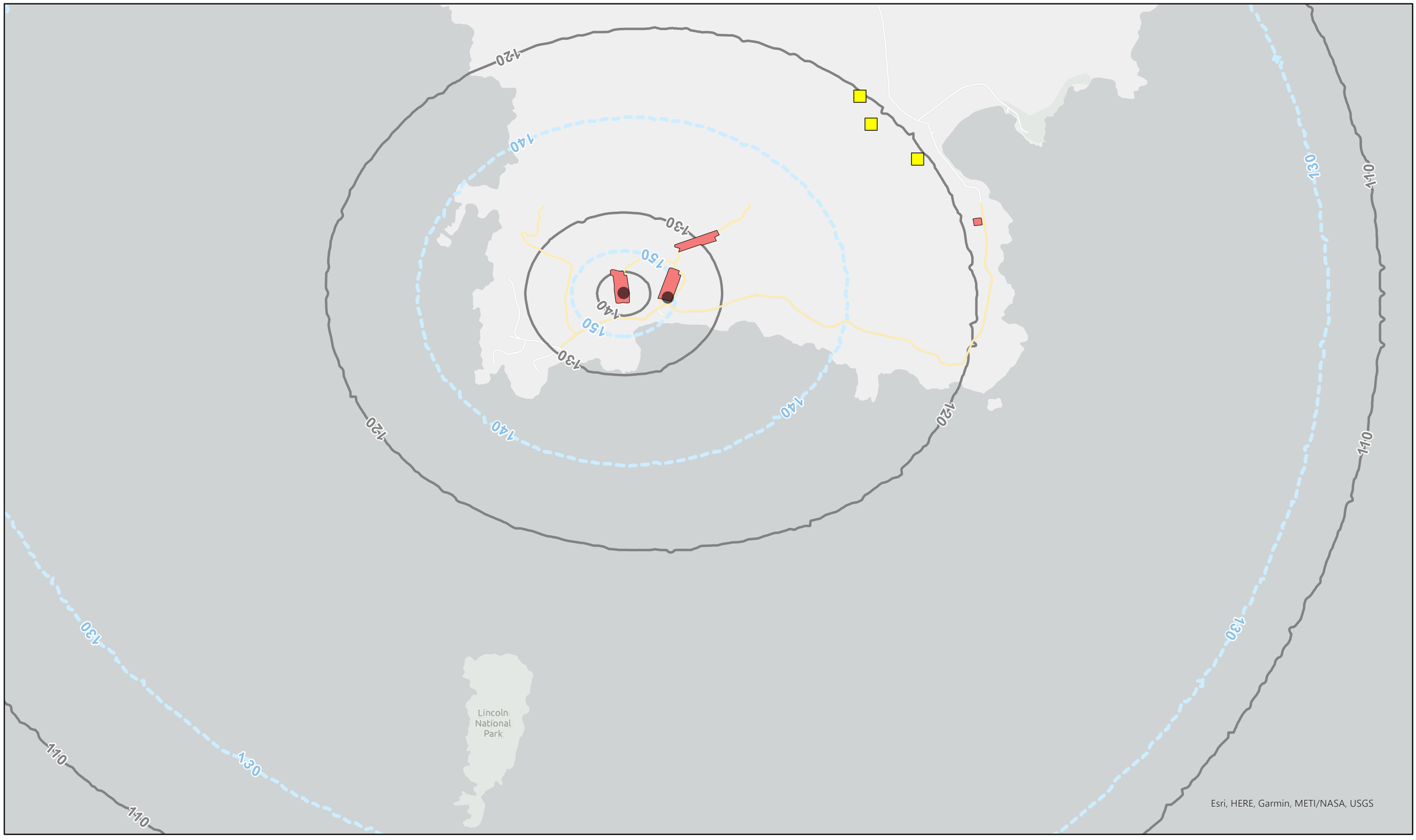
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{AE} NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE B

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
E

A3 size



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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3

Kilometers
(when printed at A3)

L_E Noise Levels (dB)

- Falcon 9 (Site A)
- New Shepard (Site A)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

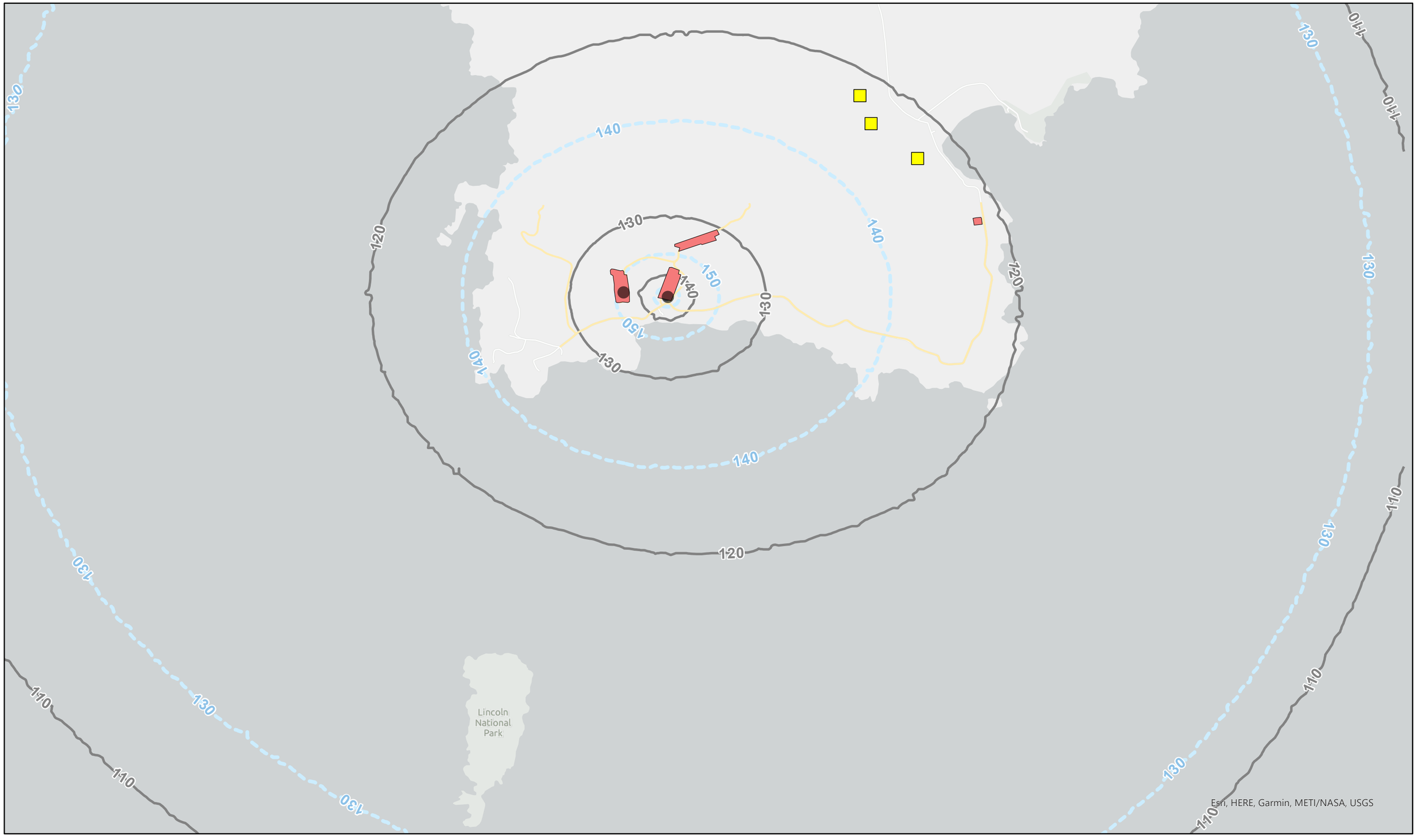
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_E NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE A

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
F

A3 size



PROJECT ID 60627263
CREATED BY LDE
LAST MODIFIED LDE 02 MAR 2022

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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_E Noise Levels (dB)

- Falcon 9 (Site B)
- New Shepard (Site B)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

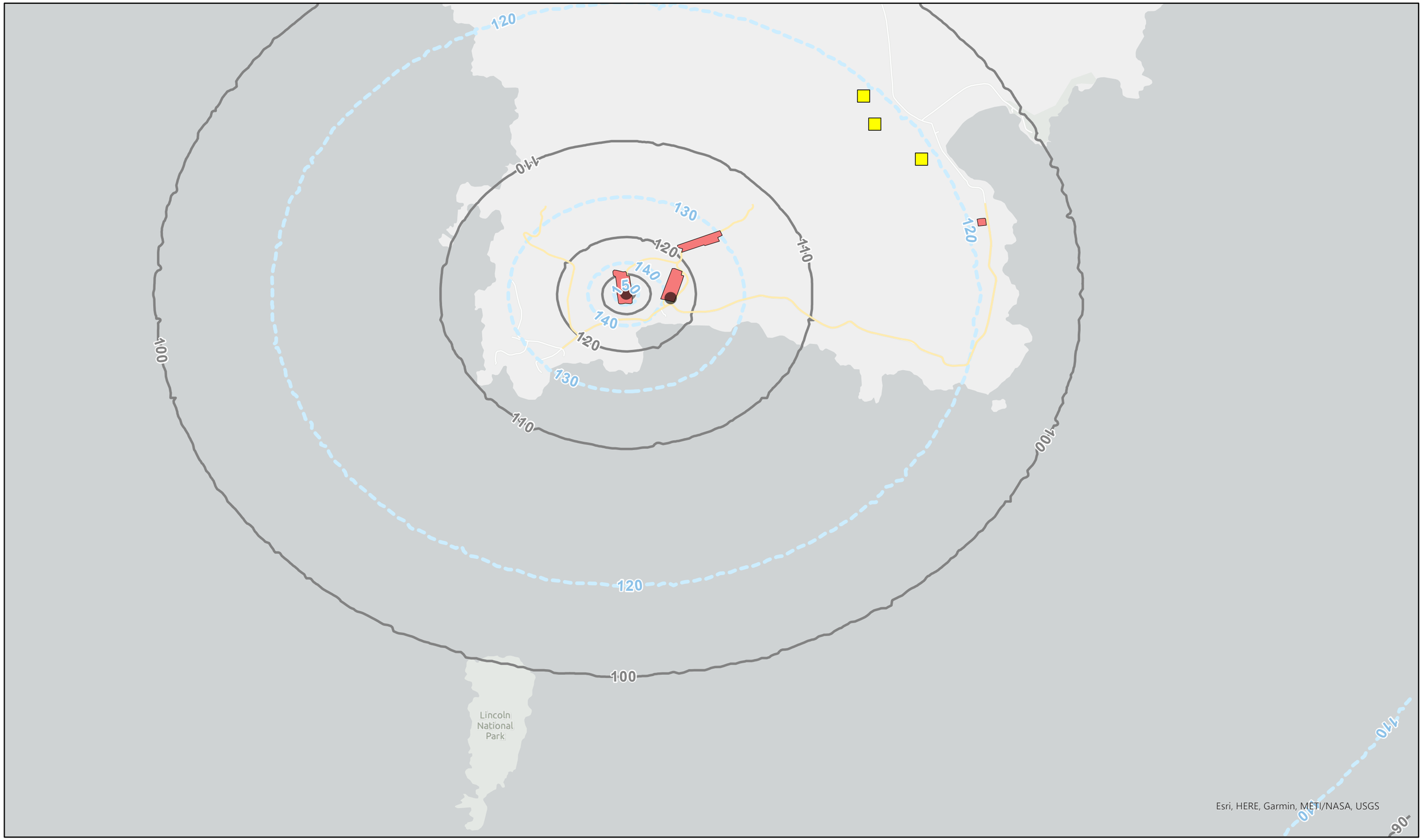
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_E NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE B

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
G

A3 size



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LAST MODIFIED LDE 02 MAR 2022

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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_{max} Noise Levels (dB)

- Falcon 9 (Site A)
- New Shepard (Site A)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

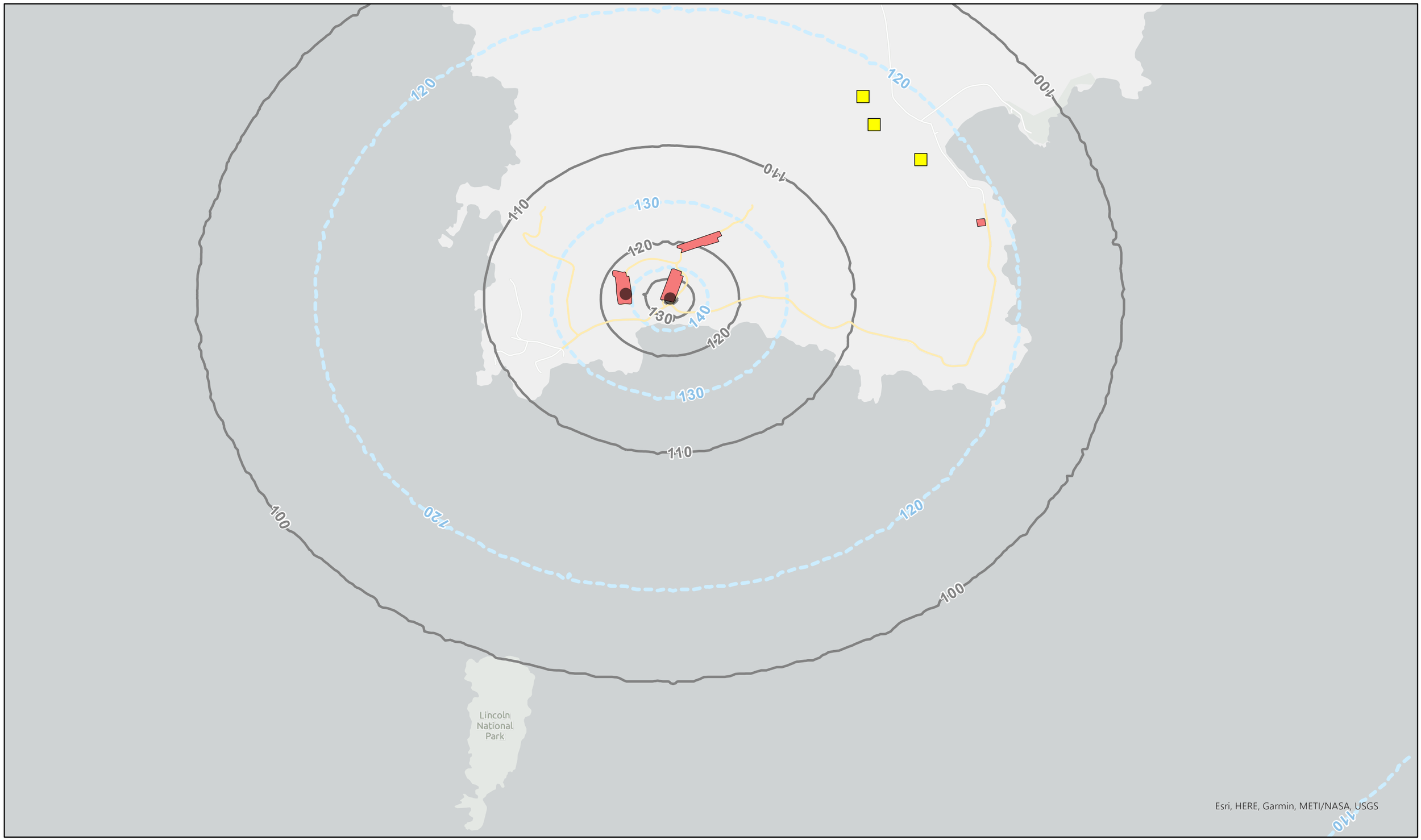
Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{MAX} NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE A

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
H

A3 size



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CREATED BY LDE
LAST MODIFIED LDE 02 MAR 2022

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N

DATUM GDA 1994, PROJECTION MGA ZONE 53

0 1.5 3
Kilometers
(when printed at A3)

L_{max} Noise Levels (dB)

- Falcon 9 (Site B)
- New Shepard (Site B)
- Southern Launch Infrastructure
- Residential Locations
- Southern Launch Tracks
- Launch Pad

Details within this map are to provide a prediction of the noise impacts for nominal launch scenarios for nominal rocket types at the project sites.

Airborne noise predictions have been carried out using Rumble 3.0 software. Contours should be considered indicative and used for planning purposes only.

CALCULATED L_{MAX} NOISE LEVELS FOR A ROCKET LAUNCH AT LAUNCH SITE B

Client: Southern Launch
Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise Assessment

Figure
I

A3 size

Appendix D

Wildlife criteria

Appendix D Wildlife criteria

A desktop study was undertaken of relevant scientific research that describes the impacts of noise on wildlife receptors. This step was considered important as there are limited standards, regulation and guidelines available for assessing airborne noise and ground vibration impacts in on wildlife.

Birds have been identified as the primary noise-sensitive receptors for this Project however mammal and reptile species have also been noted within the Project Area.

It was found that scientific information on the hearing sensitivity of local wildlife species to in-air sound is scarce or non-existent. In the absence of specific criteria, guidance for similar species and taxa have been used.

This information has been used to support the terrestrial and marine mammal assessments.

Birds

Noise and vibration have the potential to adversely affect wildlife and sensitive habitat located near construction and operational activities. Noise impacts may include changes in behaviour and physical harm, which have the potential to adversely impact sensitive wildlife populations.

The California Department of Transportation's *Technical Guidance for the Assessment and Mitigation of the Effects of Traffic Noise and Road Construction Noise on Birds* (Dooling & Popper, 2016) provides a comprehensive summary of the studied effects of noise on birds from the construction and operation of roads. The *Technical Guidance* recommended interim guidelines for potential effects to birds from different noise sources are presented in Table 40.

Table 40 Recommended interim guidelines for potential effects from different noise sources (Dooling & Popper 2016)

Noise source type	Noise effect			
	PTS onset L_{Amax}, dB(A)	TTS onset L_{Aeq}, dB(A)	Masking L_{Aeq}, dB(A)	Potential behavioural effects
Single impulse (for example, starter's pistol 6" from the ear)	140[1]	Not available[3]	Not applicable[5]	Any audible component of traffic and construction noise has the potential of causing behavioural and/or physiological effects. These are independent of any direct auditory effects on the auditory system of PTS, TTS or masking.
Multiple impulse (for example, jackhammer and pile driver)	125[1]	Not available[3]	50-60[6]	
Non-strike continuous (for example, construction noise)	Not applicable[2]	93[4]	50-60[6]	
Traffic and construction noise	Not applicable[2]	93[4]	50-60[6]	
Alarms (97 dB/ 100 ft)	Not applicable[2]	Not applicable[2]	Not applicable[7]	
Estimates based on bird data from Hashino et al. (1988) and other impulse noise exposure studies in small mammals. Noise levels from these sources do not reach levels capable of causing auditory damage and/or permanent threshold shift based on empirical data on hearing loss in birds from the laboratory. No data available on TTS onset in birds caused by impulsive sounds. Estimates based on study of TTS onset by continuous noise in the budgerigar and similar studies in small mammals. Cannot have masking from a single impulse. Conservative estimate based on addition of two uncorrelated noises. Above ambient noise levels, critical ratio data from 14 bird species, well documented short-term behavioural adaption strategies				

Noise source type	Noise effect			
	PTS onset L_{Amax}, dB(A)	TTS onset L_{Aeq}, dB(A)	Masking L_{Aeq}, dB(A)	Potential behavioural effects
and a background of ambient noise of a quiet suburban area would suggest noise guidelines in the range of 50-60 dB(A). Alarms are non-continuous; therefore, they are unlikely to cause masking effects.				

For a bird (based on the median data from masking studies on 14 bird species), Dooling & Popper (2016) suggest an interim guideline threshold of 50 dB(A) to assess where noise may begin to interfere with acoustic communication in birds.

The A-weighting, designed for the response of the human ear to sound is considered acceptable for birds, as humans hear just as well or better than birds over a much wider range of frequencies (Dooling & Popper, The effects of highway noise on birds, 2007). Accounting for variations in ambient noise environments, and variation in hearing sensitivity between individual birds and species, a precautionary threshold of 50 dB(A) has been adopted to identify where birds may be at risk of masking effects.

Noise emissions from construction and ground-based operational activities are expected to fall into the categories of multiple impulse noise, non-strike continuous, and traffic and construction noise, i.e. 93 dB(A).

Noise from a single impulse source is considered relevant to noise associated with the maximum noise produced by a rocket launch. Accordingly, the maximum noise produced by a rocket launch has been compared to the relevant PTS thresholds.

Mammals

The range of hearing for mammals and reptiles and the consequent sensitivity to anthropogenic noise are not as well researched. However, behavioural, and physical responses like those listed have been noted in available literature. Studies of terrestrial mammals have shown that noise levels of 120 dBA can damage mammals' ears, and levels at 95 dBA can cause temporary loss of hearing acuity (Wyle, 2003). It is likely that the possible impacts to mammals would be like birds noting that mammals would be unable to move away from the noise being produced as quickly and may be exposed to higher levels for longer.

Marine mammals

Marine mammals have a hearing sensitivity that is different to humans and other animals. Frequency weighting is a method to account for these differing sensitivities, particularly when considering whether a sound might affect an animal's hearing.

The frequency weighting used to describe the hearing of marine mammals has historically been referred to as M-weighting. Figure 7 shows a range of weighting functions for a range of marine mammal groups.

These curves emphasise the frequencies within the estimated hearing range of each group. This means that sounds at frequencies where hearing sensitivity is lower must be louder to have the same level of potential impact.

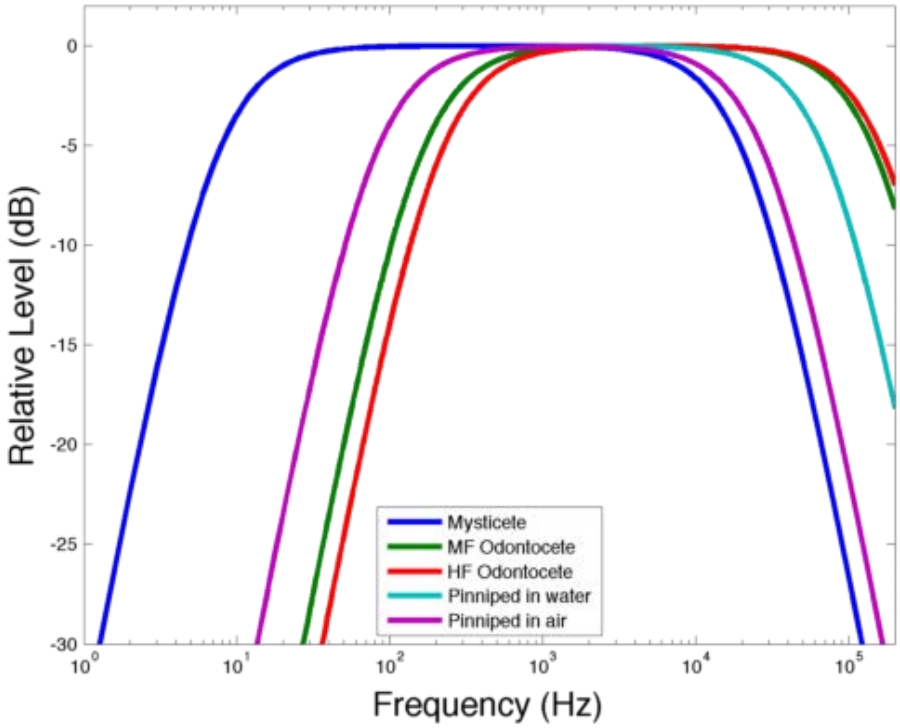


Figure 7 Weighting functions for marine mammals, M-weighting (Southall et al. 2007).

The M-weighted curves provide a means for interpreting sound from the perspective of marine mammals and allows for predicted values to be compared to relevant criteria. However, the tools and methodology used to calculate in-air noise levels for this assessment do not output single M-weighted decibel values.

Consequently, predicted noise levels need to be adjusted from the model output to an M-weighted value that can be compared to the relevant marine mammal criteria. The conversion between unweighted and M-weighted values for Other Marine Carnivores in air (OCA) and phocid carnivores in air (PCA) has been undertaken using the second equation and the values from Table 5 in Southall 2019 (see Table 41).

Table 41 M-weighting curve

M-weighting curve	Octave Band Centre Frequency, Hz							
	31.5	63	125	250	500	1k	2k	4k
OCA	-49.1	-40.7	-32.3	-24.0	-15.8	-8.4	-2.9	-0.3
PCA	-41.6	-29.9	-18.5	-8.8	-2.5	-0.1	-0.6	-4.3

For the calculation of rocket noise, the individual frequencies predicted at receptor located are embedded within the calculation software and not available to the user. Consequently, a single value adjustment (dB) to the overall level has been based on the difference between unweighted and M-weighted levels for a nominal rocket noise frequency spectrum.

Table 42 Unweighted and M-weighted values for operational rocket noise

Source	Weighting	Octave Band Centre Frequency, Hz[1]								Overall Level
		31.5	63	125	250	500	1k	2k	4k	
Nominal rocket noise	Unweighted	144.6	151.1	154.5	153.8	151.5	148.8	144.6	139.6	160
	M-weighted (OCA Curve)	110.4	122.1	129.9	135.6	140.4	141.7	139.3	134.1	146

Source	Weighting	Octave Band Centre Frequency, Hz[1]								Overall Level
		31.5	63	125	250	500	1k	2k	4k	
	M-weighted (PCA Curve)	121.2	136.0	145.1	149.0	148.7	144.0	135.3	134.4	153

1. Values have only be calculated where octave band data was available

An approximate adjustment of -7 dB has been assumed for the PCA weighting and -14 dB for the OCA weighting when referring to the overall unweighted rocket launch noise levels.

Specific criteria for the marine mammals relevant to this project have been presented in the marine technical report for Southern Launch.

C

RESONATE SPECIALIST ACOUSTIC ADVICE

Resonate

Southern Launch - Whalers Way Orbital Launch Complex

Environmental Noise Advice

A210940RP1 Revision 0

Thursday, 30 June 2022

Resonate

Document Information

Project	Southern Launch - Whalers Way Orbital Launch Complex
Client	Southern Launch
Report title	Environmental Noise Advice
Project Number	A210940

Revision Table

Report revision	Date	Description	Author	Reviewer
0	30 June 2022	First Issue	Nick Henrys	Darren Jurevicius

Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
DNL	Day-Night-Level (DNL) is the A-weighted equivalent continuous sound level for a 24 hour period with an additional 10 dB imposed on the equivalent sound levels for the night time hours between 10 pm and 7 am. The DNL is a metric used by the US Federal Aviation Administration and is not used in South Australian noise policy. The South Australian EPA's *Environmental Protection (Noise) Policy* uses a separate A-weighted equivalent continuous sound level criterion for both day and night (i.e. $L_{Aeq,day}$ and $L_{Aeq,night}$). DNL and $L_{Aeq,day}$ or $L_{Aeq,night}$ results must not be compared. Nevertheless, DNL is an appropriate metric for community noise assessment of single or cumulative events when assessed in context.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of loudness.
dB(A)	Units of the A-weighted sound level.
dB_{rms}	Root mean square sound pressure over the measurement period, expressed in dB re 1 µPa for underwater noise
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second.
L_{90}	Noise level exceeded for 90 % of the measurement time. The L_{90} level is commonly referred to as the background noise level.
$L_{eq,T}$	Equivalent Noise Level—Energy averaged noise level over the measurement time (T). Environmental noise criteria for prevention of human annoyance and sleep disturbance for continuous noise sources are often expressed as L_{Aeq}, for example in the South Australian EPA's *Environmental Protection (Noise) Policy.* Hearing damage prevention thresholds can also be expressed as equivalent noise levels where the potential for hearing damage to occur depends on both the sound pressure level and duration of exposure. For example the limit of 85 dB $L_{Aeq,8hrs}$ that applies under Australian WHS Regulations for workplace noise.
L_{max}	The maximum rms noise level. The Lmax or LAmax metric indicates the maximum sound level occurring for a fraction of a second (i.e. 125 milliseconds for 'fast' time weighting on a sound level meter). This metric is appropriate for community noise assessment of a single, brief event, such as a rocket launch. The maximum sound level is important in assessing the interference caused by a noise event with conversation, watching TV, sleep, or other activities. Although it provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the duration that the sound is heard.
L_{peak}	Peak sound pressure over the measurement period. L_{peak} is distinct from L_{max}, in that L_{peak} denotes the peak instantaneous sound pressure level in a raw waveform, while L_{max} is the maximum rms level 'averaged' over a brief period (typically 125 milliseconds). L_{peak} values are always higher than L_{max} for a given noise source.

M-weighting	Frequency weightings designed to best reflect the hearing sensitivity of marine mammals, similar to the use of the A-weighting for measuring noise impacts on humans. Noise levels for Low frequency cetaceans are expressed in decibels using the Low Frequency M-weighting function, annotated as dB(M_{lf})
Noise source	Premises or a place at which an activity is undertaken, or a machine or device is operated, resulting in the emission of noise
PTS	Permanent Threshold Shift. Irreversible and permanent reduction in auditory sensitivity.
SEL	Sound Exposure Level (SEL or L_E) is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event, and a period during which the event is heard. Mathematically, SEL represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Instead, it represents the total acoustic energy transmitted to the listener during an event. SEL is a useful metric for comparing the total acoustic energy transmitted by similar noise source activities (e.g. rocket launches). It is not suited for comparing to noise policy that has been fundamentally based on World Health Organisation (WHO) noise guidelines. For a rocket launch, SEL is expected to be greater than the L_{max}. Units are dB re 1 μPa^2s for underwater noise and dB re 20 μPa^2s for airborne noise
SEL_C / $SEL_{24\ hr}$	Cumulative Sound Exposure Level. Total sound energy over an exposure period, usually 24 hours when assessing impacts of noise on marine fauna (SEL_{24hr}).
SPL	Sound Pressure Level. The sound pressure averaged over the measurement period, usually expressed in dB re 1 µPa for underwater sound and dB re 20 µPa for airborne sound.
SWL	The Sound Power Level (SWL) is a measure of the acoustic energy emitted from a source of noise, expressed in decibels
TTS	Temporary Threshold Shift. Short-term reversible reduction in auditory sensitivity. TTS will be gradually reversed upon removing exposure to the high noise levels that cause the change in hearing sensitivity.

Table of Contents

1 Introduction

Resonate have been engaged to provide technical advice on potential noise impacts on terrestrial and marine fauna from launch activities at the Whalers Way Orbital Launch Complex. This advice is intended to be supplementary to, and should be read in conjunction with, the *Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration*, prepared by AECOM (28 April 2022).

The purpose of this advice is provide context and interpretation of airborne noise levels predicted by AECOM, for the purpose of assessment of potential impacts on fauna. Airborne noise levels are also converted to underwater noise levels for comparison with relevant criteria for marine fauna relating to potential adverse effects on marine fauna that could be present in the project area.

This advice also includes prediction of noise emissions from a Vega (137 tonne) rocket launch to supplement AECOM's predictions of noise from New Shepard (75 tonne) and Falcon 9 (549 tonne).

This report is not intended to form a standalone assessment of potential noise impacts on listed species and ecological communities. Rather, marine and terrestrial ecology specialists will undertake those assessments using the *Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration* and the supplementary advice contained in this report as inputs.

2 Marine and Terrestrial Fauna Noise Criteria

2.1 Background

Sound pressures are measured with a hydrophone when underwater and a microphone when in air. The international standard unit of sound pressure is the Pascal (Pa). Sound pressures encountered underwater and in air range from levels just detectable by the mammal ear (hundreds of micro Pascals (µPa)) to much greater levels causing hearing damage (billions of Pa). Because this range is so enormous, sound pressure is normally described in a logarithmic scale in terms of a sound pressure level (SPL) with units of decibel (dB), referenced to a standard pressure of 1 µPa for underwater and 20 µPa for airborne acoustics.

Due to the different reference levels, density and speed of sound in air and water media, there is a difference of approximately 62 dB for a sound with the same absolute intensity in air and water. For example, a sound level of 100 dB re 20 µPa in air is approximately equivalent to 162 dB re 1 µPa in water.

Sounds are usually characterized according to whether they are continuous or impulsive in character. Continuous sounds occur without pauses and include shipping noise and dredging. Impulsive sounds (such as hammer piling) are of short duration and can occur singularly, irregularly, or as part of a repeating pattern, over a broad range of frequencies.

Noise from launch activities would generally be characterised as continuous rather than impulsive, although it should be noted that it is of limited duration compared to many other sources of continuous underwater noise.

Marine animals live in an environment in which vision is not the primary sense because light does not penetrate far beneath the surface of the ocean. As such, marine mammals have become reliant upon sound, instead of light, as their primary sense for communication and being aware of their surrounding environment. Marine mammal communication has a variety of functions such as intra-sexual selection, mother/calf cohesion, group cohesion, individual recognition and danger avoidance.

The following provides a brief overview of the effects that may occur because of an animal being exposed to noise. Consideration of this information, together with information on the biological importance of the area as a habitat for the considered species, e.g. breeding, calving or resting areas, or confined migratory routes or feeding areas, is used to assess the likely impact of a noise source.

- *Risk of fatality* – When exposed to significant noise levels, either immediate mortality or tissue and/or physiological damage can result. The injury may be sufficiently severe that death occurs sometime later due to decreased fitness. Mortality can also have a direct effect upon animal populations, especially if it affects individuals close to maturity. Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.
- *Hearing injury* – Short or long term changes in hearing sensitivity (TTS or PTS) may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, as well as cause deterioration in communication between individuals. This may affect growth, survival, and reproductive success.
- *Masking* – The presence of man-made sounds may make it difficult to detect biologically significant sounds against the noise background. Masking of sounds from predators may result in reduced survival. Masking of sounds used for orientation and navigation may affect the ability to find preferred habitats and in the case of fish, spawning areas, affecting recruitment, growth, survival, and reproduction.
- *Behavioural responses* – Behavioural responses may cause displacement from preferred habitats, which could affect feeding, growth, predation, survival, and reproductive success.

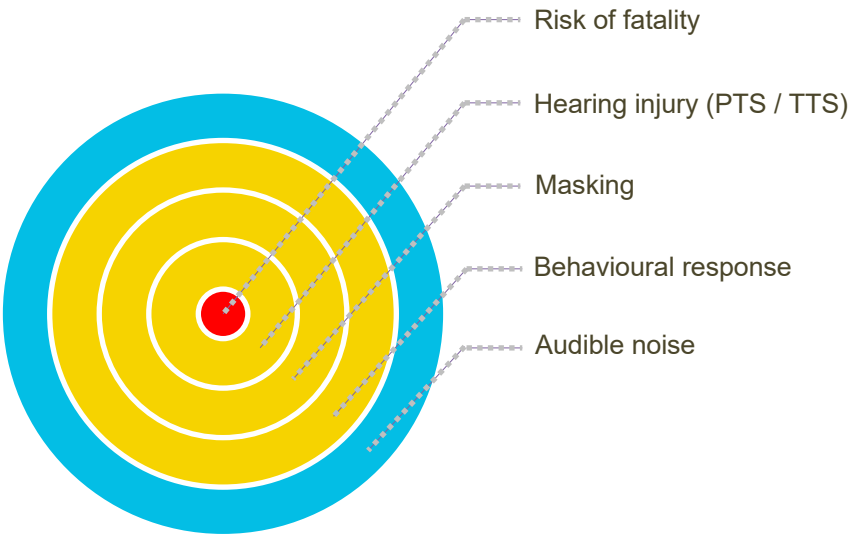


Figure 1: Overview of potential noise effects upon marine fauna

While Figure 1 acknowledges that the severity of noise effects relates to distance from the noise source, however note that the 'zones' of hearing injury, masking and behavioural response may overlap. Overlap results from comparing cumulative sound exposure threshold metrics with single event peak or behavioural sound level metrics.

Examples of reactions or behaviour that may indicate a whale or dolphin is disturbed include:

- attempts to leave the area
- regular changes in direction or speed of swimming
- hasty dives
- changes in breathing patterns
- increased time spent diving compared to time spent at the surface
- changes in acoustic behaviour
- aggressive behaviours such as tail slashes and trumpet blows.

2.2 Criteria

The adopted noise criteria for marine and terrestrial fauna that may be present in the project area are shown Table A to Table C and are based on the DIT Draft Underwater Piling and Dredging Noise Guidelines (2021), Southall et al. (2019), Popper et al. (2014), and Dooling and Popper (2016).

Table A: Underwater noise criteria for physiological impacts on marine mammals (adapted from Southall et al., 2019)

Functional hearing group	Impact	Physiological noise exposure onset criteria	
		Impulsive	Continuous
Low-frequency cetaceans	TTS	Peak 213 dB SEL_{24hr} 168 dB(LF)	SEL_{24hr} 179 dB(LF)
	PTS	Peak 219 dB SEL_{24hr} 183 dB(LF)	SEL_{24hr} 199 dB(LF)
High-frequency cetaceans	TTS	Peak 224 dB SEL_{24hr} 178 dB(HF)	SEL_{24hr} 179 dB(HF)
	PTS	Peak 230 dB SEL_{24hr} 185 dB(HF)	SEL_{24hr} 198 dB(HF)
Pinnipeds (other carnivores in water)	TTS	Peak 226 dB SEL_{24hr} 188 dB(OCW)	SEL_{24hr} 199 dB(OCW)
	PTS	Peak 232 dB SEL_{24hr} 203 dB(OCW)	SEL_{24hr} 219 dB(OCW)
Pinnipeds – Other Carnivores in Air (SEL = dB re 20 μPa^2s, Peak = dB re 20 µPa)	TTS	Peak 161dB SEL_{24hr} 146 dB(OCA)	SEL_{24hr} 157 dB(OCA)
	PTS	Peak 167 dB(OCA) SEL_{24hr} 161 dB(OCA)	SEL_{24hr} 177 dB(OCA)

Table B: Underwater noise criteria for marine mammal behavioural response (DIT, 2022)

Species	Behavioural noise exposure criteria	
	Impact piling (Impulsive)	Vibratory / DTH Piling and Dredging (Continuous)
Cetaceans	SPL 160 dB rms	SPL 120 dB rms
Pinnipeds	SPL 160 dB rms	SPL 120 dB rms

Table C: Noise criteria for fishes, marine turtles and birds (Popper et al, 2014; Dooling & Popper, 2016)

Functional Hearing Group	Source character	Organ damage / increased Risk of fatality	PTS	TTS	Behavioural Response
Fish (no swim bladder) For example: Great White Shark Mackeral Shark	Continuous	**N**: Low **I**: Low **F**: Low	**N**: Low **I**: Low **F**: Low	**N**: Moderate **I**: Low **F**: Low	**N**: Moderate **I**: Moderate **F**: Low
	Impulsive	Peak 213 dB SEL_{24hr} 219 dB	Peak 213 dB SEL_{24hr} 216 dB	SEL_{24hr} 186 dB	**N**: High **I**: Moderate **F**: Low
Fish (with swim bladder) For example: Pipefish Seahorses Seadragons	Continuous	**N**: Low **I**: Low **F**: Low	SPL 170 dB for 48 h	SPL 158 dB for 12 h	**N**: High **I**: Moderate **F**: Low
	Impulsive	Peak >207 dB SEL_{24hr} 207 dB	Peak >207 dB SEL_{24hr} 203 dB	SEL_{24hr} 186 dB	**N**: High **I**: High **F**: Moderate
Marine Turtles For example: Loggerhead Turtle Green Sea Turtle Leatherback Turtle Pacific Ridley Turtle	Continuous	**N**: Low **I**: Low **F**: Low	**N**: Low **I**: Low **F**: Low	**N**: Moderate **I**: Low **F**: Low	**N**: High **I**: Moderate **F**: Low
	Impulsive	Peak 207 dB SEL_{24hr} 210 dB	**N**: High **I**: Low **F**: Low	**N**: High **I**: Low **F**: Low	**N**: High **I**: Moderate **F**: Low
Birds in air (dB re 20 µPa)	Continuous	-	-	93 dB(A)	(2)
	Impulsive	-	140 dB(A)	-	(2)

(1) N (near), I (intermediate), F (far) distance from the noise source.

(2) Dooling & Popper (2016) note that any audible component of noise has the potential of causing a behavioural response in birds

Popper et al. (2014) note that where insufficient data exist to make a recommendation for guidelines, a subjective approach is adopted in which the relative risk of an effect is placed in order of rank at three distances from the source:

- Near (N) = tens of meters from the source
- Intermediate (I) = hundreds of meters from the source
- Far (F) = thousands of meters from the source.

Dooling & Popper (2016) note that the recommended guideline level of 93 dB(A) for TTS in birds is based partly on a study by Dooling (1980) in which budgerigars were exposed to continuous noise for 72 hours.

While Dooling & Popper (2016) do not specify an acoustic metric for PTS and TTS thresholds, it is generally appropriate to use a maximum or peak level for impulsive noise, and an equivalent noise level (i.e. $L_{eq,T}$) for continuous noise where the potential for hearing damage depends on both the level and duration of noise exposure, i.e. the total sound energy received in a given period.

An *equivalent noise level* ($L_{eq,T}$) is defined as the steady sound pressure level which, over a given period of time (T), has the same total sound energy as a fluctuating or non-steady noise. This allows a direct comparison of hearing loss potential of different noise levels and exposure times. For example, exposure to a steady noise of 107 dB(A) for one hour is equivalent to continuous exposure to 93 dB(A) for 24 hours (i.e. 93 dB $L_{Aeq,24hr}$), as both result in the same total sound energy and therefore same expected potential for hearing injury.

Equivalent noise levels are also used to assess potential for hearing damage to occur in humans, for example noise exposure in the workplace is assessed against an standard of 85 dB $L_{Aeq,8hr}$. In this case, the period of eight hours relates to the duration of a typical working day. Shorter exposure to higher noise levels is converted to an eight hour equivalent noise level for comparison with the standard, e.g. exposure to 88 dB(A) for four hours is equivalent to 85 dB $L_{Aeq,8hr}$.

An averaging time of 24 hours (i.e. $L_{Aeq,24hr}$) is considered suitable for assessment of TTS in birds on the basis that this time window is consistent with the cumulative noise assessment period for many other species including marine mammals and fishes, and is conservative since it is less than the 72 hour continuous exposure in the study that the criteria is derived from.

Dooling & Popper (2016) note that there is variation in potential for hearing loss between different bird species, for example Japanese quail showed greater susceptibility to PTS compared to budgerigars, while canaries and zebra finches were less susceptible and recovered faster from temporary hearing loss. However, when taken as a whole; the literature reviewed by Dooling & Popper (2016) indicates that birds in general are relatively more resistant to PTS and TTS than humans.

3 Predicted Rocket Noise Levels

3.1 Noise modelling

Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration provides predicted noise level contours for launch of Falcon 9 and New Shepard rockets from Site A and Site B.

It is understood that that the Falcon 9 (at approximately 549 tonnes) is considerably heavier than the largest vehicle that is proposed to be launched from Whalers Way Orbital Launch Complex (approximately 110 tonnes), while the suborbital New Shepard rocket is smaller (75 tonnes). Acoustic power is proportional to rocket exhaust mechanical power (thrust), meaning that larger rockets typically generate higher noise levels. Predicted noise levels from a hypothetical Falcon 9 launch are therefore likely to be higher than actual worst-case noise levels, while predicted noise levels from a New Shepard launch may be lower.

To quantify expected noise levels from a nominal worst case launch, Resonate have undertaken additional modelling of noise emissions from launch of a 137 tonne Avio Vega rocket. This is slightly larger than the nominal largest launch vehicle and therefore expected to provide a conservative representation of worst case noise emissions.

Noise levels from this rocket were predicted using the RUMBLE 3.0 computer modelling package, which has also been used in AECOM's *Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration*. RUMBLE 3.0 implements a modified version of the 'SP-8072' rocket noise prediction algorithm developed by NASA (Eldred, 1971), and has been approved by the United States Federal Aviation Administration (FAA) as suitable for predicting noise from rocket launch activities.

Inputs to the RUMBLE 3.0 model are presented in Appendix A.

3.2 Predicted airborne noise levels

Predicted airborne noise level contours (L_{max}, L_{Amax}, L_E, L_{AE}, and $L_{Aeq,24hr}$) for launch of a Vega rocket from Site B are presented in Appendix B. Predicted noise levels from Falcon 9 and New Shepard launches can be found in Appendix C of *Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration*.

Note that predicted noise propagation from Site A can be expected to follow the same patterns as Site B. Site B noise contours only have been presented for brevity since it is closer to the nearest shoreline and therefore worst case in relation to potential underwater noise impacts.

As shown in Appendix B, predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB L_{Amax} and 93 dB $L_{Aeq,24hr}$ respectively, even in very close proximity to the launch site. On this basis there is low risk of hearing injury to birds as a result of a nominal worst case rocket launch. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system.

Worst-case airborne noise levels at the nearest shoreline are predicted to be up to SEL_{24hr} 131 dB(OCA) re 20 μPa^2s which complies with TTS and PTS criteria for otariid pinnipeds in air.

Whales are not expected to be affected by noise in air, since their ears are underwater (even when surfacing to breathe), other than on rare occasions when breaching.

3.3 Predicted underwater noise levels

3.3.1 Sound transmission from air to water

Sound generally transmits poorly across the interface of two media with greatly different acoustic impedances, such as air and water. Direct sound transmission from air into water only occurs within a cone of 13° from the vertical. The implication for this assessment is that airborne noise from rockets can only effectively transmit to the water when the rocket is at significant altitude.

Sound transmission loss between air and water is dependent on incidence angle, frequency, water depth, seabed properties, surface conditions and other factors.

This assessment is based on empirical measurements presented in Bevans (2018) in which in-air and underwater acoustic measurements were undertaken during helicopter hovers at different altitudes above shallow water (16m depth). It should be noted that these measurements were undertaken with a helicopter overhead, which results in the highest levels of air to water sound transmission.

As shown in Appendix B, noise levels of up to approximately 125 dB L_{Amax} and 137 dB L_{AE} are predicted at the nearest shoreline to launch Site B during launch of a Vega or equivalent rocket. However the highest airborne noise levels received at this location during a launch, would occur when the rocket is close to the ground. As noted above, sound transmission from air into water only occurs within a cone of 13° from the vertical. A rocket launched from either launch site, with an approximately vertical launch trajectory would need to be at approximately 2km altitude before the angle of incidence is sufficiently small to allow for significant transmission of airborne sound into water.

Based on noise level reduction due to spherical spreading of sound and air absorption (and not accounting for any additional noise reduction due to decreasing thrust and forward flight effects), noise from a rocket at this altitude are expected to be at least 20 dB less than the maximum noise when the rocket is at or near ground level.

This results in adjusted airborne noise levels from a Vega or equivalent rocket at minimum 2,000m altitude of 105 dB L_{Amax} and 117 dB L_{AE}, received at the nearest shoreline.

Rocket launch noise is generally broadband. An indicative spectrum is shown in Table D below, based on the spectrum presented in *Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration*.

Table D: Indicative worst-case octave band sound level spectra for launch noise at the nearest shoreline, from a Vega or equivalent rocket at 2,000m altitude.

Octave Band Frequency (Hz) Sound Pressure Levels, dB re 20 µPa							Overall SPL, dB(A)
63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	
112	110	108	103	96	92	89	105

3.4 Underwater noise levels

Based on the launch sound level spectra shown in Table D, and air to water transmission loss from Bevans (2018), underwater noise levels of up to 125 dB rms and SEL_{24hr} 137 dB re 1 µPa are predicted due to launch of a Vega or equivalent rocket.

The predicted underwater noise levels are less than the hearing damage thresholds for fish and turtle species. A noise level of up to SEL_{24hr} 135 dB(LF) SEL is predicted with application of a low frequency marine mammal (LF) weighting. This is less than the TTS criteria of SEL_{24hr} 168 dB(LF) for impulsive noise and SEL_C 179 dB(LF) for continuous noise. Underwater noise levels are also less than the (significantly higher) TTS and PTS thresholds for other marine mammal species.

The worst-case predicted underwater noise level of 125 dB rms exceeds the behavioural criteria of 120 dB rms for cetaceans and pinnipeds in relation to continuous noise sources, however it should be noted that based on nominal trajectory information in the AECOM report, the duration of underwater noise exposure during rocket launches is likely to be approximately 30 seconds or less, on a limited number of occasions per year. Underwater noise levels from New Shepard or equivalent (or smaller) rockets are expected to be less than 120 dB rms.

It should be noted that ambient underwater noise levels in a coastal environment can frequently exceed 125 dB rms due to noise from wind and waves.

The area potentially affected by underwater noise levels above 120 dB rms is also limited to approximately 1,000m from either launch site (approx. 750m from the shore). The potential for adverse behaviour impacts is therefore limited due to the relatively small area impacted and the limited frequency and duration of potential exposure.

It should be noted that both airborne and underwater noise levels will be monitored during test launches.

4 References

Bevans, Dieter Alexander. Light Helicopter Sound for Underwater Acoustics Experiments. University of California, San Diego, 2018.

Department for Infrastructure and Transport. Underwater Piling and Dredging Noise Guidelines (DRAFT WIP). DIT (2021)

Dooling, R. J. (1980). Behavior and psychophysics of hearing in birds. In Comparative studies of hearing in vertebrates (pp. 261-288). Springer, New York, NY.

Dooling, R. J., and A. N. Popper. "Technical guidance for assessment and mitigation of the effects of highway and road construction noise on birds." The California Department of Transportation, Division of Environmental Analysis, Sacramento, California, USA (2016).

Eldred, K. M. (1971). Acoustic loads generated by the propulsion system. National Aeronautics and Space Administration

Eller, A. I., & Cavanagh, R. C. (2000). Subsonic aircraft noise at and beneath the ocean surface: Estimation of risk for effects on marine mammals. SCIENCE APPLICATIONS INTERNATIONAL CORPMCLEAN VA.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., ... & Tavolga, W. N. (2014). Sound exposure guidelines. In ASA S3/SC1. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (pp. 33-51). Springer, Cham.

Southall, B. L., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., ... & Tyack, P. L. (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2).

Appendix A – Rocket noise modelling inputs

Resonate

Table 5: Launch site locations

Launch Site	Latitude	Longitude
Site A	-34.932804	135.637994
Site B	-34.933906	135.643307

Table 6: Nominal trajectory

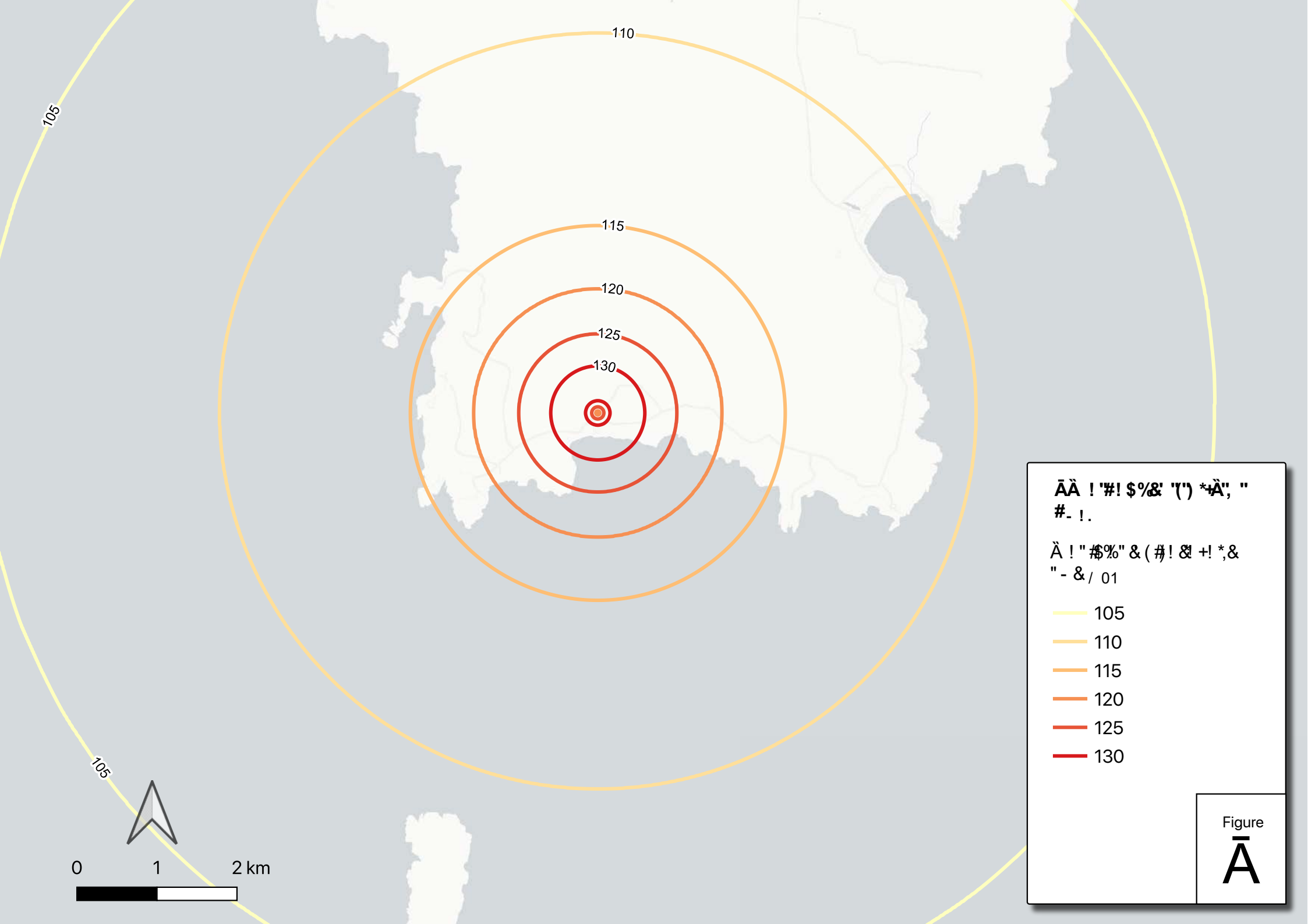
Time after lift-off (s)	Speed (km/h)	Altitude (m)	Downrange distance (m)	Pitch (Degrees)
0	0	0	0	90.0
10	106	192	0	90.0
30	389	1,520	20	89.1
60	1,042	7,200	780	82.4
120	3,880	38,000	17,600	61.4

Table 7: Launch vehicle and engine details

Class	Units	Details
Model (Vehicle Name)	-	Vega
Airframe Reference	-	-
Type	-	ELV
Manufacturer	-	Avio
Capacity	-	-
Deployment	-	Orbital
Number of Stages	-	4
Length	m	30
	ft	98.43
Weight	kg	137000
	lbs	302033.30
Diameter	m	3
	ft	9.84
Engine Model (first stage)	-	P80
Engine Manufacturer	-	Avio
Propellant Description	-	Al-HTPB 1912
Thrust per Engine (SL) *(Average)*	kN	1963
	lbf	8731.86
Nozzle Exit Diameter	m	0.978
	ft	3.209
Nozzle Exit Velocity	m/s	2746.8

Class	Units	Details
	ft/s	9012
Nozzle Count*	-	1
Number of Engines per Core	-	1
Number of Cores	-	1
Burn Time	s	106.8
Mass Flow Rate	kg/s	827.4
T2W	-	14.33

Appendix B – Predicted Noise Contours (Vega, Site B)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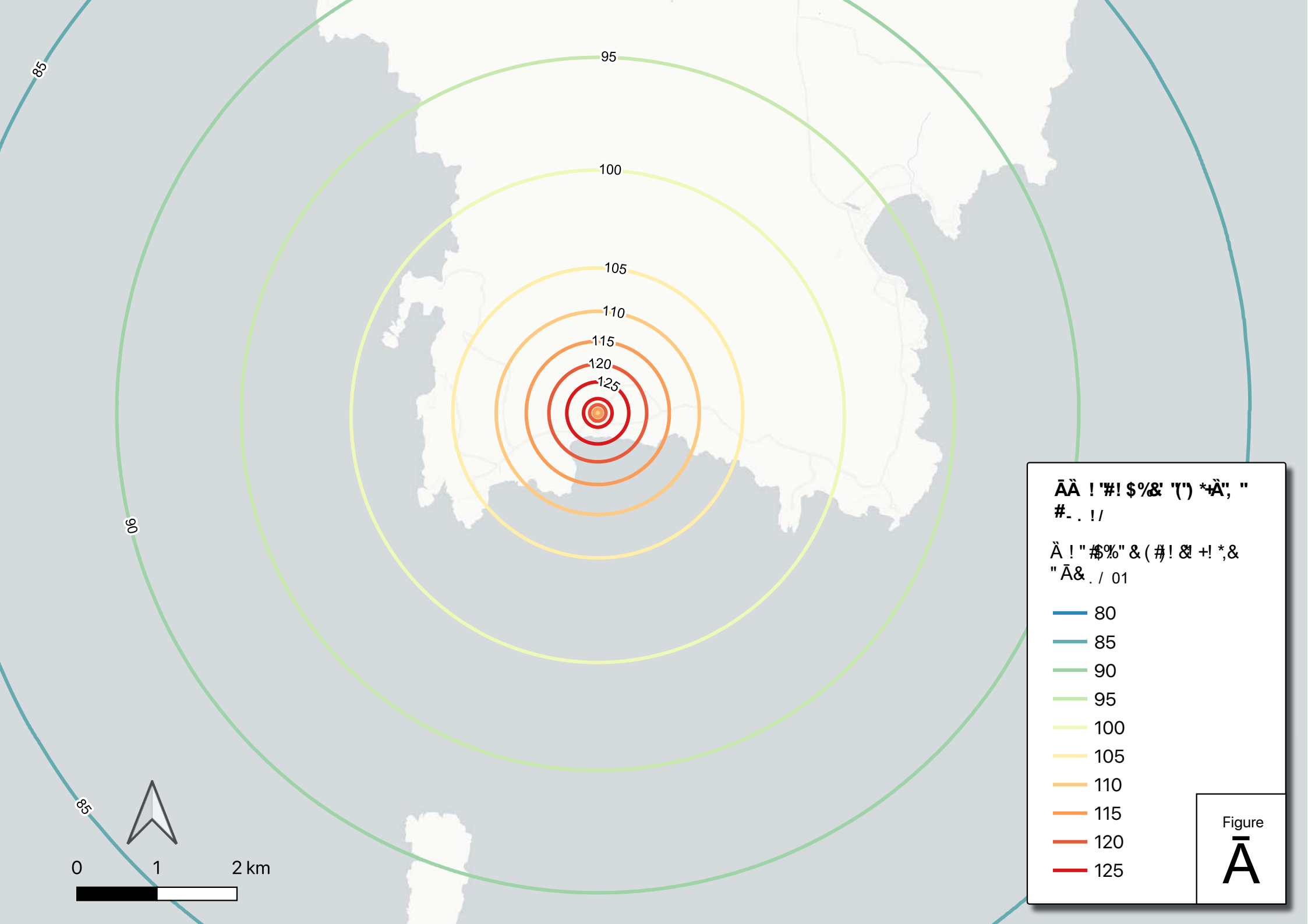
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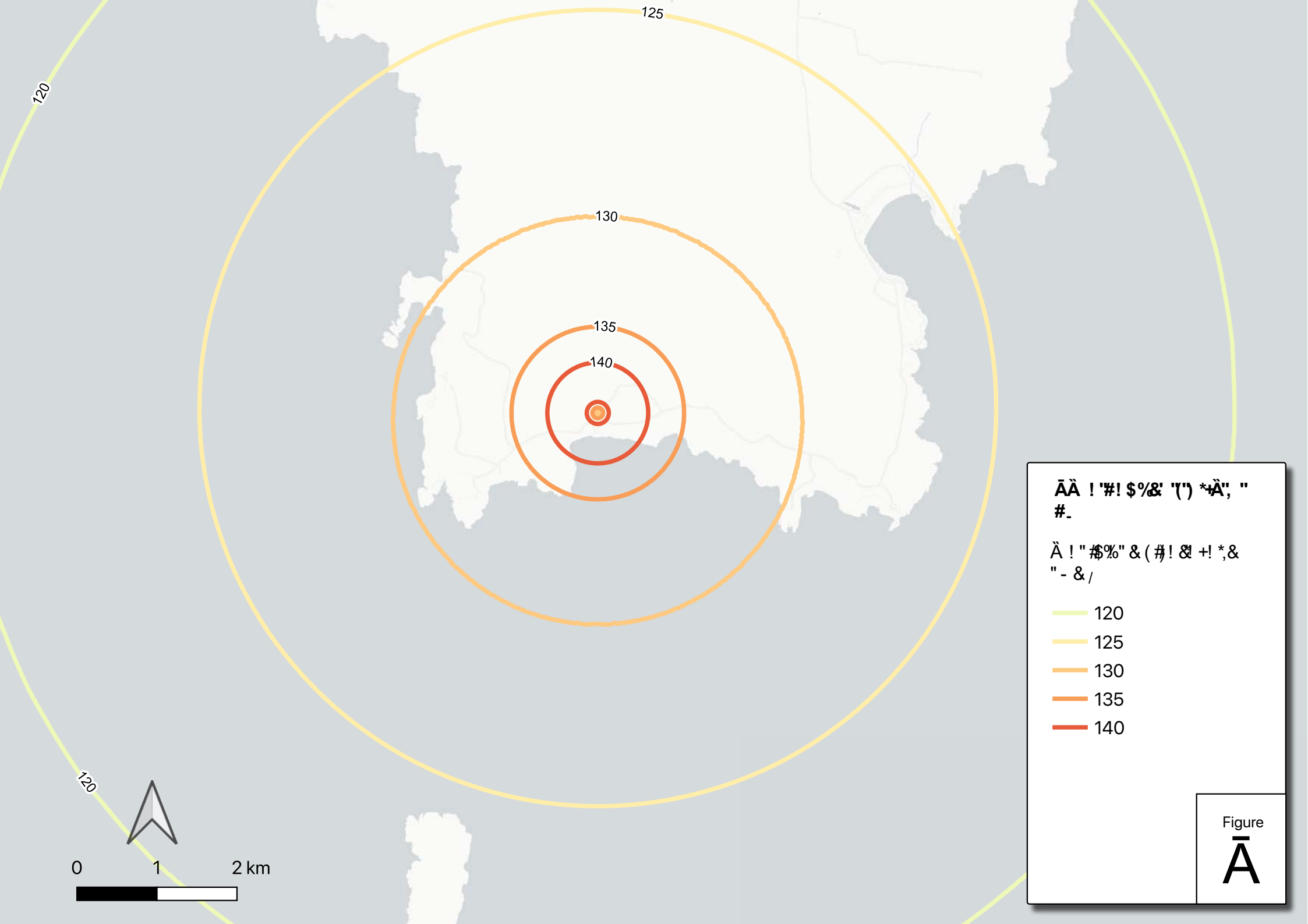
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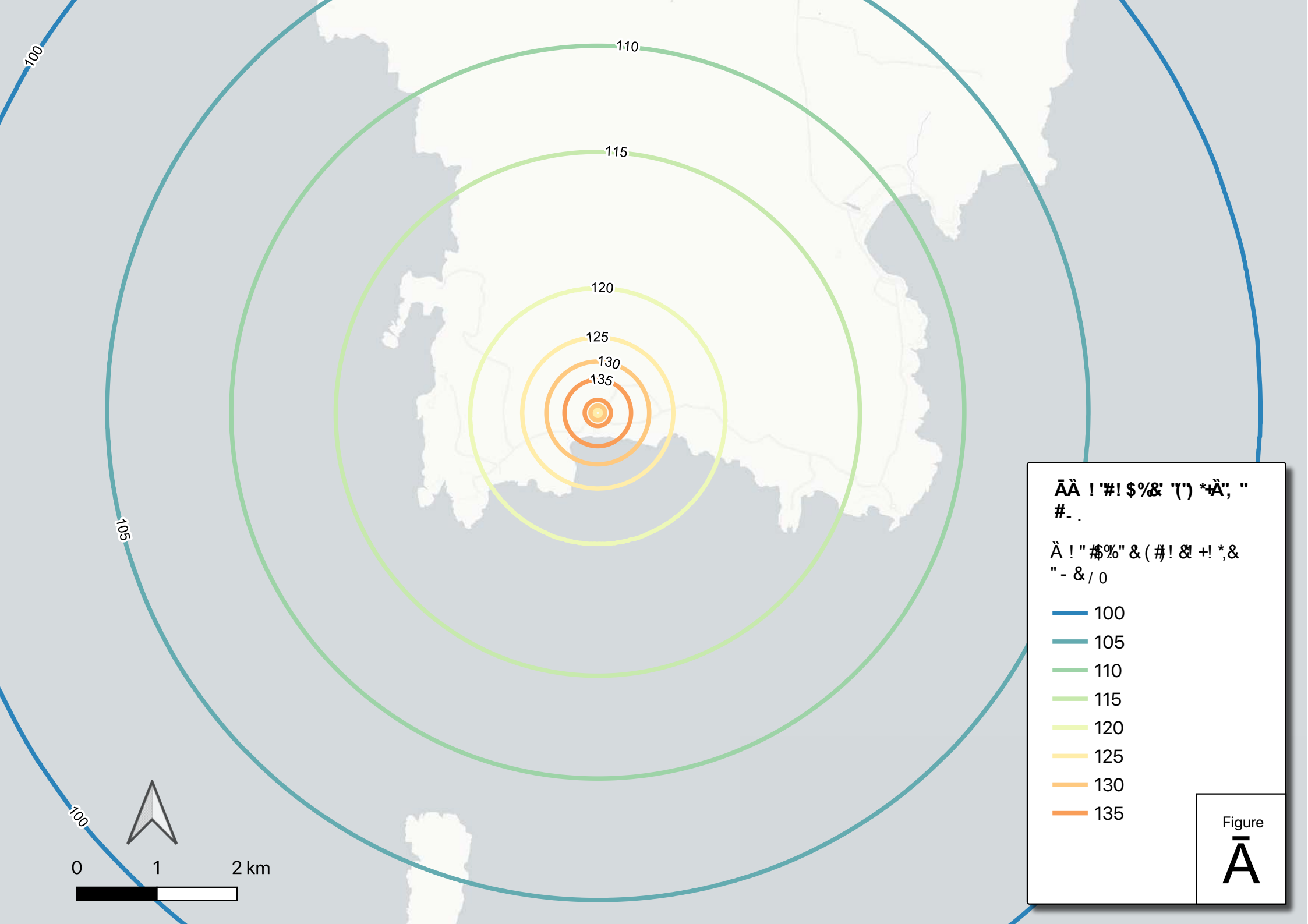
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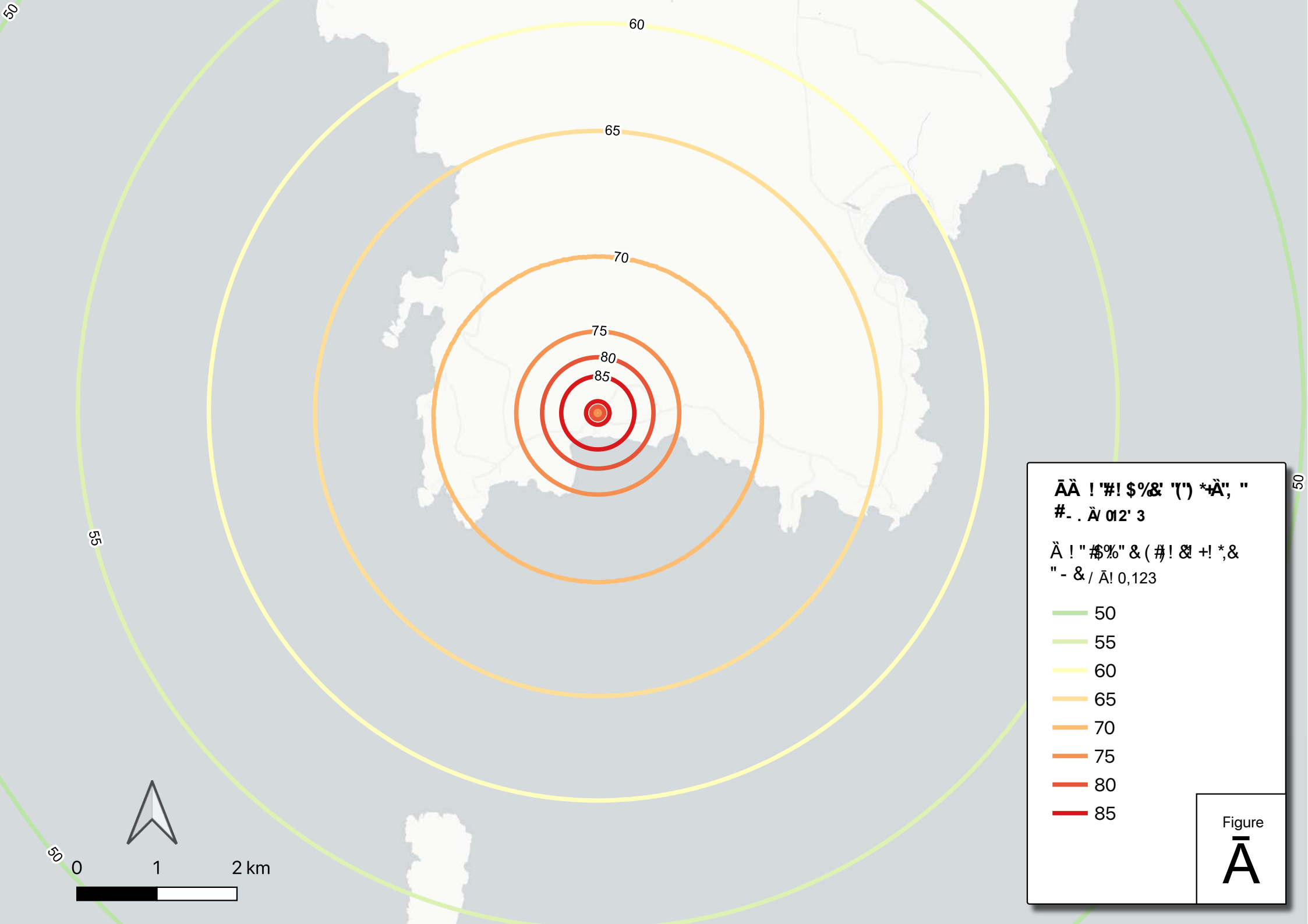
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Resonate

Southern Launch

Hapith I Motor Static Test

A210940RP2 Revision 0

Wednesday, 20 July 2022

Resonate

Document Information

Project	Hapith I Motor Static Test
Client	Southern Launch
Report title	Hapith I Motor Static Test
Project Number	A210940

Revision Table

Report revision	Date	Description	Author	Reviewer
0	20 July 2022	First Issue	Nick Henrys	Darren Jurevicius

Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
DNL	Day-Night-Level (DNL) is the A-weighted equivalent continuous sound level for a 24 hour period with an additional 10 dB imposed on the equivalent sound levels for the night time hours between 10 pm and 7 am. The DNL is a metric used by the US Federal Aviation Administration and is not used in South Australian noise policy. The South Australian EPA's *Environmental Protection (Noise) Policy* uses a separate A-weighted equivalent continuous sound level criterion for both day and night (i.e. $L_{Aeq,day}$ and $L_{Aeq,night}$). DNL and $L_{Aeq,day}$ or $L_{Aeq,night}$ results must not be compared. Nevertheless, DNL is an appropriate metric for community noise assessment of single or cumulative events when assessed in context.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of loudness.
dB(A)	Units of the A-weighted sound level.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second.
$L_{eq,T}$	Equivalent Noise Level—Energy averaged noise level over the measurement time (T). Environmental noise criteria for prevention of human annoyance and sleep disturbance for continuous noise sources are often expressed as L_{Aeq}, for example in the South Australian EPA's *Environmental Protection (Noise) Policy*. Hearing damage prevention thresholds can also be expressed as equivalent noise levels where the potential for hearing damage to occur depends on both the sound pressure level and duration of exposure. For example the limit of 85 dB $L_{Aeq,8hrs}$ that applies under Australian WHS Regulations for workplace noise.
L_{max}	The maximum rms noise level. The Lmax or LAmax metric indicates the maximum sound level occurring for a fraction of a second (i.e. 125 milliseconds for 'fast' time weighting on a sound level meter). This metric is appropriate for community noise assessment of a single, brief event, such as a rocket launch. The maximum sound level is important in assessing the interference caused by a noise event with conversation, watching TV, sleep, or other activities. Although it provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the duration that the sound is heard.
Noise source	Premises or a place at which an activity is undertaken, or a machine or device is operated, resulting in the emission of noise

SEL	Sound Exposure Level (SEL or L_E) is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event, and a period during which the event is heard. Mathematically, SEL represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Instead, it represents the total acoustic energy transmitted to the listener during an event. SEL is a useful metric for comparing the total acoustic energy transmitted by similar noise source activities (e.g. rocket launches). It is not suited for comparing to noise policy that has been fundamentally based on World Health Organisation (WHO) noise guidelines. For a rocket launch, SEL is expected to be greater than the L_{max}.
SPL	Sound Pressure Level. The sound pressure averaged over the measurement period.
SWL	The Sound Power Level (SWL) is a measure of the acoustic energy emitted from a source of noise, expressed in decibels

Resonate

Table of Contents

1 Introduction

Resonate were engaged to undertake noise measurements during a static motor test of a Hapith I rocket at a site in Helidon, Queensland. Measurements were undertaken at eight locations at distances ranging from approximately 60 metres to 6 km from the test pad. The purpose of measurements was to:

- quantify the Sound Power Level (SWL) of the rocket motor;
- validate noise modelling predictions; and
- estimate the noise attenuation provided by the 'flame trench' and water deluge system.

1.1 Static test

The static test occurred at approximately 4:00pm on 9 June 2022. An image of the static test setup (looking south) is presented in Figure 1. The test pad is inset in a quarry face, with the motor nozzles approximately 1m below the upper ground surface level. A flame diverter was situated below the rocket, while shipping containers were situated to the south and west as shown.

Figure 1: Static test setup (photo taken from location N1 looking south)

Details of the test vehicle are presented in Table 1 below.

Table 1 Test vehicle details

Class	Units	Details
Model (Vehicle Name)	-	Hapith 1
Airframe Reference	-	-
Type	*(ELV or RLV)*	*ELV*
Manufacturer	-	AtSpace
Capacity	-	-
Deployment	-	Suborbital
Number of Stages	-	2
Length	m	10.1
	ft	33.14
Weight	kg	3250
	lbs	7165.02
Diameter	m	1.46
	ft	4.79
Engine Model (first stage)	-	Stage1
Engine Manufacturer	-	AtSpace
Propellant Description	-	Hybrid
Thrust per Engine (SL) *(Average)*	kN	11.55
	lbf	51.38
Nozzle Exit Diameter	m	0.206
	ft	0.676
Nozzle Exit Velocity	m/s	1758
	ft/s	5768
Nozzle Count*	-	1
Number of Engines per Core	-	4
Number of Cores	-	1
Burn Time	s	65.5
Mass Flow Rate	kg/s	24.4
T2W	-	14.22

2 Measurement methodology

2.1 Measurement Locations

Measurement locations including distance from the test pad and noise logger details are presented in Table 2 and Figure 2 below.

Table 2 Measurement locations

Location	Latitude	Longitude	Distance from test pad (m)	Logger Type	Serial Number
N1	-27.5062484	152.1483161	120	B&K2250	3001247
N2	-27.5037974	152.1500505	461	Ngara	TR204375
N3	-27.4835131	152.1622109	2,990	NOR139	1392947
N4	-27.4630067	152.1822826	5,960	NOR139	1392976
S1	-27.5077046	152.1479563	62	B&K2250	2749881
S2	-27.5114871	152.1562125	937	NTi XL2	A2A-18358-E0
S3	-27.5219526	152.1607314	2,060	NL-42	01000318
S4	-27.528993	152.1648989	2,930	Ngara	TR203914

2.2 Instrumentation

The noise measurements were taken with noise loggers presented in Table 1 above, which are Class 1 or 2 instruments suitable for field use. The sound level meters were calibrated both before and after the measurements using a Class 1 Brüel & Kjær 4231 sound level calibrator, and the calibration was found to have not drifted. The sound level meters and calibrator carry current calibration certificates from a NATA accredited laboratory. Copies of the calibration certificates are available on request.

2.3 Procedure

Noise measurements were undertaken in accordance with the following:

- The microphone of the sound level meter was at a height of approximately 1.2 to 1.5 metres above the ground and at least 3.5 metres away from any wall or facade.
- The axis of maximum sensitivity of the microphone of the sound level meter was directed towards the noise source.
- A wind shield was used during all measurements.
- Noise measurements were generally undertaken in 100 millisecond intervals including spectral and statistical levels. Audio data was also recorded at all locations with the exception of S3.
- Data from the nearest Bureau of Meteorology (BOM) weather station at Gatton was also obtained for the noise monitoring period.

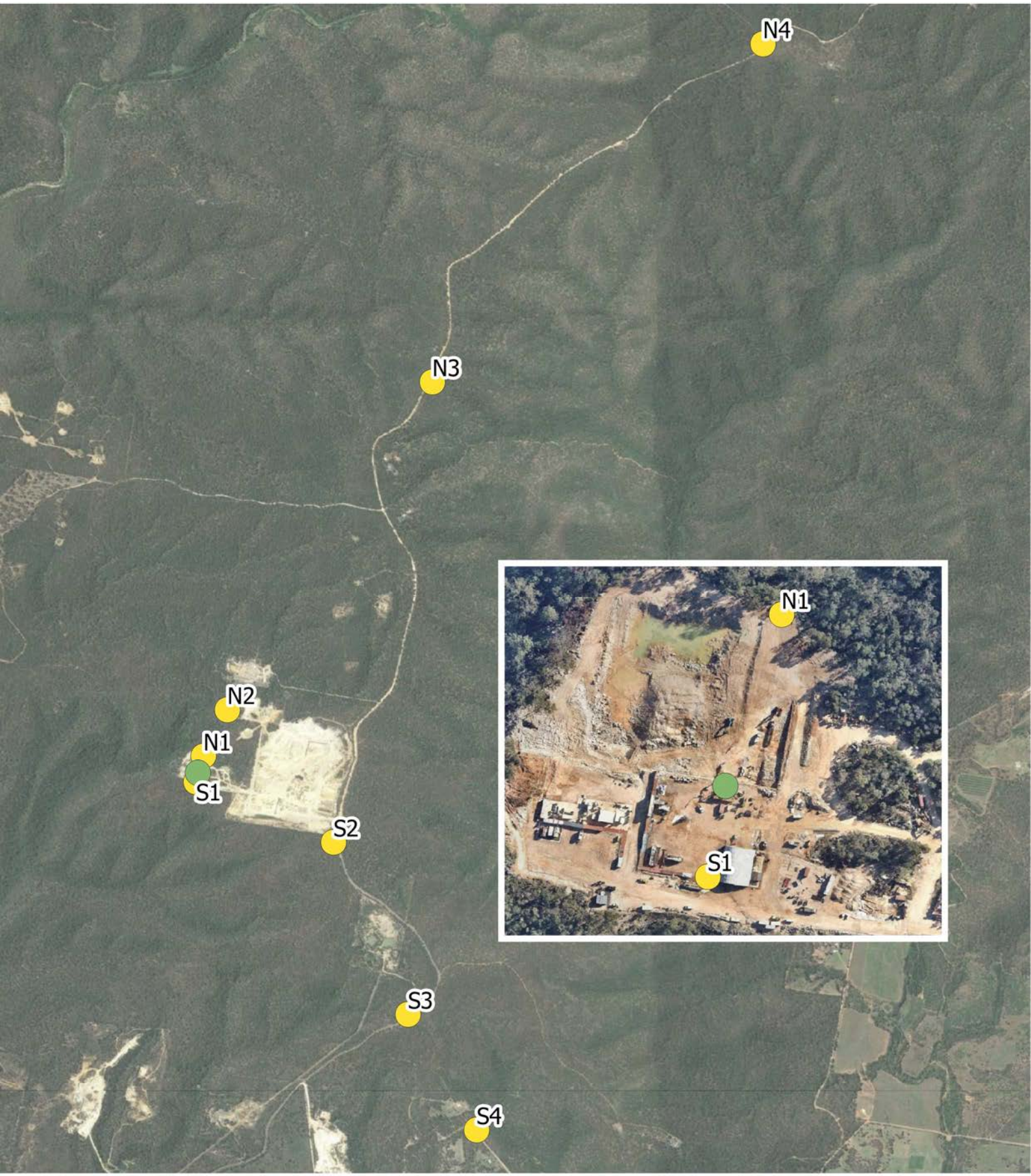


Figure 2
Noise Logging Locations

3 Results

3.1 Results summary

Unweighted and A-Weighted maximum (L_{Max} / L_{Amax}) and Sound Exposure Level (L_E / L_{AE}) results for each measurement location are presented in Table 3.

Table 3: Measurement result summary

Location	Unweighted, dB		A-Weighted, dB(A)		Notes
	L_{max}	L_E	L_{Amax}	L_{AE}	
N1	120	121	112	116	
N2	104	110	97	106	
N3	73	83	65	75	
N4	67	78	52	66	
S1	115	122	107	122	
S2	90	94	82	94	Influenced by truck pass-by during test
S3	-	-	64	76	
S4	-	-	-	-	Data not usable due to equipment fault

100 millisecond L_{eq} and L_{Aeq} data for each location is also presented in Figure 2 (unweighted) and Figure 3 (A-weighted). Note unweighted data is not available for Location S3.

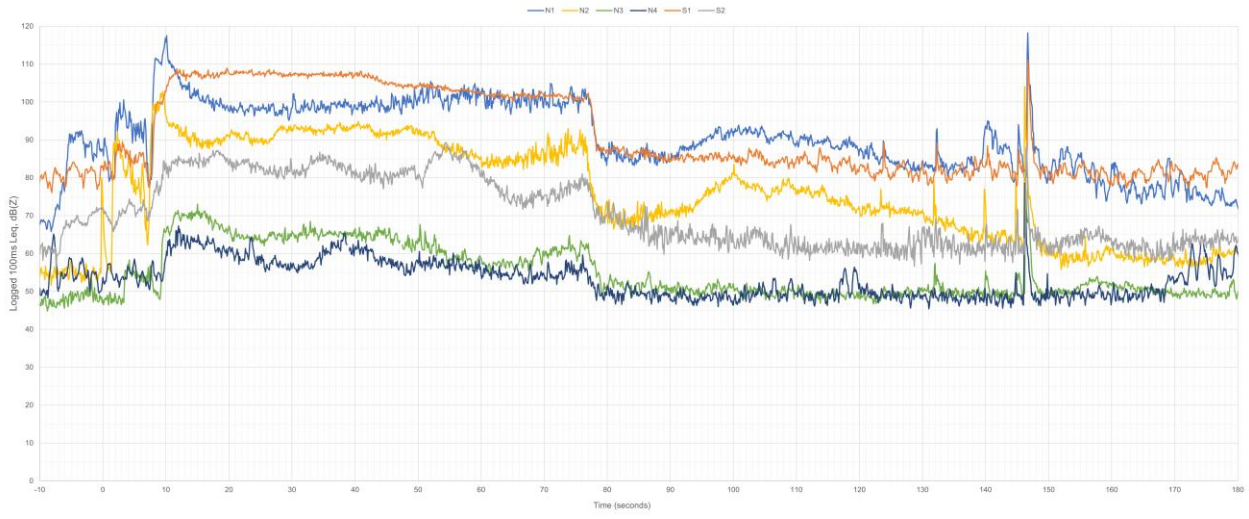


Figure 2 Logged 100 ms noise levels (dB L_{eq})

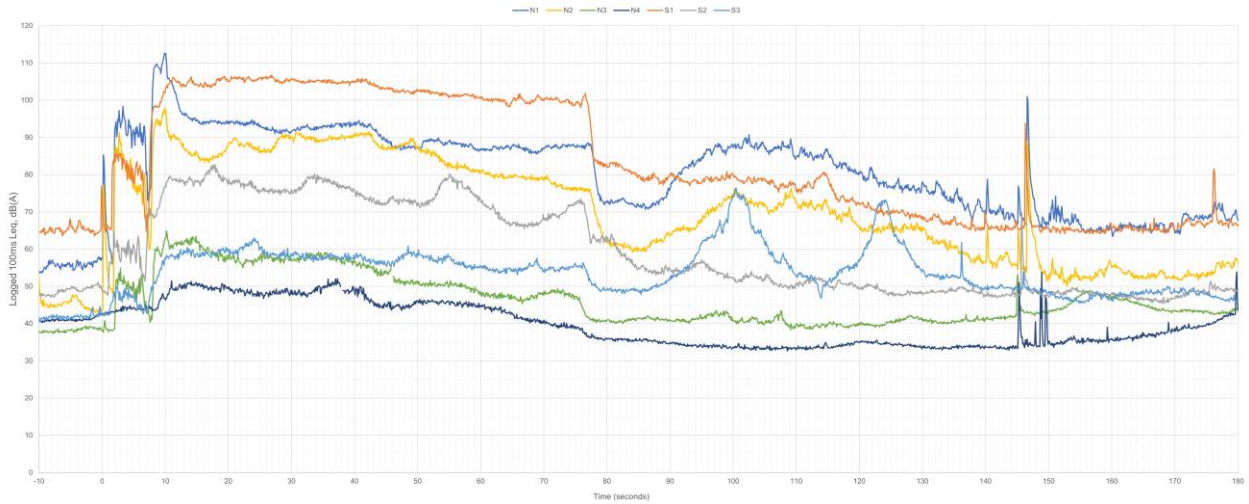


Figure 3 Logged 100 ms noise levels (dB L_{Aeq})

The 100 millisecond data shows the rocket burn from approximately T=10 seconds to 80 seconds. After this period, residual heat caused part of the rocket body to catch fire which subsequently resulted in a tank rupture at approximately T=145 seconds.

Other aspects of the data to note include:

- Noise levels at locations N1 and N2 decrease by at least 10 dB between T=10 seconds and 15 seconds. This may be due to heat from the rocket exhaust converting deluge water into steam which was then distributed over a large volume and may have increased the effectiveness of water deluge as a noise mitigation measure.
- Noise levels at S1 were higher than at N1 for a significant duration during the test. Whilst S1 is closer to the test pad than N1, this result was not necessarily expected due to the shielding provided by quarry face and containers. However, this could be due to a combination of the following factors:
  - high temperature gradients affecting noise propagation in the vicinity of the rocket;
  - a gap in the containers compromising the level of noise mitigation provided; and
  - the water deluge system providing more noise mitigation to the north than to the south.
- A-weighted noise levels at N2 were similar to at N1 for a period during the test. This may be due to high temperature gradients affecting noise propagation in the vicinity of the rocket.
- High noise levels at location S3 at approximately 100 seconds and 120 seconds were due to vehicle pass-bys.

3.2 Calculated Sound Power Level

Noise modelling has been undertaken to calculate the rocket motor Sound Power Level (i.e. the acoustic energy emitted by the noise source) during the static test. Modelling was undertaken in SoundPLAN Environmental Software v8.2 program, using the ISO 9613-2: 1996 algorithm.

This method predicts sound pressure levels under meteorological conditions favourable to propagation from noise sources. These conditions are for downwind propagation, or, equivalently, propagation under a well-developed moderate groundbased temperature inversion, such as commonly occurs at night.

Specific terms are provided in the algorithms for the following physical effects:

- geometrical divergence
- atmospheric absorption
- ground effect

- reflection from surfaces
- screening by obstacles.

After exclusion of extraneous or anomalous data, the results indicate a sound power level of 158 dB(A) L_{max}, plus or minus 3 dB.

An indicative third octave band sound power level spectra (dB Linear) is shown below in Figure 4.

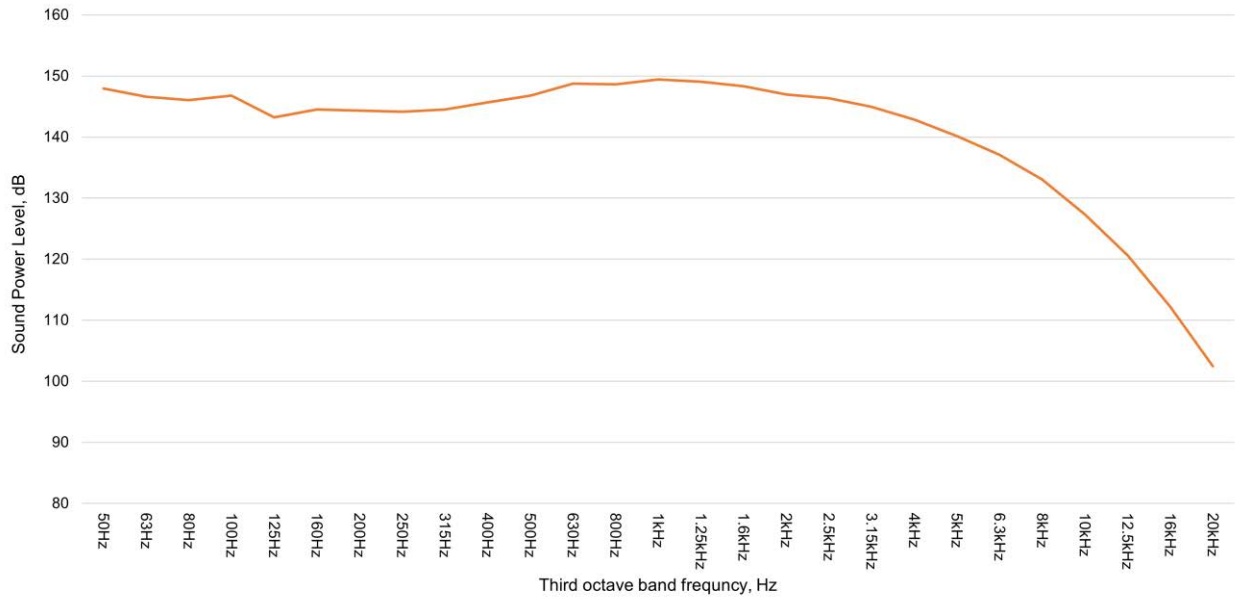


Figure 4 Indicative third octave band sound power level spectra

4 Comparison with RUMBLE modelling

Noise levels from the static test were predicted using the RUMBLE 3.0 computer modelling package, which has also been used in AECOM's *Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration*. RUMBLE 3.0 implements a modified version of the 'SP-8072' rocket noise prediction algorithm developed by NASA (Eldred, 1971), and has been approved by the United States Federal Aviation Administration (FAA) as suitable for predicting noise from rocket launch activities.

Note that the RUMBLE 3.0 noise model does not take into account shielding from topography and noise barriers, as these are generally of limited significance for predicting noise from rocket launches when the noise source is airborne for the majority of the time. However, these factors can have a significant impact on predicted noise levels at distance from a static test when the noise source is located at or very close to ground level.

A comparison between measured and modelled noise levels is presented in Table 4. Predicted noise contours from RUMBLE 3.0 model are also presented in Appendix A.

We note that for brevity only the L_{Amax} predictions have measurements are presented however the difference between measurements and predictions would likely be similar for other metrics.

Table 4 Comparison between RUMBLE 3.0 predicted noise levels and measured noise levels (dB L_{Amax})

Location	Predicted noise level, dB L_{Amax}	Measured noise level, dB L_{Amax}	Difference, dB
N1	112	112	0
N2	94	97	-3
N3	71	65	6
N4	60	52	8
S1	118	107	11
S2	87	82	5
S3	77	64	13
S4	71	-	-

Measured noise levels are most consistent with modelling results at locations near to the test site where there is line of sight between the measurement location and test pad (e.g. N1). At larger distances and/or where there is shielding from topography or noise barriers (shipping containers), the measurement results are consistently less than predicted. This is expected since the RUMBLE model does not account for topography and shielding. The measured noise level is slightly higher than the predicted noise level at location N2. This may be due to reflection of sound off the quarry face, which is also not accounted for in the RUMBLE model.

For further comparison, noise contours have been predicted using the ISO 9613-2: 1996 algorithm implemented in SoundPLAN 8.2. These are also presented in Appendix A. We note the predicted noise levels based on ISO 9613-2 show good agreement with RUMBLE 3.0 predictions, other than in locations where the prediction location is shielded from the test site by topography or noise barriers (shipping containers and the like). In these locations the ISO 9613-2 model more closely matches the measured noise levels.

We note that ISO 9613-2 is generally only appropriate for noise sources relatively close to the ground (for example a static test), while RUMBLE 3.0 remains the most appropriate noise modelling methodology for rocket launches. Further validation monitoring is recommended during a launch.

5 Conclusion

Noise measurements were undertaken at eight locations during a static motor test of a Hapith I rocket at a site in Helidon, Queensland.

Based on the measurement data the rocket test had a sound power level of 158 ±3 dB(A).

Comparison with predicted levels using a RUMBLE 3.0 model showed the measured levels were less than predicted at all locations, with the exception of an under-prediction by 3 dB(A) at location N2, approximately 460m to the north of the rocket, where measured levels may have been elevated due to noise reflecting off the quarry face immediately south of the test pad.

Predicted noise levels were equivalent to measured noise levels at N1, 120m to the north of the rocket, while at all other locations noise levels were over-predicted by between 5 and 13 dB(A). This result was expected due to topography, shielding and ground absorption effects not accounted for in the RUMBLE model.

A comparison with predictions using the ISO 9613-2: 1996 algorithm showed generally better agreement with measurement results however it should be noted that this finding is likely limited to static tests only where the source is near ground level, and RUMBLE is expected to be more appropriate for rocket launches where shielding and ground effects are of less significance.

Indicatively the water deluge system may have reduced noise levels by approximately 10 dB or more at measurement locations to the north, however further investigation and measurements of additional launches are required to confirm this finding and quantify the reduction with a higher level of accuracy.

The shipping containers and quarry face to the south of the rocket provided some degree of noise mitigation. Additional investigation would be needed to quantify this and relate this finding to flame trench arrangements at other launch sites.

Appendix A – Predicted noise contours

0 1 2 km

Helidon - Hapith I Static Test

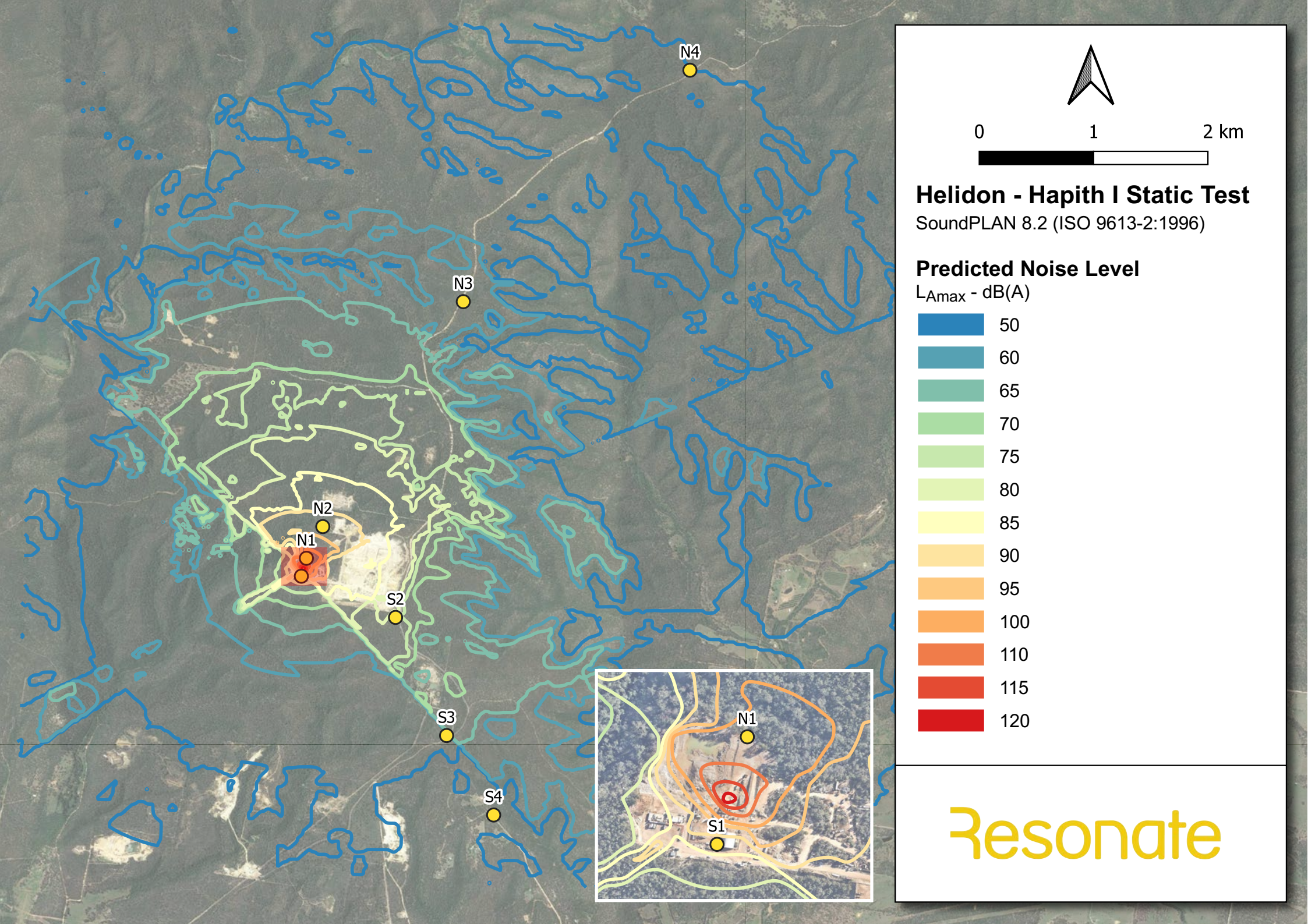
RUMBLE v3.0

Predicted Noise Level

L_{Amax} - dB(A)

- 50
- 60
- 65
- 70
- 75
- 80
- 85
- 90
- 95
- 100
- 110
- 115
- 120

Resonate


N4
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N2
N1
S2
S3
S4
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1
2 km
Helidon - Hapith I Static Test
SoundPLAN 8.2 (ISO 9613-2:1996)
Predicted Noise Level
LAmax - dB(A)
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70
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100
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115
120
N1
S1
Resonate

D AECOM TERRESTRIAL ECOLOGY

AECOM

Southern Launch
03-Aug-2022

Whalers Way Orbital Launch Complex

Terrestrial Biodiversity Technical Report

Whalers Way Orbital Launch Complex

Terrestrial Biodiversity Technical Report

Client: Southern Launch

ABN: 33 621 420 504

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03-Aug-2022

Job No.: 60627263

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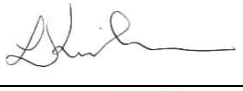
Quality Information

Document	Whalers Way Orbital Launch Complex 60627263
Ref	\\na.aecomnet.com\lfs\apac\adelaide-auadl1\legacy\aecom_projects\606x\60627263 southern launch whalers way\400_technical\431_flora and fauna\030822_60627263_whalersway_terrestrial biodiversity technical report_rev 9_final.docx
Date	03-Aug-2022
Prepared by	Floora de Wit, Andrew Sinel, Matthew McDonnell, Madeleine Wheeler
Reviewed by	Michael Manou

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
B	09- Apr--2020	Draft for Internal Review	Linda Kirchner Technical Director - Impact Assessment & Permitting	
0	15-Apr-2020	Draft for Client Review	Linda Kirchner Technical Director - Impact Assessment & Permitting	
1	15-Jul-2020	Revised Draft for Internal Review	Linda Kirchner Technical Director - Impact Assessment & Permitting	
2	23-Jul-2020	Draft for Client Review	Linda Kirchner Technical Director - Impact Assessment & Permitting	
3	04-Sep-2020	Final	Linda Kirchner Technical Director - Impact Assessment & Permitting	
4	21-Dec-2020	Revised Final	Linda Kirchner Technical Director - Impact Assessment & Permitting	
5	23-Feb-2021	Revised Final	Linda Kirchner Technical Director - Impact Assessment & Permitting	
6	18-May-2021	Revised Final	Linda Kirchner Technical Director - Impact Assessment & Permitting	
7	01-Jun-2021	Revised Final	Linda Kirchner Technical Director - Impact Assessment & Permitting	
8	15-Feb-2022	Final - Response to EIS Submissions	Michael Manou Area Manager - Adelaide	

9	03-Aug-2022	Final - Response to EIS Submissions	Michael Manou Area Manager - Adelaide	

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Acronyms

Abbreviation	Meaning
AECOM	AECOM Australia Pty Ltd
BAM	Bushland Assessment Method
BDBSA	Biological Databases of South Australia
BOM	Bureau of Meteorology
CCTV	Closed-circuit television
CFS	Country Fire Service
CEMP	Construction Environmental Management Plan
DAWE	Department of Agriculture, Water and Environment (Commonwealth)
Development Act	*Development Act 1993 (SA)*
DEW	Department for Environment and Water (SA)
DIT	Department for Infrastructure and Transport (SA)
EIS	Environmental Impact Statement
EP	Eyre Peninsula
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
GPS	Global Positioning System
Ha	Hectare
HA	Heritage Agreement
IBRA	Interim Biogeographic Regionalisation for Australia
L_{A90}	A-weighted, sound level just exceeded for 90% of the measurement period
L_{Aeq}	A-weighted Leq sound level
L_{Amax}	Maximum instantaneous sound pressure level
LSA Act	*Landscape South Australia Act 2019* (SA)
ML	Megalitre
MNES	Matters of National Environmental Significance
NP	National Park
NPW Act	*National Parks and Wildlife Act 1972* (SA)
NV Act	*Native Vegetation Act 1991* (SA)
NVC	Native Vegetation Council

Abbreviation	Meaning
OEMP	Operational Environmental Management Plan
PDI Act 2016	*Planning, Development and Infrastructure Act 2016*
PMST	Protected Matters Search Tool
PTS	Permanent Threshold Shift
SA	South Australia
SARIG	South Australian Resources Information Gateway
SEB	Significant Environmental Benefit
SEDMP	Soil Erosion and Drainage Management Plan
SIG 1.1	Significant Impact Guidelines 1.1 Matters of National Environmental Significance
Southern Launch	SouthernLaunch.Space Pty Ltd
SPC	State Planning Commission
SWL	Sound Power Level
TEC	Threatened Ecological Community
TTS	Temporary Threshold Shift
UBS	Unit Biodiversity Score
WONS	Weed of National Significance
WWOLC	Whalers Way Orbital Launch Complex

Executive Summary

AECOM Australia Pty Ltd (AECOM) were engaged by SouthernLaunch.Space Pty Ltd (Southern Launch) to undertake a terrestrial biodiversity assessment for the Whalers Way Orbital Launch Complex (WWOLC) (the Project). Southern Launch intend 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 Project comprises of the following key components, which hereinafter will be referred to as the Project Area:

- Launch Site A;
- Launch Site B;
- Infrastructure Site D;
- Range Control Facility Site E;
- Access Upgrades; and
- General Site Infrastructure.

The terrestrial biodiversity assessment initially included a desktop assessment and baseline flora and fauna survey. The outcomes of the baseline survey determined the need for a targeted threatened bird survey and targeted spring flora survey which were subsequently undertaken. The impact assessment considered the results of the terrestrial biodiversity assessment and defined the potential impacts of the Project on terrestrial biodiversity to determine the significance of those impacts associated with the Project.

Southern Launch gained approval from State Government to undertake three Test Launches using the non-explosive Hapith I rocket to gather empirical data to be used to validate modelled data and to determine the impact of launches on the environment through specific observation before, during, and after the three test launches. At the time of preparing this version of the Terrestrial Biodiversity Report there had been one Test Launch undertaken.

The assessment of noise for this Project has been developing over the extended assessment timeframe time as familiarisation with software modelling packages has increased, updates to software have been released and additional literature has been referenced.

Initially, and due to lack of available rocket vehicle data for modelling purposes, the Space X Falcon 9 was adopted as a worst case scenario for the assessment of noise impacts from the proposed facility. Whilst, from an impact on sensitive receivers perspective, the Falcon 9 proved that the impacts upon the nearest sensitive receivers were seen as meeting with appropriate acoustic guidelines, the use of the Falcon 9 was not indicative of the size of rockets to be launched from Whalers Way. In fact, the Falcon 9 was approximately four times larger than the largest rocket expected to be launched on the site.

The next largest rocket, the Blue Origin New Shepard was slightly smaller than the largest rocket expected, so represented close to, but not, the upper bounds of the size of vehicle to be launched from the proposed facility. In order to provide a more realistic quantum of the types of rockets to be launched from Whalers Way, further work was undertaken which enabled the software to be tailored for custom rocket vehicles based on size, thrust, tonnage and other technical metrics. This enabled the software to be tailored for custom rocket vehicles based on size, thrust, tonnage and other technical metrics.

A realistic upper bounds vehicle was then inputted into the software which was the 137 tonne Vega Orbital rocket. By comparison the Falcon 9 which was previously used is 549 tonnes. This has provided Southern Launch with a realistic set of noise measurements.

The version of this Terrestrial Biodiversity Report is an update to address comments received during the public exhibition period of Environmental Impact Statement (EIS), to include the results from the

Test Launch 1 of the Project's Test Launch Campaign and the results of a further targeted fauna survey completed in December 2021 during consideration of the relocation of Launch Site A.

This report presents the results of the field surveys, an assessment of impacts, and the significance of impacts on species of State and Commonwealth conservation significance. The report has addressed the Assessment Guidelines prepared for this Project by the State Planning Commission (SPC 2020).

Terrestrial Biodiversity Assessment

Six vegetation associations were described and mapped, including four Low Shrublands and two Mixed Mallee complexes. Vegetation condition was largely moderate to high except at Infrastructure Site D where vegetation condition was lower due to historical degradation.

One flora species, the West Coast Mintbush (*Prostanthera calycina*) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was considered likely to occur within the Project Area post the desktop assessment and baseline survey. A further three State listed flora species protected under the South Australian *National Parks and Wildlife Act 1972* (NPW Act) were considered likely to occur within the Project Area post the desktop assessment and baseline survey:

- Alcock's Wattle (*Acacia alcockii*), Rare under the NPW Act;
- Port Lincoln Guinea-flower (*Hibbertia cinerea*), Rare under the NPW Act; and
- Western Daddy-long-legs (*Caladenia bicalliata ssp. bicalliata*), Rare under the NPW Act.

No conservation significant flora or Threatened Ecological Communities (TECs) protected under the EPBC Act or NPW Act were recorded during the targeted flora surveys and are considered unlikely to be present.

Six Threatened bird species were recorded during the field surveys (baseline and targeted) including four species listed under the EPBC Act:

- Diamond Firetail (*Stagonopleura guttata*), Vulnerable NPW Act;
- Eastern Osprey (*Pandion haliaetus*), Migratory and Marine EPBC Act, Endangered NPW Act;
- Mallee Whipbird or White-Bellied Whipbird (*Psophodes leucogaster leucogaster*), Vulnerable EPBC Act, Endangered NPW Act;
- Rock Parrot (*Neophema petrophila*), Rare NPW Act;
- Southern Emu-wren (Eyre Peninsula) (*Stipiturus malachurus parimeda*); Vulnerable EPBC Act, Endangered NPW Act; and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Marine EPBC Act, Endangered NPW Act.

Three fauna habitats were defined and mapped including Coastal Heath, Shrubland on Scree, and Low Mallee.

Impact Assessment

For the purposes of the impact assessment a Project Area was defined within which all activities necessary for the purposes of constructing and operating the Project will occur. Project impacts considered planned activities (i.e. construction of launch pads and associated infrastructure, vehicle movement, rocket launches) and unplanned events (i.e. chemicals spills, launch failures) that may occur.

Impacts that have been considered include:

- Clearing of native vegetation;
- Degradation of adjacent vegetation;
- Fauna species injury or mortality;
- Disturbance to breeding and foraging habitat;
- Displacement of species from invasion of weed and pest species;

- Edge effects;
- Habitat fragmentation;
- Barrier effects;
- Dust and light;
- Noise;
- Contamination of surface water (chemical spills); and
- Increased fire risk.

Of these, clearing of native vegetation, noise, increased fire risk and light pollution are likely to lead to impacts to flora and fauna.

For this assessment only species listed under State or Commonwealth legislation have been considered. Significant environmental values that may be impacted are summarised below:

- The clearance of 23.4 hectares (ha) of native vegetation is considered level 4 clearance and is seriously at variance with principle 1a and 1b and at variance with principle 1e of the Principles of Clearance under the *Native Vegetation Act 1999* (NV Act);
- Clearing 23.4 ha of native vegetation which will be offset through a Significant Environment Benefit (SEB) of 2606.94 SEB points, which results in a $1,816,951.65 offset plus an administration fee of $99,932.34 to the South Australia Native Vegetation Council (NVC) under the SA NV Act. Southern Launch will provide a SEB in the form of an inground offset provided by SEB credit providers within the region. SEB offsets will be like-for-like with habitat cleared; and
- Significant impact to two fauna species listed as Threatened under the EPBC Act including the Mallee Whipbird and the Southern Emu-wren (Eyre Peninsula) including habitat loss, increased fire risk, fauna mortality from vehicle strike, and indirect impacts that may lead to behavioural changes from noise.

Other impacts that were identified include:

- Two inactive nests for the Eastern Osprey located greater than 2 km from the Project Area where rocket launches are proposed. Potential indirect impacts to the Eastern Osprey and White-bellied Sea-eagle may occur;
- Direct and indirect impacts to State listed fauna species including habitat loss, fauna mortality from vehicle strike, and indirect impacts that may lead to behavioural changes from noise and light; and
- Habitat loss of 23.4 ha for State listed fauna species will be managed as part of the SEB offsets package proposed for the Project.

Noise from launches would temporarily alter the quiet setting of the natural environment for one to two minutes during launches and for up to 15 seconds during testing. These events have the potential to disturb nearby residents and have an adverse physiological or behavioural impact on the wildlife located in the local habitat. Predicted noise levels from launch of a Vega rocket are less than the recommended Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) guideline criteria of 140 dB L_{Amax} and 93 dB $L_{Aeq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to birds as a result of a nominal worst case rocket launch. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system.

The Southern Emu Wren (Eyre Peninsula), Mallee Whipbird and other protected species that inhabit the areas close to the launch site are at greatest risk of increased stress, adverse behaviour reactions, and physiological impacts. Coastal species are predicted to generally be exposed to low levels of noise however a brief behavioural response is possible.

A test launch campaign to further assess the potential noise impacts on bird species has been commissioned for the Project, with one launch taken place.

Test Launch 1 Impacts

Avian surveys of multiple control sites were undertaken, within the Lincoln National Park (NP) as well as multiple sites within the Project Area and immediate surrounds at Whalers Way, in August 2021 (Pre-Launch) and September 2021 (Post-Launch) during Test Launch 1. The avian surveys collected short-term behavioural response data of the local avian community. No immediate short-term impacts on local avian community and particularly the two focal species, Southern Emu Wren (Eyre Peninsula) and Mallee Whipbird were concluded from Test Launch 1. Despite this, it is highly recommended that further survey work to determine potential longer-term impacts of launches is undertaken. In proposing future avian surveys for the two focal species, breeding and non-breeding season should be considered a factor in the likelihood of observing the actual number of birds at sites of interest. Long-term monitoring should consider the deployment of Autonomous Recording Units to gather long-term data on species richness in addition to call frequency of all local avian species in the areas of interest.

Queensland Hapith I Static Motor Test

A static motor test was undertaken at Helidon, Queensland on 9 June 2022 where Resonate collected noise data at eight locations between 60 m and approximately 6 km from the test site. This static motor test has provided further data that noise levels did not exceed the permanent hearing damage threshold of 140 dB L_{Amax} or the 93 dB $L_{Aeq,24hr}$ TTS threshold shift for temporary hearing loss in birds, at any of the measurement locations.

Measured noise levels were compared to predicted noise levels (using RUMBLE 3.0 modelling software) which showed that measured levels were less than or equal predicted levels at all locations, with the exception of one location. At this location measured levels were 3 dB higher than predicted; however this was likely caused by reflection of noise from topographic features and structures specific to the test site. In general the comparison to modelling showed that the model tended to over-prediction noise levels and is therefore conservative, although this finding may be limited to static tests. Further noise monitoring of launch events is recommended to provide additional model validation data.

The noise data also showed noise from the static test was audible above background levels at all monitoring locations, however noise levels were of a similar magnitude or less than noise from vehicle pass-bys at monitoring locations 937 m and 2,060 m from the test site. Based on Dooling & Popper (2016) a similar test at Whalers Way has the potential for a brief behavioural response in bird species.

Mitigation Measures

The mitigation hierarchy as devised by the NVC (2017) has been applied during the design of the Project. This included reducing the footprint as far as practicable to avoid clearing native vegetation, and implementing a CEMP and OEMP to manage indirect impacts during construction and operation. They also include:

- Reduction of the footprint as far as practicable to avoid clearing native vegetation with the size of the Project Area reduced in size from 70.58 ha to 23.4 ha from concept design. This clearance area may be further reduced through refinements made during final design and construction;
- The results from the Site Selection Survey and Test Launch 1 of the Test Launch Campaign identified the original location of the Launch Site A contains high density of records of the Southern Emu-wren (Eyre Peninsula) and it was inferred that habitat within the original location for Launch Site A is critical habitat for the species. Considering the data collected during the Test Launch Campaign and the submissions received during the public exhibition period of the EIS, a further targeted bird survey for both the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird at multiple site options for Launch Site A was undertaken. The key objective was to identify a new location for Launch Site A to minimise impacts to both species as much as possible, with consideration of ecology, heritage, and launch trajectories constraints. A new proposed site location for Launch Site A has been identified that will have a lower impact on the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird compared to the original Launch Site A option. Full details of this relocation of Launch Site A is provided in the Response Document;
- Proposed access tracks have been aligned with existing public access tracks where possible;

- The Project incorporates micro-lift and small-lift rocket vehicles that do not require large areas for infrastructure;
- Areas that will be cleared to support construction, such as batter slopes and access, will be rehabilitated in accordance with a rehabilitation plan;
- Rehabilitation of tracks that are remnants of previously visited but closed areas or unnecessary areas are proposed to be rehabilitated as a staged approach utilising clearance material from clearance areas. Rehabilitation will consist of ripping off the existing base material where present, spreading of topsoil from other clearance areas which will provide the seedbank, and placement of organic material on top to stabilise and prevent erosion until natural regeneration occurs. These rehabilitation areas will act in reducing fragmentation of vegetation within the primary Southern Emu-wren (Eyre Peninsula) habitat;
- Mitigation measures outlined in the CEMP and OEMP will include monitoring and contingency actions to ensure that the proposed management measures are effective and fit-for-purpose;
- Specific Management plans will be prepared for the ongoing protection of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird during construction and operation of the Project; and
- Indirect impacts to the Eastern Osprey and White-bellied Sea-eagle to be managed and monitored through surveys and monitoring detailed in the EBS Ecology (2022) Whaler's Way Coastal Raptor review.

Where impacts to native vegetation or threatened fauna species cannot be avoided by the Project, they will be offset through State and / or Commonwealth requirements.

The Project has been referred to the Commonwealth Department of Agriculture, Water and Environment (DAWE) under the EPBC Act (EPBC Ref: 2021/9013). On 10 September 2021, a delegate of the Minister for the Environment decided that the proposed action is a controlled action and that it will be assessed by preliminary documentation. Southern Launch are in the process of preparing the preliminary documentation, EPBC Offset Package and specific management plans for Threatened species.

The Project will be referred to the NVC under the SA *Native Vegetation Act 1991* (NV Act).

1.0 Introduction

1.1 Project Overview

AECOM Australia Pty Ltd (AECOM) were engaged by SouthernLaunch.Space Pty Ltd (Southern Launch) to undertake a terrestrial biodiversity assessment for the Whalers Way Orbital Launch Complex (WWOLC) (the Project). Southern Launch is proposing to establish a multi-user rocket launch facility that will service the growing demand for the launch of domestic and international vehicles for Polar and Sun Synchronous orbit satellite insertion.

The complex will be designed to launch the latest technology 'smallsat' satellites, which are typically weighted between several kilograms ('cubesat') to a maximum of several hundred kilograms. Consequently, the launch vehicles (rockets) will also be relatively small (in comparison to earlier satellite launch vehicles and heavy-lift rockets), typically being in the range of 10 to 30 m tall.

It is expected the of operation of the WWOLC will accommodate in the order of one rocket launch per two months, increasing over time to one rocket launch per fortnight to a maximum of 36 launches per year. Whilst several weeks of preparation will be involved in preparing for a launch, the actual launch itself, from ignition to orbit, will take approximately 45 minutes. Of this time, the launch will only result in impacts on the terrestrial site and locality for a period of up to three minutes.

The WWOLC is proposed to be developed in stages over time in response to emerging market opportunities and conditions.

The current proposal represents the initial development of the complex and is the subject of the Environmental Impact Statement (EIS) at the state level for the Project. It comprises two separate rocket launching sites and supporting infrastructure.

The Project comprises of the following key components, which hereinafter will be referred to as the Project Area (see Figure 1):

- Launch Site A;
- Launch Site B;
- Infrastructure Site D;
- Range Control Facility Site E;
- Access Upgrades; and
- General Site Infrastructure.

The key components are further detailed in Table 1. The supporting infrastructure and temporary facilitates required during construction will be located within the relevant Project Area footprint either being the launch site, infrastructure site or range control facility detailed above. This ensures the total Project disturbance footprint is within the Project Area assessed throughout this report.

Two launch sites are proposed containing a range of elements and structures and will provide integrated, and largely self-contained facilities for the assembly, preparation, staging, fuelling, and the launch of the various vehicles to be launched from the WWOLC.

As a result of the comments received from the SA Government, public submissions provided, and further analysis undertaken by Southern Launch's ecology and cultural heritage advisors, an alteration to the proposed Launch Site A has been made. This launch site will be moved 700 m to the north east as depicted in Figure 15.

Launch Site A was originally closer to the coast. Assessment of the original site suggested the disturbance to this vegetation would negatively impact upon two *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed species, the Mallee Whipbird (*Psophodes leucogaster leucogaster*) and the Southern Emu-wren (Eyre Peninsula) (*Stipiturus malachurus parimeda*) found in this area.

A thorough analysis has therefore been undertaken to identify a more suitable location from both an ecology and a cultural heritage perspective. Several sites were identified and respectfully ruled out. The ecological risk assessment is further detailed throughout this report, in particular in Section 6.3.

Table 1 Project Key Components

ELEMENT	Description	TIMING
Launch Site – Site B	A rocket launch facility sited and designed to support small lift launch vehicles with sizes from micro to small conventional (less than 10 tonnes up to approximately 60 tonnes).	Stage 1 - 2022
Range Control Facility – Site E	A permanent range control facility which will provide facilities for launch control, range control, security, office, administration, and visitor facilities.	Stage 2 – 2022/2024
Infrastructure Site – Site D	Infrastructure facilities including a dam, magazine, and ancillary storage facilities.	Stage 3 – 2022/2024
Launch Site – Site A	A rocket launch facility which will predominantly be utilised for larger launch vehicles (greater than 30 tonnes to up to approximately 100 tonnes).	Stage 4 – 2024/2025
Access Upgrades	Existing access tracks will be upgraded as required to provide appropriate all-weather access to each of the sites. New access connections will be provided to connect the sites to the existing and upgraded access tracks.	Progressively from the commencement of the Project.
Supporting Infrastructure	• Diesel and/or Hydrogen Fuel Cell Powered Generators. • Helicopter Pad(s). • Water Tanks. • Water Capture and Treatment Systems associated with each site. • 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. • Construction of internal access roads. • Visitor viewing area and interpretative facilities. • Signage. • Lighting. • Noise monitoring equipment. • Radar and telemetry equipment. • Safety and security related upgrades including fencing, gates, cameras and sensors.	Progressively from commencement of project as each launch site is developed.
Temporary facilities required during construction	• Temporary concrete batching plant. • Temporary site and construction offices and facilities. • Temporary water storage. • Temporary laydown areas. • Temporary access tracks.	At the commencement of each stage of construction.

For further details of the construction and operation aspects of the Project refer to the Project Description within the Response Document.

The Project was declared a Major Development under the South Australian *Development Act 1993* (Development Act) by the Minister for Planning on 22 August 2019.

The Project has been referred to the Commonwealth Department of Agriculture, Water and Environment (DAWE) under the EPBC Act (EPBC Ref: 2021/9013). On 10 September 2021, a delegate of the Minister for the Environment decided that the proposed action is a controlled action and that it will be assessed by preliminary documentation.

1.2 Location

The Project Area is located at the southern tip of the Eyre Peninsula in Sleaford, commonly known as Whalers Way (see Figure 1). It is approximately 25 km southwest of Port Lincoln in South Australia (SA), in the District Council of Lower Eyre Peninsula and comprises a portion of the allotment identified in Table 2. The land is owned by Theakstone Property Pty Ltd. Southern Launch have entered into a Commercial Access License ('the License') with Theakstone Property Pty Ltd for specified purposes associated with the Project.

The Project Area has access from Right Whale Road at the north eastern corner of the land. Access to the Project Area from Port Lincoln follows Proper Bay Road, Fishery Bay Road to Right Whale Road before entering the site and continuing via private access track commonly known as Whalers Way Road.

Table 2 Certificate of Title for the Project Location (as of June 2020)

Allotment	Plan	Hundred	Volume	Folio
101	71437	Sleaford	5993	374

1.3 Purpose of the Report

The purpose of this report is to:

- Present the results of the terrestrial biodiversity assessment;
- Define the potential Project impacts and determine the significance of these impacts on species of conservation significance;
- Assess potential terrestrial biodiversity impacts from the construction and operation of the Project; and
- (where required) Identify feasible and reasonable mitigation measures.

This technical report has been prepared to address DIT's Assessment Guidelines for the Project that are associated with terrestrial biodiversity. The structure and content of the report has been specifically designed to support the Major Development Application and provide sufficient information to satisfy the requirements of Commonwealth and State legislation and be used to inform a Native Vegetation Clearance Application

This version of the Terrestrial Biodiversity Report is an update to address comments received from both the public and key government stakeholders during the public exhibition period of the EIS, to include the results from the Test Launch 1 and the results of the targeted fauna survey completed in December 2021 for the relocation of Launch Site A.

PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 07 FEB 2022

AECOM
www.aecom.com

N

Coordinate System: GDA 1994 MGA Zone 53

0 250 500 1,000

metres

1:20,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones

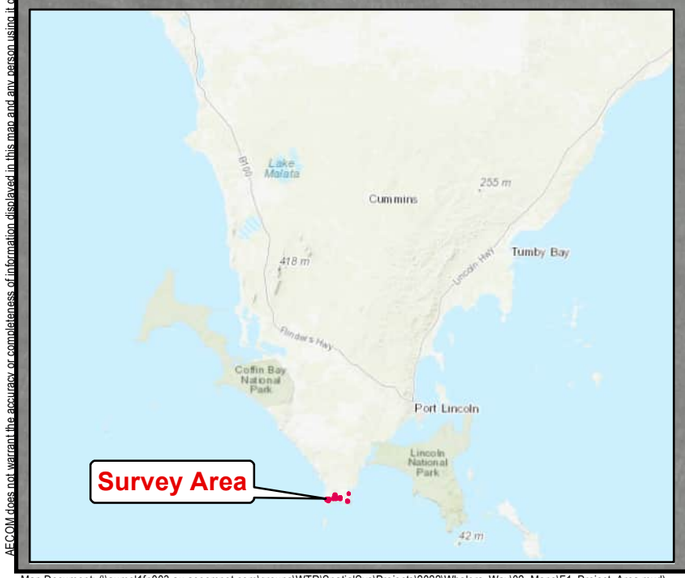
Range Control Site E

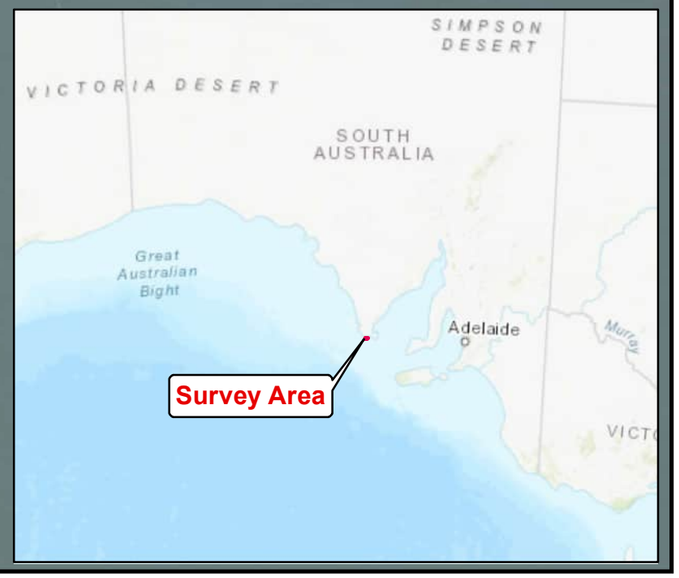
Infrastructure Site D

Launch Site A

Launch Site B

Whalers Way Rd





Project Area

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F1

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F1_Project_Area.mxd)

2.0 Legislative Framework

An overview of the Commonwealth and State legislation that is relevant to environmental aspects of the Project is presented in Table 3.

Table 3 Legislation Description and Relevance to the Project

Legislation	Description and Project Relevance
Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999	The EPBC Act protects Matters of National Environmental Significance (MNES) which includes Ramsar Wetlands, Threatened species, Threatened ecological communities (TEC) and Migratory species. Any significant impacts on MNES requires the approval of the Commonwealth Minister for the Environment. This is done though a three-step process: Referral, Assessment, and Approval. This technical report will inform the Referral stage of this process. The Commonwealth Department of Agriculture, Water and Environment (DAWE) assesses the information in the Referral and attachments (including this report) and makes recommendations to the Commonwealth Minister for the Environment (or delegate) on whether the project impacts are significant enough to require Assessment and Approval.
South Australia	
Planning, Development Infrastructure Act 2016	The *Planning, Development Infrastructure Act 2016* (PDI Act) provides for planning and regulates development in the State, to regulate the use and management of land and buildings and the design and construction of buildings. Subject to this Act, no development may be undertaken unless the development is an approved development. A development is an approved development if, and only if, a relevant authority has assessed the development against, and granted consent in respect of the provisions of an appropriate Development Plan. The PDI Act establishes a new planning and development scheme to replace the current scheme operating under the Development Act.
Landscape South Australia Act 2019	Under the *Landscape South Australia Act 2019* (LSA Act) landholders have a legal responsibility to manage declared pest plants and animals and prevent land and water degradation. Under the LSA Act there is eight new regional Landscape SA boards (LSA boards), responsible for administering the LSA Act.
National Parks and Wildlife Act 1972	Native plants and animals in SA are protected under the *National Parks and Wildlife Act 1972* (NPW Act). It is an offence to take a native plant or protected animal without approval. Threatened plant and animal species are listed in Schedules 7 (Endangered species), 8 (Vulnerable species) and 9 (Rare species) of the NPW Act. Persons must not: • Take a native plant on a reserve, wilderness protection area, wilderness protection zone, land reserved for public purposes, a forest reserve or any other Crown land; • Take a native plant of a prescribed species on private land; • Take a native plant on private land without the consent of the owner (such plants may also be covered by the NV Act; • Take a protected animal or the eggs of a protected animal without approval; • Keep protected animals unless authorised to do so; and • Use poison to kill a protected animal without approval.

Legislation	Description and Project Relevance
Native Vegetation Act 1991	Native vegetation in SA is protected under the NV Act and *Native Vegetation Regulations 2017*. Any proposed clearance of native vegetation in SA (unless exempt under the *Native Vegetation Regulations 2017*) is to be assessed against the NV Act Principles of Clearance and requires approval from the Native Vegetation Council (NVC). The Project is considered to fall under Part 3, Division 5, Regulation 12 & 13 Major Developments and Projects. The requirements a proponent must undertake for the clearance of native vegetation for Major Developments and Projects include: • Notification or application to NVC: In accordance with the PDI Act, the NVC is provided an EIS, Public Environment Report or Development Report for comment; • Assessment: The NVC will assess the clearance against whether there are any other alternatives that involve no clearance, less clearance or clearance of vegetation that is less significant (or has been degraded to a greater extent than the vegetation proposed to be cleared); • Approval: Clearance can occur if development consent is granted under the PDI Act and the provision of a Significant Environmental Benefit (SEB) (on-ground or payment) is approved by the NVC; and • SEB: Required as per SEB approval (or payment into the Native Vegetation Fund).

3.0 Methodology

The scope included a terrestrial biodiversity assessment and impact assessment, described below.

3.1 Terrestrial Biodiversity Assessment

The terrestrial biodiversity assessment included a desktop assessment, baseline field survey, targeted field survey, data processing, and a reporting component.

3.1.1 Desktop Assessment

A detailed desktop assessment was conducted to inform the baseline field survey, describe the existing environment, and determine the potential environmental values present within the Project Area. The desktop assessment considered the following resources:

- The EPBC Act Protected Matters Search Tool (PMST) administered by DAWE was searched for an area encompassing an additional 10 km buffer on the Project Area (DAWE 2020a);
- The Department for Environment and Water (DEW) Biological Databases of SA (BDBSA) via NatureMaps was used to identify flora and fauna records and vegetation mapping (DEW 2020a);
- SA Resources Information Gateway (SARIG, 2020); and
- Eyre Peninsula fauna surveys 2004 and 2009 as published on NatureMaps (DEW 2020b) and in Brandle (2010).

Additional reports including site specific background documents and previous investigation reports were utilised as appropriate including:

- Bird Report 1982-1999 (Carpenter et al. 2003);
- Western Whipbird National Recovery Plan (DELWP 2016);
- Approved Conservation Advice for West Coast Mintbush (DEWHA 2008);
- Approved Conservation Advice for Southern Emu-wren (Eyre Peninsula) (DotE 2013a);
- Species Profile and Threats Database for Australian Fairy Tern, Mallee Whipbird, Southern Emu-wren, Eastern Osprey (DAWE 2020);
- Approved Conservation Advice for Fairy Tern (DSEWPC 2011);
- Distribution and status of the Osprey in South Australia (Dennis, T.E. 2007a);
- Behavioural Ecology of the Southern Emu-wren (Maguire G. S. 2005);
- The Western Whipbird on Eyre Peninsula (McNamara, D. 1966);
- Status Review and Action Plan for the Southern Emu-wren (Eyre Peninsula) (Pickett M, 2002);
- Status and Distribution of the Southern Emu-wren (Eyre Peninsula) at the Proposed Cathedral Rocks Windfarm Site (Pickett, M. 2003);
- Recovery Planning for the Southern Emu-wren (Eyre Peninsula) - 2004 Survey (Pickett, M. 2004a);
- Draft Recovery Plan for the Southern Emu-wren (Eyre Peninsula) - 2005 – 2009 (Pickett, M. 2004b);
- Southern Emu-wren (Eyre Peninsula) and Western Whipbird Monitoring at the Cathedral Rocks Wind Farm Heritage Agreement Area - Spring 2004 (Pickett, M. 2004c);
- Southern Emu-wren (Eyre Peninsula) and Western Whipbird Monitoring at the Cathedral Rocks Wind Farm Heritage Agreement Area - Spring 2005 (Pickett, M. 2005);
- Habitat Management Guidelines for the Southern Emu-wren (Eyre Peninsula). Port Lincoln, South Australia (Pickett M, 2006);

- Eyre Peninsula Coastal Action Plan and Conservation Priority Study, Volume 1, Eyre Peninsula NRM Board and Department of Environment and Natural Resources, Adelaide (Caton, B., Detmar, S., Fotheringham, D., Laurence, S., Quinn, J., Royal, M., Rubbo, N. and Sandercock, R. 2011);
- The status of the Osprey (*Pandion haliaetus cristatus*) in Australia. *Journal of Raptor Research 48:* 408-414 (Dennis, T. E. and Clancy, G. P. 2014);
- A review of Osprey distribution and population stability in South Australia. *South Australian Ornithologist 43*, 38–54 (Detmar, S. A. and Dennis, T. E. 2018);
- The status of the White-bellied Sea-Eagle and Osprey on Kangaroo Island in 2005. *South Australian Ornithologist 35*, 47–51. December 2006 (Dennis TE and Baxter CI 2006);
- The White-bellied Sea-Eagle as a key indicator species by which to measure the health and stability of coastal biodiversity in South Australia. Prepared for Kangaroo Island Natural Resources Management Board 2014, updated 2015 (Dennis TE, Detmar S and Patterson C 2015);
- Distribution and status of White-bellied Seaeagle, Haliaeetus leucogaster, and Eastern Osprey, Pandion cristatus, populations in South Australia. The Journal of the *South Australian Ornithological Association Inc. V37 (Part 1)* (Dennis TE, Detmar SA, Brooks AV and Dennis HM 2011a);
- Phases and Duration of the White-bellied Sea-Eagle Haliaeetus leucogaster breeding season in South Australia and the implications for habitat management. *Corella 36*:63-68 (Dennis TE, Fitzpatrick GJ and Brittain RW (2012);
- Effects of human disturbance on productivity of White-bellied Sea-Eagles (*Haliaeetus leucogaster*). *Emu 111*:179-185 (Dennis TE, McIntosh RR final inspection and Shaughnessy PD 2011b);
- A review of Osprey distribution and population stability in South Australia. *South Australian Ornithologist 43* (1-2) (Detmar, S. A. and Dennis, T. E. 2018);
- A review of White-bellied Sea-Eagle distribution and population stability over time in South Australia. *South Australian Ornithologist* Pp.55-71 (Dennis T.E. and Detmar, S.A., 2018);
- Detailed assessment of potential impacts to Eastern Osprey and White-bellied Sea-eagle at Whalers Way (Jacobs 2020); and
- Whaler's Way Coastal Raptor Review (EBS Ecology 2022).

A likelihood of occurrence assessment was completed for all Threatened species and communities that were identified in the desktop assessment. The existing environment of Whalers Way and the Project Area was used to determine the likelihood of occurrence.

The likelihood assessment considers the presence of suitable habitat, number of records, date of records, and proximity of known records to Whalers Way. Four categories are used for the assessment, including:

- **Unlikely**: No preferred/suitable habitat present. Species unlikely to be present on the site at any time or during any season. No records of species/community in Project Area;
- **Possible**: Potentially suitable habitat present lacking condition, specific floristics, or complexity data. Species may visit or fly over however habitat is unlikely to be considered critical to the survival of the species. No recent records of species/community in Project Area;
- **Likely**: Suitable habitat is present. One or more recent records of species/community; and
- **Known**: Species known to be present, confirmed records and suitable habitat is present.

The likelihood of assessment was undertaken initially at the desktop assessment stage of the Project and then updated post the baseline surveys and targeted flora and fauna surveys. Refer to Appendix

E for likelihood of occurrence assessment for Threatened flora species and Appendix F for likelihood of occurrence assessment for Threatened fauna species.

3.1.2 Field Survey

A baseline field survey was undertaken between 16 - 19 March 2020 by a NVC Accredited ecologist.

3.1.2.1 Flora and Vegetation

A vegetation survey was undertaken in accordance with the NVC Bushland Assessment Method (BAM) (Native Vegetation Council, 2019). The NVC BAM was designed for assessing vegetation that is located within the agricultural region of SA. The BAM uses biodiversity 'surrogates' or 'indicators' to measure biodiversity value against benchmark communities. Each area to be assessed is termed an application area (Launch Site), within which different vegetation associations (Sites) are identified.

Three components of the biodiversity value of the site are measured and scored (Table 4) including vegetation condition, conservation value and landscape context. These three component scores are combined to provide a Unit Biodiversity Score (UBS) for a hectare (ha) which can be multiplied by the size of the Site (ha) to provide a Total Biodiversity Score for the Site.

The Project Area was traversed on foot and a flora species inventory was recorded.

Table 4 Components Measured to Determine the Biodiversity Value of a Site

Parameter	Factors
Vegetation condition	• Vegetation utilisation (i.e. level of grazing); • Biotic (i.e. presence of litter mats and palatable shrubs under canopies) and physical disturbance (i.e. bare scalds, tracks and other soil disturbance); • Vegetation stratum; and • Introduced plant species cover (i.e. weed cover).
Conservation value	• The presence of Commonwealth or State listed Threatened ecological communities, and their conservation rating; • Number of Threatened plant species recorded at the site, and their conservation rating; and • Number of Threatened fauna species for potential habitat occurs within the site, and their conservation rating.
Landscape context	• Number of landform features in the Project Area; • Size of the Project Area; • Percentage (%) of vegetation protected within the Interim Biogeographic Regionalisation for Australia (IBRA) sub-region; and • Presence of a wetland, watercourse or lake.
Mean annual rainfall	• The mean annual rainfall for the assessment area.
Area of clearance	• The area of native vegetation (ha) to be cleared for the Project.

Targeted searches were conducted for Threatened flora species that were considered likely to occur in the Project Area. A ramble survey method was adopted (i.e. randomly walking through areas of vegetation attempting to cover different topography and habitats) to ensure best coverage of the Project Area.

Where Threatened flora species were identified, the following was recorded:

- Location using a handheld Global Positioning System (GPS) unit (accuracy 5m);
- Population extent;
- Vegetation association; and
- Additional habitat observations where relevant.

3.1.2.2 Fauna and Fauna Habitat

Fauna habitats were assessed for specific habitat components including consideration of structural diversity and refuge opportunities for fauna, in order to determine the potential for these habitats to support Threatened species. The survey focussed on searching for habitat that would be utilised by Threatened species identified in the desktop assessment as having the potential to occur in the area.

Fauna habitat assessments were undertaken at sample point locations throughout the Project Area that were considered the best representative of the area where qualitative aspects such as canopy coverage, surface strew, litter, and understorey density were recorded. The fauna habitat assessments included:

- Location;
- General habitat description;
- Habitat condition and disturbance types;
- Dominant/characteristic flora species and vegetation layers;
- Presence and abundance of key habitat features such as large mature trees, small and large hollows, fallen logs, course and fine litter, decorticating bark, bare ground, grass, stones and boulders, rock crevices, soil cracks, vines, dense shrubs, and water bodies;
- Presence of fauna and secondary signs (e.g. scats, digging, tracks, burrows, egg shell, bones, feathers); and
- Connectivity of habitat.

Fauna observations focussed on avian species, using distinctive calls and direct observation. All observations were made between daylight hours of 0700 and 1700.

3.2 Targeted Fauna Survey

Targeted fauna surveys were commissioned following the baseline survey to determine the presence and extent of particular Threatened fauna species utilising the native vegetation at Whalers Way. Two fauna species of conservation significance including the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird were subject to additional targeted field surveys between 22 - 24 June 2020.

Methods utilised to conduct field surveys were informed by relevant available information for the two species including:

- Species Profiles and Threats database information (DAWE 2020b);
- Approved Conservation Advice for *Stipiturus malachurus parimeda* (Southern Emu-wren - Eyre Peninsula) (DotE 2013a);
- Survey Guidelines for Australia's Threatened Birds: Guidelines for detecting birds listed as Threatened under the EPBC Act (DEWHA 2010); and
- Behavioural Ecology of the Southern Emu-wren (*Stipiturus malachurus*) (Maguire 2015).

The Southern Emu-wren (Eyre Peninsula) assessment was undertaken as a broadscale assessment, covering an area of approximately 350 ha over 3 days (DEWHA 2010). The overall assessment was comprised of targeting known records and then searching within key habitat types where previous observations have not been made to fill gaps in distribution. Within the Project Area those known habitats which occur but without known records, were also checked for observations.

All previous records within the Whalers Way area were from 2002 -2008. No new records since that period have been made nor any known records lodged with DEW confirmed since then.

The methodology involved walking through the preferred habitat and listening for calls or physical signs of the species. If a call was heard or brief sightings, judicious use of call playback applications were used to confirm the sighting. A hand held GPS unit was used to record the location within 10 m and the number and sex of individuals was recorded where possible.

Mallee Whipbird are incredibly difficult to observe by sight but have a highly unique and unmistakeable call. According to the Guidelines for detecting birds listed as Threatened under the EPBC Act (DEWHA 2010), they are described as timid, elusive and cryptic, occupy dense habitat and more often heard than seen. Distinctive song is usually the only indication of presence. Detection by this method is determined as the best method for this species. Five previous records in the Whalers Way area from 2004 were also recorded by call. This species was recorded frequently during baseline ecological assessments. Due to the inability in many cases to get within close range, very flexible spatial accuracy on observations is required at 0-100 m (DEWHA 2010). For further information on the species refer to Appendix A.

3.2.1 Relocation of Launch Site A Targeted Fauna Bird Survey

The results from the Site Selection Survey and Test Launch 1 of the Test Launch Campaign identified the original location of the Launch Site A contains high density of records of the Southern Emu-wren (Eyre Peninsula), and it was inferred that habitat in within the original location for Launch Site A is critical habitat for the species. Considering the data collected during the Test Launch Campaign and the EIS submissions from both the public and State Government agencies, a further targeted bird survey for both the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird at multiple site options for Launch Site A was undertaken to locate a site to minimise impacts to both species as much as possible, with consideration of ecology, heritage, and launch trajectories constraints. Through this a new proposed site for Launch Site A was determined that will have a lower impact on the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird compared to the original Launch Site A option. Full details of this relocation of Launch Site A is provided in the Response Document.

A total of five options (Options 1 – 5) were put forward for consideration for the targeted survey. Option 1 was not surveyed for the presence of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird as this site was identified as being unsuitable for cultural heritage reasons.

This additional targeted field survey was conducted between 16 -17 December 2021 using the same methodology as detailed above. Refer to Appendix B for further details.

3.3 Targeted Flora Survey

A targeted flora spring survey was commissioned following the baseline survey to determine the presence and extent of EPBC Act and NPW Act listed flora species utilising the Project Area at Whalers Way. A desktop assessment was undertaken for the individual infrastructure locations with a 20 km buffer applied. The Baseline assessment undertook a standard 10 km buffer which is typically suitable to garner a cross section of species within the local area. The location and shape of the Whalers Way area means that buffers of 10 km have 75% of the area within a marine environment and do not cover a wide range of terrestrial habitat types. An updated desktop assessment using a 20 km buffer enables a more thorough baseline in determining the extent of possible species utilising this habitat, which can then further guide a targeted assessment.

The targeted flora spring survey was undertaken by NVC Accredited ecologists between 13 – 15 October 2020.

The Project Area was assessed by means of a grid search with an approximately 10 m intervals giving a 5 m each side of the transect search. The desktop assessment guided the targeted survey with species that were considered likely to occur given highest order of priority, with other additional herbaceous annual species not previously recorded added to flora species lists for the bushland assessments.

Access tracks were assessed with one surveyor covering each side as an up and back method with approximately 10 m covered off on each side. The Whalers Way Road was assessed from a vehicle driven at walking pace along each side of the road.

Additional sites were assessed whereby areas of highest habitat preference were examined to determine if any Threatened species were present within Whalers Way but potentially not within the Project area footprints. This was largely undertaken as cliff top surveys, swales with richer soil types, or areas of poorly represented vegetation communities such as *Melaleuca* ephemeral swales immediately north of the Project Area.

Following the baseline surveys, and based on existing records and presence of habitat within the Project areas, four Threatened flora species protected under the either the EPBC Act or NPW Act were considered as likely occurring within the Project Area, and a further seven flora species protected under the either the EPBC Act or NPW Act were considered possible to occur within the Project Area. These species were targeted during the targeted spring flora survey (Refer to Section 5.1.2 for details of species).

3.4 Test Launch Campaign Ecology Surveys

Southern Launch gained approval from State Government to undertake three test launches using the non-explosive Hapith I rocket. The test launches gathered empirical data to be used to validate modelled data and to determine the impact of launches on the environment through specific observation before, during and after the three test launches. The proposed Test Launch Campaign aims to capture data that can be used to aid both the South Australian Government's Major Development Assessment and the Commonwealth Governments EPBC assessment on the proposed WWOLC. Responses received from agencies and the community during the public exhibition of the EIS suggested that further research is required. This Test Launch Campaign provides an empirical data set that can be referenced in the Response Document.

Data collection of the Test Launch Campaign includes a detailed series of works around noise and vibration monitoring, air quality monitoring and assessment of terrestrial and marine ecological effects to: (1) validate modelled data; and (2) determine the impact of launches on the environment with detailed monitoring and investigations undertaken prior, during and after each launch event.

The primary terrestrial avian species of concern within the Whalers Way area are the Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird. Both Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird have been observed at the site of the Project in 2020 during a baseline vegetation survey and a targeted bird survey (Ecosphere Ecological Solutions 2020a,b).

To measure potential impacts of the Test Launch Campaign on terrestrial avian fauna a methodology was developed by experienced fauna ecologists with specific knowledge of the two focal bird species. Avian data will be collected, as per the below proposed schedule:

- Site Selection Survey;
- Test Launch 1 – Pre-Launch Survey;
- Test Launch 1 – Post-Launch Survey;
- Test Launch 2 – Pre-Launch Survey;
- Test Launch 2 – Post-Launch Survey; and
- Test Launch 3 – Post-Launch Survey.

The intention is for Test Launch 2 and Test Launch 3 to be undertaken within a 2-3 month time period, therefore removing the requirement to undertake a Pre-Launch Survey prior to Test Launch 3. The data collected from the Post Launch Survey 2 will provide sufficient data. If Test Launch 3 is delayed greater than a three month period then this methodology will need to be revised and the requirement for a Pre-Launch Survey before Test launch 3 may be necessary.

The specific objectives of the Test Launch Campaign survey are to:

- Re-visit all impact sites (Whalers Way) and control sites (Lincoln NP) that were established during the site selection survey;
- At Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird Control and Impacts Sites:
    - Undertake terrestrial avian surveys including, 20min/2ha active searches (Birdlife 2021a and DEW biological survey methods (Heard and Channon 1997; Owens 2000)) to determine presence of common avian species and target species Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird; and

  - Undertake playback experiments before and after test launches to determine impacts on the local avian fauna community including the Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird.

- Incorporate noise and vibration monitoring data into the mapping and analysis.

Further details of methodology for the Site Selection Survey and Test Launch 1 Pre-Launch and Post-Launch Surveys is summarised below and detailed in Appendix I and Appendix J respectively.

3.4.1 Site Selection Survey

The Site Selection Survey was conducted by experienced fauna ecologists with specific knowledge of the two focal species between 15 to 18 June 2021. The field survey was conducted under the following research and ethics permits/licenses:

- Scientific Research Permit No. E27057-1 (Department for Environment and Water);
- Wildlife Ethics Committee (WEC) Approval No. 6/2021, (Wildlife Ethics Committee); and
- Scientific Licence No. 370 (Animal Welfare, National Parks and Wildlife SA).

The focus of the Site Selection Survey was to establish Impact and Control Sites, with the aim to find individuals and record individual song of each of the target species. Known locations within Whalers Way (Impact Sites) were surveyed and previous locations of Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird records in Lincoln NP were surveyed to establish Control Sites, away from potential impacts of the Test Launch Campaign.

At each site the following information was recorded for the two target species (if present):

- Location (hand-held GPS);
- Detection method (heard or seen); and
- Number of individuals.

Detection of birds: At each site a quick audio playback was used to initially detect if Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird were present at sites. At each Southern Emu-wren (Eyre Peninsula) site one surveyor briefly broadcasted either the '*malachurus* AM -song' (32 seconds) or the '*littleri* AM – song and contact calls' (29 seconds) from the electronic Michael Morcombe eGuide to the Birds of Australia.

At each Mallee Whipbird site audio playback was used initially (songs from electronic Michael Morcombe eGuide to the Birds of Australia), however given the lack of response to these stimuli surveyors stopped using playback to initiate response. Instead, surveyors listened for song at previously identified Mallee Whipbird sites. As soon as a focal bird(s) were heard and/or seen the broadcast of playback was discontinued. Both surveyors would then aim to approach the location of the focal bird species as quietly as possible, stand still and record any vocalisations (calls and or songs) that were elicited in response to the broadcast. A surveyor would spend up to 15 minutes at a site to gain multiple song recordings of the focal species.

Song recordings: To record vocalisations, a High-Resolution Digital Audio Recorder 702 or 722 with 151 a 48 kHz sampling rate and 24 bit-depth (Sound Devices, LLC, Reedsburg, WI) connected to 7 152 a NTG8 shotgun microphone (RODE Microphones, LLC, Long Beach, CA; frequency 153 response 0.04 – 20 kHz) was used.

For full details of the Site Selection Survey methodology, refer to Appendix I.

3.4.2 Test Launch 1

The Pre-Launch and Post-Launch surveys were conducted utilising the same research and ethics permits/licenses as detailed in Section 3.4.1. The Pre-Launch survey was undertaken from 18 – 21 August 2021 by two teams of two ecologists with specific knowledge of the two focal bird species. Test Launch 1 was undertaken by Southern Launch on 16 September 2021. The Post-Launch survey was undertaken from 21 – 24 September 2021 by the same two teams of two ecologists.

Avian surveys were undertaken to determine presence and abundance of common terrestrial avian species and the focal species Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird at control

and impact sites. Active Searches Surveys (20min/2ha) were undertaken from 7am onwards with a focus on a diurnal activity pattern including early mornings and late afternoons, but surveys continued throughout the day, due to changing weather conditions

At each site the following information was recorded for the two target species (if present):

- Location (hand-held GPS);
- Detection method (heard or seen); and
- Number of individuals.

Avian surveys were limited to one survey a site in a day, to eliminate the possibility of double counting a particular bird.

Playback stimuli

Recordings of local songs of the two focal species were acquired during the Site Selection Survey as detailed in Section 3.4.1 and these songs were used to prepare the playback stimuli to be used for playback experiments. Southern Emu-wren (Eyre Peninsula) stimuli consisted of a song lasting between 4–10 seconds. Mallee Whipbird songs were repeated at approximately 5-10 second intervals so that there were six series of vocalisations per minute. Given that Mallee Whipbird males defend their territory with singing bouts of 3–15 minutes duration (Webster 1966). Mallee Whipbird stimuli consisted of a song bout, lasting for one minute. A total of 6 Southern Emu-wren (Eyre Peninsula) and 7 Mallee Whipbird playback tracks were created using local songs.

Playback experiments

Playback experiments were undertaken before (Pre-Launch) and after the test launch (Post-Launch) at sites where there was a territorial group, to quantify potential impacts of the launch on the occurrence and behaviour of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird. Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird sites were suspected of being a territory according to previous surveys performed in 2020 and 2021, where there were multiple sightings of a focal species at the same location within a year or between surveys.

At each Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird control and impact site an audio playback of local Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird song was used to detect if either species were present at sites and to measure a behavioural response of focal territories. To control for pseudo-replication, ecologists did not perform replicate playback experiments of the same treatment at a single location either within or between survey periods. To avoid effects of habituation, playback experiments were done at least one day apart, and direct neighbours were not tested on the same day.

Playbacks were performed with a portable Ultimate Ears Wonderboom 2 Deep speaker (Ultimate Ears) with a frequency range of 75 Hz - 20 kHz and an iPhone (Apple Inc., Cupertino, CA). Ecologists placed the speaker on the ground, concealed in vegetation. During playback experiments ecologists concealed themselves as much as possible amongst vegetation to minimise any potential effect of their presence. The set-up of the phone and speaker did not take longer than 2 mins. Playback duration was for 3 minutes following 1 minute of silence (pre-trial) to perform pre-playback observations. The 3 minutes of playback consisted of 1 minute song - 1 minute silence – 1 minute song. Ecologists spend less than 10 minutes at a site to perform the experiment (including set-up and data collection).

Ecologists documented pre-playback and playback observations separately. The variables recorded were: 1) latency (in seconds) of the focal bird to come within 20 m of the speaker, 2) latency (in seconds) of the focal bird to come within 10 m of the speaker, 3) the minimum distance (in metres) of the bird to the speaker, 4) the number of observed speaker crosses and 5) the number of vocalisations.

For full details of the Test Launch 1 methodology, refer to Appendix J.

3.5 Impact Assessment

The impact assessment takes into consideration the Project Area and the immediate surrounds of the defined Project Area, which includes the Whalers Way Peninsula to ensure both direct and indirect impacts were considered.

The Project impacts considered planned activities (e.g. construction of launch pads and associated infrastructure, vehicle movement, rocket launches) and unplanned events (e.g. chemical spills, launch failures) that may occur during construction and operation. These were used to inform the assessment against the EPBC Act *Significant Impact Guidelines 1.1 Matters of National Environmental Significance* (DEWHA 2013) (SIG 1.1) and the terrestrial biodiversity elements of the Assessment Guidelines (DPTI 2020).

The impact assessment considered impacts on terrestrial flora and fauna species protected under Commonwealth EPBC Act and the SA NPW Act.

The impact assessment considers all ecological values that occur in the Project Area. Values are discussed in terms of their listing status, existing knowledge and the potential for Project interaction.

The assessment of impacts on terrestrial species considered the following relevant documents and guidelines:

- Conservation Advice for West Coast Mintbush (*Prostanthera calycina*) (DEWHA 2008);
- Species Profiles and Threats database information (DAWE 2020b);
- Conservation Advice for *Stipiturus malachurus parimeda* (Southern Emu-wren - Eyre Peninsula) (DotE 2013a);
- Conservation Advice for Fairy Tern (*Sternula nereis nereis*) (DSEWPAC 2011); and
- Behavioural Ecology of the Southern Emu-wren (*Stipiturus malachurus*) (Maguire 2015).

3.5.1 Assessment of Matters of National Environmental Significance

Section 6.5 provides an assessment against the SIG 1.1. The Project has the potential to have a significant impact on MNES values of Threatened species and Migratory species. The environmental values of the Project as they relate to the EPBC Act were determined through a review of the EPBC PMST (DAWE 2020a), the baseline and targeted surveys, and review of known and available scientific information on relevant EPBC Act listed species in relation to their habitat needs and requirements.

The assessment of significance of the impact was determined by considering SIG 1.1 which states:

> *'A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.*

The likelihood of the Project resulting in a significant impact is assessed as:

- Unlikely;
- Potential; or
- Likely.

3.5.2 Major Development Assessment

The Project was declared a Major Development by the South Australian Minister for Planning on 22 August 2019. The Application was referred to the independent statutory authority State Planning Commission (SPC). The SPC considered the application and identified the key social, environmental and economic issues relevant to the assessment of the proposed development and determined that it would be assessed via an EIS. Assessment Guidelines have been prepared that have been addressed in the EIS in order for SPC to conduct their formal assessment.

This report has provided an assessment against the terrestrial biodiversity guidelines focussing on ecological values including:

- Native vegetation;
- Terrestrial flora and fauna species and habitats; and
- Introduced weeds, pathogens and pests.

3.6 Limitations

3.6.1 Ecological Surveys

The compiled list of fauna observations does not represent all species expected to occur within the Project Area. Being an opportunistic only survey, the likelihood of detection of many species is largely reduced with many species active for small periods of the day or nocturnal, limiting the ability to assess their occurrence. Despite this, habitat assessment through vegetation association mapping combined with historical records allows for reasonable determination of the likelihood of presence of Threatened species.

The survey results present a snapshot in time of current conditions. Fauna species that have been recorded previously at Whalers Way (identified in the desktop assessment) were also recognised as occurring in the Project Area.

The 2020 targeted survey for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird was conducted in winter and the 2021 targeted survey was conducted in summer. Spring is considered the ideal survey time for maximising presence of these two species as both species nesting and breeding season is from spring through summer.

Marine species have been included in the desktop assessment however the report did not include an assessment of these species or impacts on these. A detailed assessment for Marine species has been captured in the Marine Biodiversity Technical Report.

3.6.2 Impact Assessment

This report and assessment have been prepared under the Assessment Guidelines and approval pathway detailed in the former Development Act. As the Project was declared a Major Project pursuant to Section 46 of the Development Act, the assessment will continue under the Development Act, notwithstanding of the implementation of the PDI Act and the Planning and Design Code for the subject site on 31 July 2020.

Species listed as Marine under the EPBC Act were not assessed as part of this assessment.

Species that had a moderate or low likelihood of occurrence in the terrestrial biodiversity assessment were not included in the impact assessment.

The assessment of significance is informed by publicly available information. Gaps in knowledge may influence the outcome of the significance assessment.

Where critical habitat for a species is not specified, the DEWHA (2013) SIG 1.1 were used which defines critical habitat as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators); and
- To maintain genetic diversity and long-term evolutionary development, or for the reintroduction of populations or recovery of the species or ecological community.

4.0 Existing Conditions

4.1 Climate

Climate at Whalers Way is classified as warm-summer Mediterranean climate under the Koppen and Geiger system. This depicts the warmest month as greater than or equal to 10 °C, and the temperature of the coldest month as less than 18 °C but greater than –3 °C. Precipitation in the driest month of the summer half of the year is less than 30 mm and less than one-third of the wettest month of the winter half. The temperature of each of the four warmest months are 10 °C or above but the warmest month is less than 22 °C.

Temperature and rainfall data were obtained from the Bureau of Meteorology (BOM) (2020) online database from weather stations North Shields (Port Lincoln AWS) and Port Lincoln (Westmere) respectively. Temperate data shows colder maximum monthly temperatures in 2019 by 1.2 °C to 3 °C. Daily minimum temperatures were relatively similar to the average mean minimum temperatures.

Rainfall in the months preceding the baseline survey in 2020 was often below average. Mean annual rainfall is 575.3 mm, with 2019 experiencing a dry year of only 436.2 mm of rain. The effects of the changing climate on flora, vegetation, and fauna species remains unknown. The baseline survey was conducted after a dry spell of eight months (Figure 2). Follow up assessments undertaken during 2020 had a rainfall total of 555 mm representing close to average rainfall and suitable for the identification of the extent of species richness present onsite.

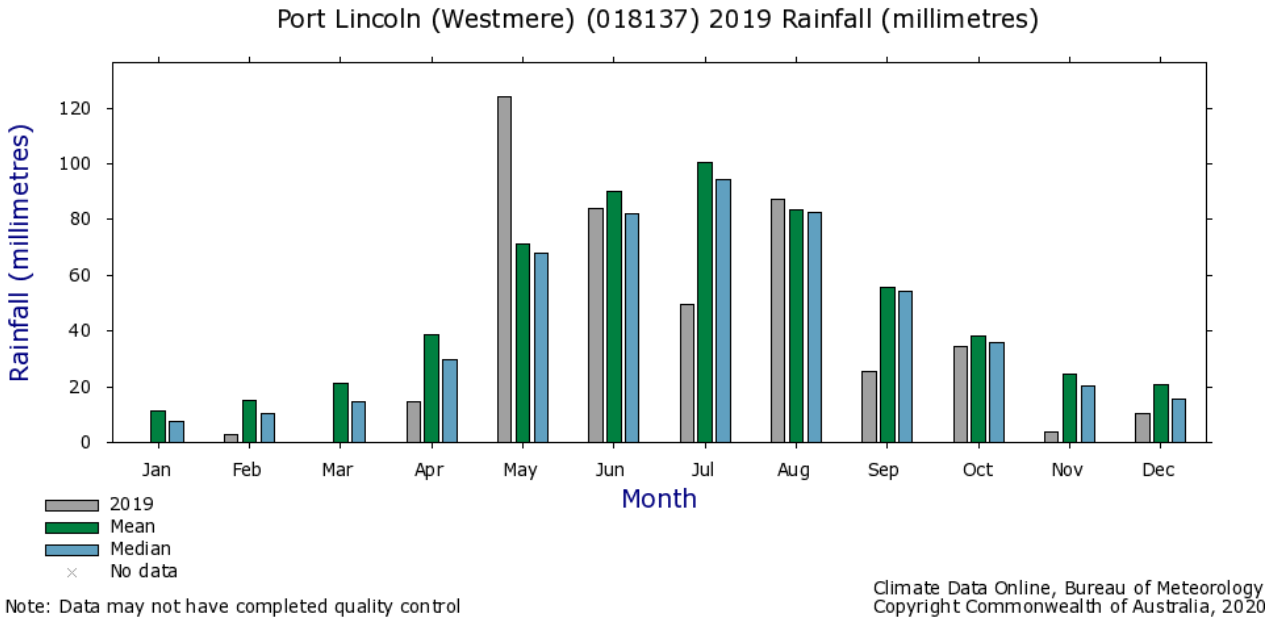


Figure 2 Rainfall Data (Port Lincoln Westmere Station 018137) (BOM, 2020)

4.2 Conservation Reserves and Marine Parks

There are no national recreation and conservation parks, or regional reserves protected under the NPW Act within the Project Area. The following conservation reserves are located within the vicinity of the Project Area:

- Thorny Passage Marine Park located approximately 500 m south of the Project Area;
- Sleaford Mere Conservation Park located approximately 8 km northeast of the Project Area;
- Lincoln NP located approximately 8 km northeast of the Project Area (which Includes Liguanea Island, within 7 km south of the Project Area); and
- Lincoln Conservation Park located approximately 13 km north of the Project Area.

4.3 Native Vegetation Heritage Agreement

A Heritage Agreement covering the Project Area was established under the former SA *Heritage Act 1978* (now replaced by the *Heritage Places Act 1993*) of Portion, registered as dealing number 6456268 listed on the current Certificate of Title for the purposes of a Native Vegetation Heritage Agreement HA 148. The Agreement is now protected under the NV Act. Under the above agreement the land (being the land subject to the agreement as depicted on the 'Plan for Heritage Agreement') is dedicated to the conservation of native vegetation and native fauna.

The Native Vegetation Heritage Agreement HA 148 will require amendment in order to facilitate the Project.

4.4 Noise

Unattended baseline monitoring was undertaken at five locations to observe and quantify the existing acoustic environment at sensitive receptors near the proposed Project infrastructure. Suitable monitoring locations were identified in areas where sensitive receptors could be affected by noise produced by the proposed construction and operational activities.

These measurements were incorporated into the field activities being carried out as part of the baseline flora and fauna survey between Tuesday 17th March and Friday 19th March 2020. It is expected that the noise environment across the study area would be like those measured at the five monitoring locations.

Measurements were undertaken continuously over several days to capture any variations in the noise environment at each site. This information provides an important 'snap-shot' of the noise levels near the proposed project infrastructure.

Existing noise levels were monitored and reported with reference to the following descriptors:

- **L_{A90} noise level**: The dBA noise level that is exceeded for 90 per cent of a specified period. Commonly referred to as the *background* noise level; and
- **L_{Aeq} noise level**: The L_{Aeq} reflects all noise occurring during the measurement period and is commonly referred to as the *ambient* noise level. It approximately equates to the average level for many typical environmental noise scenarios.

Each monitoring location was described in terms of the vegetation present in the area as outlined in Table 5. Notes included in this table provide an indication of the typical noise environment of each monitoring location.

Table 5 Measurement Locations and Site Descriptions

Site ID	Site Description	Environment Notes	Measured Noise Level, dB			
			Day (L_{A90})	Night (L_{A90})	Day (L_{Aeq})	Night (L_{Aeq})
1	*Eucalyptus angulosa*, low mixed Mallee	Low Mallee, average height approximately 1.5m tall. Some leaf rustle noise. No sea noise noted.	24	32	42	37
2	*Eucalyptus angulosa*, low mixed Mallee	Noise logger placed in semi open area where breaks in dense bush. No sea noise noted.	23	30	38	33
3	*Eucalyptus diversifolia*, mixed low Mallee	Noise logger placed in semi open area where breaks in dense bush, quite large areas of low heath breaks within patches. No sea noise noted.	23	26	39	30

Site ID	Site Description	Environment Notes	Measured Noise Level, dB			
			Day (L_{A90})	Night (L_{A90})	Day (L_{Aeq})	Night (L_{Aeq})
4	Degraded *leucopogon parvifolius*, Open shrubland	Noise logger located approximately 300 metres away from windmill. No sea noise notes.	27	35	46	41
5	*Beyeria lechenaultia*, very low shrubland	Gentle sea noise audible at western end. Very low levels of shrub noise, with very low shrubland average height of 0.5m.	24	30	51	48

Human presence near the proposed launch sites is assumed to be limited to permitted tourist activities. Accordingly, exposure to anthropogenic noise would be limited to intermittent light vehicles and light aircraft.

The local acoustic environment was observed to be predominantly influenced by weather-induced noise, such as wind interaction with nearby vegetation. This is confirmed by the measured sound pressure levels that are consistent with rural and remote areas with low residential density and little to no exposure to transportation or industrial noise.

Further detail regarding the methodology and findings from baseline noise monitoring can be found in the *Whalers Way Orbital Launch Complex - Environmental Assessment Report - Noise Assessment* (AECOM 2022).

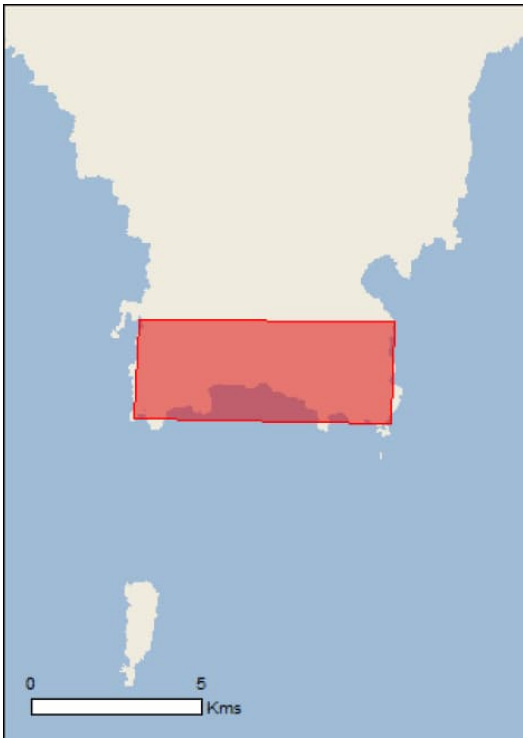
5.0 Terrestrial Biodiversity Assessment

5.1 Desktop Assessment

5.1.1 Protected Matters Search Tool

The EPBC PMST identified 44 Threatened species and 45 Migratory species listed under the EPBC Act as potentially occurring or suitable habitat potentially occur within 10 km of the Project Area (refer to Table 6). Listed Marine dependent species (i.e. turtles, sea-lions, fish, whales, other cetaceans) are included in Table 6 however are not discussed further at this stage. The PMST report is provided in Appendix D.

Table 6 EPBC Protected Matters Search Tool Results Summary

Search Area (10 km buffer)	MNES Listed under the EPBC Act	Results
	World heritage properties	None
	National heritage properties	None
	Wetlands of international importance	None
	Great Barrier Reef marine park	None
	Commonwealth marine area	1
	Threatened ecological communities	None
	Threatened species	44
	Migratory species	45
	Commonwealth land	None
	Commonwealth heritage places	None
	Listed Marine species	78
	Whales and other cetaceans	14
	Critical habitats	None
	Commonwealth reserves terrestrial	None
	Commonwealth reserves marine	None
	State and Territory reserves	6
	Regional forest agreements	None
	Invasive species	21
	Nationally important wetlands	1
	Key ecological features (marine)	2

5.1.2 Threatened Flora

The initial desktop assessment (PMST and BDBSA) identified 11 Threatened flora species that may occur within 10 km of the Project Area. Post the baseline survey a desktop assessment of a 20 km buffer was applied to enable a more through baseline in determining the extent of possible Threatened flora species utilising habitat within the region. The desktop assessment has identified 33 species of Commonwealth of State conservation including:

- Five species listed under the EPBC Act; and
- 28 species listed under the NPW Act.

Of these, four Threatened flora species are considered likely to occur within the Project Area:

- Alcock's Wattle (*Acacia alcockii*), Rare under the NPW Act;
- Port Lincoln Guinea-flower (*Hibbertia cinerea*), Rare under the NPW Act;
- Western Daddy-long-legs (*Caladenia bicalliata ssp. bicalliata*), Rare under the NPW Act; and
- West Coast Mintbush (*Prostanthera calycina*), Vulnerable under both the EPBC Act and NPW Act

An additional seven Threatened flora species are considered possible to occur within the Project Area:

- Annual Candles (*Stackhousia annua*), Vulnerable under both the EPBC Act and NPW Act;
- Eyre Peninsula Fringe-lily (*Thysanotus wangariensis*), Rare under the NPW Act;
- Hidden Leek-orchid (*Prasophyllum occultans*), Rare under the NPW Act;
- Leafless Globe-pea (*Sphaerolobium minus*), Rare under the NPW Act;
- Limestone Leek-orchid (*Prasophyllum calcicole*), Vulnerable under the NPW Act;
- Scaly Poa (*Poa fax*), Rare under the NPW Act; and
- Snowdrop Spurge (*Phyllanthus calycinus*), Rare under the NPW Act.

Lists of all flora species recorded or predicted to occur are provided in Appendix E and includes their conservation status, habitat descriptions and likelihood assessment. Those species assessed as having an unlikely occurrence in the Project Area are not considered further in this assessment.

5.1.3 Threatened Fauna

The desktop assessment (PMST and BDBSA) identified 112 Threatened fauna species that may occur within 10 km of the Project Area. This included 71 bird species, 36 fish species, 23 mammal species, and three reptile species listed as:

- Nine species listed as Threatened under the EPBC Act;
- 25 species are listed as Threatened and Migratory and/or Marine under the EPBC Act;
- 67 species are listed as Migratory and/or Marine under the EPBC Act; and
- 11 species are listed under the NPW Act.

Of these, the following Threatened fauna species are known to occur, likely to occur or possible to occur within 10 km of the Project Area:

- Australian Bustard (*Ardeotis australis*), Vulnerable under the NPW Act, known occurrence;
- Australian Fairy Tern (*Sternula nereis nereis*), Vulnerable under the EPBC Act and NPW Act, likely occurrence;
- Bar-tailed Godwit (*Limosa lapponica baueri*), Vulnerable under the EPBC Act, possible occurrence;
- Black-faced Cormorant (*Phalacrocorax fuscescens*), Marine under the EPBC Act, possible occurrence;
- Black Falcon (*Falco subniger*), Rare under the NPW Act, known occurrence;
- Cape Barren Goose (*Cereopsis novaehollandiae*) (NC), Rare under the NPW Act, known occurrence;
- Common Greenshank (*Tringa nebularia*), Migratory and/or Marine under the EPBC Act, likely occurrence;
- Diamond Firetail (*Stagonopleura guttata*), Vulnerable under the NPW Act, known occurrence;
- Eastern Osprey (*Pandion haliaetus*); Migratory and/or Marine under the EPBC Act and Endangered under the NPW Act, known occurrence;
- Elegant Parrot (*Neophema elegans*), Rare under the NPW Act, known occurrence;

- Eastern Hooded Plover (*Thinornis rubricollis rubricollis*), Vulnerable and Marine under the EPBC Act and Vulnerable under the NPW Act, likely occurrence;
- Northern Siberian Bar-tailed Godwit (*Limosa lapponica menzbieri*), Critically Endangered under the EPBC Act, possible occurrence;
- Pacific Gull (*Larus pacificus*), Marine under the EPBC Act, possible occurrence;
- Painted Buttonquail (*Turnix varius*), Rare under the NPW Act, likely occurrence;
- Peregrine Falcon (*Falco peregrinus*), Rare under the NPW Act, known occurrence;
- Purple-gaped Honeyeater (*Lichenostomus cratitius occidentalis*), Rare under the NPW Act, known occurrence;
- Rock Parrot (*Neophema petrophila*), Rare under the NPW Act, known occurrence;
- Sanderling (*Calidris alba*), Migratory under the EPBC Act, possible occurrence;
- Short-tailed Shearwater (*Ardenna tenuirostris*), Migratory and/or Marine under the EPBC Act, possible occurrence;
- Sooty Oystercatcher (*Haematopus fuliginosus*), Rare under the NPW Act, known occurrence;
- Southern Emu-wren (Eyre Peninsula), Vulnerable under the EPBC Act and Endangered under the NPW Act, known occurrence;
- Mallee Whipbird, Vulnerable under the EPBC Act and Endangered under the NPW Act, known occurrence; and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Marine under the EPBC Act and Endangered under the NPW Act, known occurrence; and
- Yellow-tailed Black Cockatoo (*Zanda (Calyptorhynchus) funerea whiteae*), Vulnerable under the NPW Act, likely occurrence.

A list of Threatened fauna species identified during the desktop assessment is provided in Appendix F. Those species that are considered to have an unlikely likelihood of occurrence are not considered further in this assessment.

5.2 Vegetation

5.2.1 Threatened Ecological Communities

No TECs are known or considered likely to occur at Whalers Way. The closest TEC is the Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Woodland, listed as Endangered under the EPBC Act. This community is known to occur approximately 30 km north of the Project Area.

5.2.2 Vegetation Associations

The Project Area encompasses 23.4 ha of native vegetation. Vegetation community composition at Whalers Way (i.e. the Project Area and surrounds) was transitional dependent on two major factors; exposure to salt laden winds, and soil type and depth. The elevation of the area ranged from 50 to 120 m above sea level.

Soil types within this area ranged from bare sheet limestone to moderately mobile sand dunes. Between these extremes, the large part of the area was highly alkaline decomposed limestone and light grey loams. Some lower elevation areas within these were grey silty loams that retained water for short periods evidenced by heavier vegetation and the presence of bog tolerant species such as Creeping brooklime (*Samolus repens*) and Stonecrop (*Crassula* sp.).

Six vegetation associations were observed within the Project Area (Table 7, Figure 3; Appendix G). Vegetation gradually transitions from one association to another, effectively causing a mosaic landscape lacking distinct changes in vegetation. The six associations were all considered typical of coastal communities that occur along the southern Eyre Peninsula.

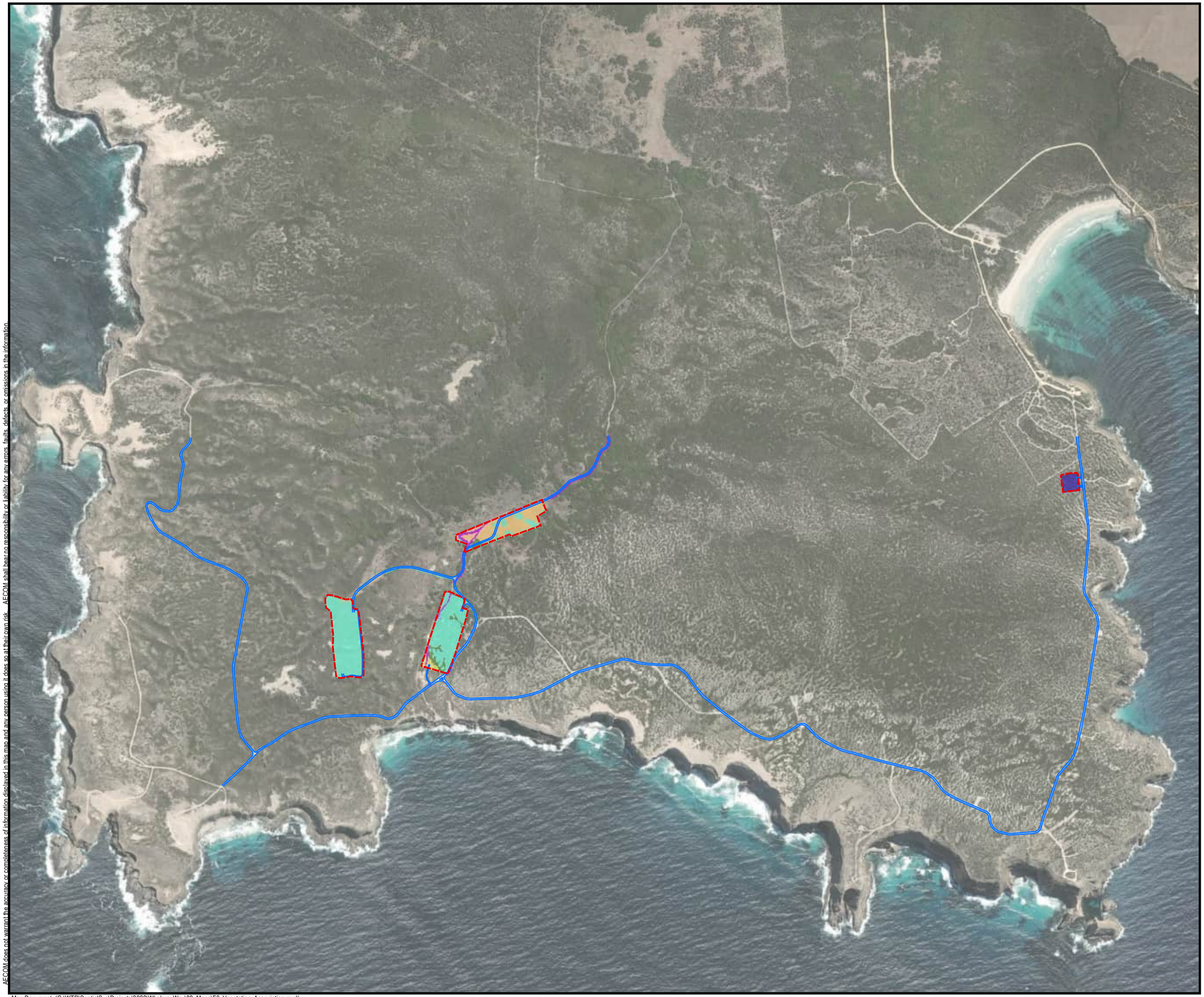
The clearance of 23.4 ha of native vegetation is considered level 4 clearance and is seriously at variance with principle 1a and 1b and at variance with principle 1e of the Principles of Clearance under the NV Act. Refer to Section 6.1.1 and Appendix K for further details on the impacts to vegetation clearance.

Table 7 Vegetation Associations Mapped within the Project Area

Number	Association Name	Association Description	Representative Photo
1	Pale Turpentine Bush (*Beyeria lechenaultii*) Dryland Tea-tree (*Melaleuca lanceolate*) Low Shrubland over sclerophyllous shrubs	Primarily dominant on the near cliff zone where stable dune habitats were present intertwined with exposed sheet limestone which was generally devoid of vegetation or contained only sparse sclerophyllous shrubs. Cover within Association 1 was generally high with the most diverse floristic community observed across the area with a mix of primarily coast front species co-habiting with other taller shrubs which were persisting in the hollows resulting in a mixed community. This association had the highest visual incidence of small skinks and dragons observed opportunistically. Low bird species richness was present with the windy conditions meaning many species were retreating to lower or more dense cover during the day.	
2	Prickly Ground Berry (*Acrotriche patula*) Very Low Open Shrubland	Occupies exposed and/or elevated sections of clifftop where a lack of soil, high alkalinity and salt laden winds result in specific niche communities dominated by ground hugging shrubs and mat plants. The average overstorey height in these areas is less than 300 mm in most instances.	

Number	Association Name	Association Description	Representative Photo
3	Coastal White Mallee (*Eucalyptus diversifolia*) Low Mixed Mallee over sclerophyllous shrubs	Recorded on stable dunes where grey sandy loams overlay sheet limestone. These were often transitional between the low coastal shrublands of the clifftop edges and the higher elevation calcareous clay loam soils. Association 3 occurs in patches, varying from circular 'hummocks' to linear lunettes further from the coast. The interpatch spaces were generally sheet limestone occupied by Association 1. With distance from the coastline, the community structure changed by way of a more continuous and taller stratum with average heights of 3.5 m and a denser canopy cover.	
4	Ridge Fruited Mallee (*Eucalyptus angulosa*) +/- Coastal White Mallee (*Eucalyptus rugosa*) Low Mixed Mallee	Present where soils were largely a calcareous silty loam. The soil surface was highly stable and formed a thick crust with high levels of biocrust and Moss species. *Melaleuca* species were a common species in this Association compared to those on lighter soils with Coastal White Mallee. Inter-patches were dominated largely by Association 6 (limestone *Callitris* sp.). In areas where the community was protected from high coastal winds the strata were taller, with an average of 3 m compared to 2 m near the coast.	

Number	Association Name	Association Description	Representative Photo
5	Coastal Bearded Heath (*Leucopogon parviflorus*) Low Very Open Shrubland over exotic annual grasses	Disturbed regenerating association with pioneer species such as Coast Bitter Bush (*Adriana quadripartita*) present that were otherwise absent from the intact sections of the Project site. Numerous environmental weed species were present throughout the area and grass species were overwhelmingly annual exotic species such as Brome (*Bromus*), Fescue (*Vulpia*) and Wild Oat (*Avena*). Overall, the condition was very poor and regeneration of local species was patchy.	
6	Native Pine (*Callitris* sp. 'Limestone') Low Shrubland	Dominated by *Callitris* sp. 'Limestone' mixed with other sclerophyllous shrubs. It occurred exclusively with Association 4 on calcareous silty loam soils. Condition of these communities was generally good with the only perennial exotic species present Sea Lavender (*Limonium companyonis*) which increased with proximity to the coast.	



PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 01 FEB 2022

AECOM
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N

Coordinate System: GDA 1994 MGA Zone 53

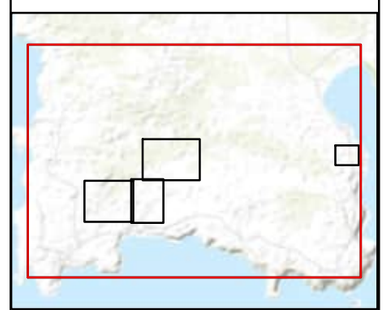
0 160 320 640

metres

1:20,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- Existing track to be maintained
- 1.*Beyeria lechnaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Teatree) Low Shrubland over slerophyllous shrubs
- 2.*Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland
- 3.*Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs
- 4. *Eucalyptus angulosa* (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee
- 5.*Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses
- 6.*Callitris canescens* (Native Pine) Low Shrubland



Vegetation Associations within the Project Area Survey Area

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F3a

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F3_Vegetation_Association.mxd)

PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 01 FEB 2022

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N

Coordinate System: GDA 1994 MGA Zone 53

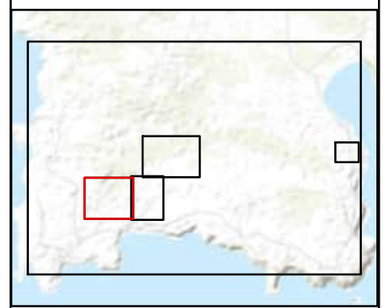
0 20 40 80

metres

1:2,750 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- 3.*Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs
- 5.*Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses
- 6.*Callitris canescens* (Native Pine) Low Shrubland



Vegetation Associations within the Project Area Lauch Site A

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F3b

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F3_Vegetation_Association.mxd)

PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 01 FEB 2022

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N

Coordinate System: GDA 1994 MGA Zone 53

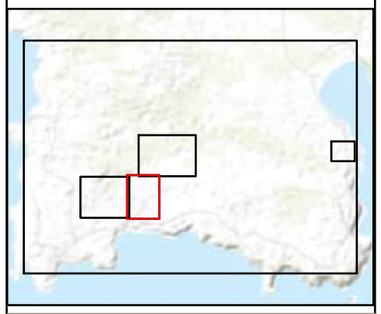
0 20 40 80

metres

1:3,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- Existing track to be maintained
- 1.*Beyeria lechnaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Teatree) Low Shrubland over slerophyllous shrubs
- 3.*Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs
- 5.*Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses
- 6.*Callitris canescens* (Native Pine) Low Shrubland



Vegetation Associations within the Project Area Launch Site B

Southern Launch Whalers Way *Flora and Fauna Assessment* Whalers Way, SA	**Figure** F3c

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F3_Vegetation_Association.mxd)

PROJECT ID 60627263
CREATED BY brierej
LAST MODIFIED brierej 01 FEB 2022

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N

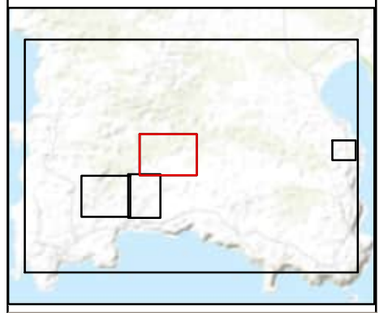
Coordinate System: GDA 1994 MGA Zone 53

0 25 50 100
metres

1:3,250 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- Existing track to be maintained
- 1.*Beyeria lechnaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Teatree) Low Shrubland over slerophyllous shrubs
- 2.*Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland
- 3.*Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs
- 5.*Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses



Vegetation Associations within the Project Area Infrastructure Site D

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F3d

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F3_Vegetation_Association.mxd)

PROJECT ID	60627263
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LAST MODIFIED	brierej 01 FEB 2022

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N

Coordinate System: GDA 1994 MGA Zone 53

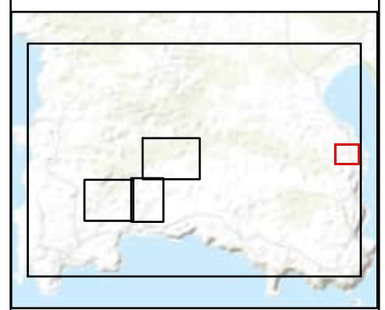
0 5 10 20

metres

1:1,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- 4. *Eucalyptus angulosa* (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee



Vegetation Associations within the Project Area
Range Control Site E

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F3e

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F3_Vegetation_Association.mxd)

The extent of the vegetation associations within the Project Area is presented in Table 8.

Table 8 Proposed Vegetation Clearance Footprint

Veg Assoc	Project Area					Total (ha)
	Site A	Site B	Site D	Site E	Access Roads	
1		0.68	0.26			**0.94**
2					0.07	**0.07**
3	7.65	6.0	1.16		1.1	**15.91**
4				1.0		**1.0**
5	0.08		4.58		0.23	**4.89**
6		0.54				**0.54**
Total	**7.73**	**7.22**	**6.0**	**1.0**	**1.4**	**23.4**

5.2.3 Vegetation Condition

The BAM assessment scores showed that Launch Site A had the highest condition score of 66.23. The condition score results from the BAM assessments are presented in Figure 4.

The scores are largely influenced by partial clearing, weed invasion and species richness.

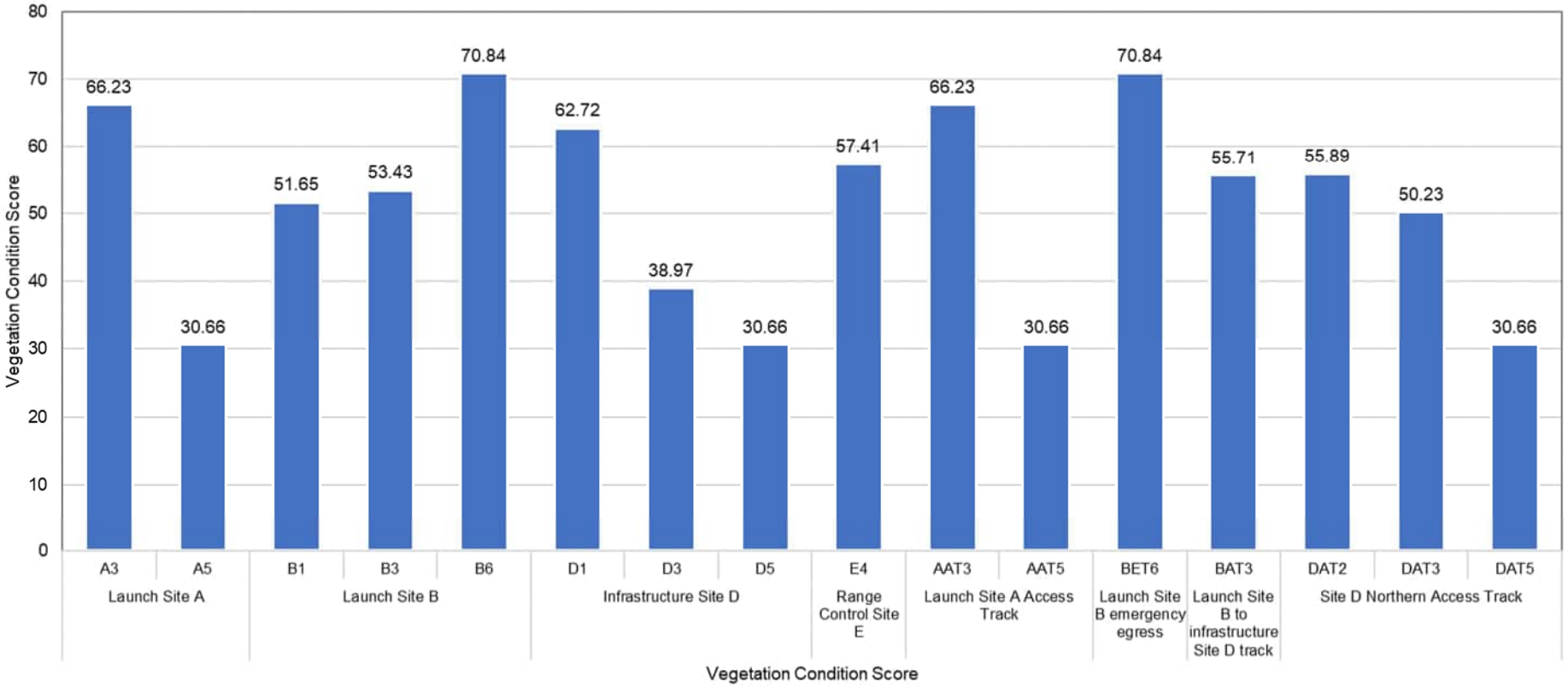


Figure 4 Vegetation Condition Scores

5.3 Flora

5.3.1 Threatened Flora Species

Following detailed assessments of the Project Area, roads/access tracks, and opportunistic searches, no Threatened flora species listed under the EPBC Act or NPW Act were observed within the Project Area or the general Whalers Way area.

The close proximity of the Project Area to the coast results in the landscape being particularly harsh and requires highly saline tolerant flora species. The alkaline nature of soils results in a very narrow pH band for nutritional availability suggesting flora species present are highly specialised.

The flora species detailed below are tolerant of these conditions, however looking over historical records show that the large majority of conservation significant records are located on the eastern side of the peninsula. These areas are likely to have a far lower salt spray load and potentially lower wind velocity.

While the vegetation is largely intact and of good condition, the diversity of flora species is comparatively low when compared with other areas of intact vegetation on the Eyre Peninsula.

There was a low likelihood of Threatened flora species being located within the Project Area. A baseline survey and a targeted flora survey across the Whalers Way general area and Project Area over two seasons, including walking the entire Whalers coastal band during targeted Southern Emu Wren (Eyre Peninsula) and Mallee Whipbird surveys did not identify any Threatened flora species.

Refer to Appendix C for full details of the targeted flora survey.

5.3.1.1 Commonwealth Listed Species

One species, the West Coast Mintbush was considered likely to occur in the desktop assessment.

West Coast Mintbush

West Coast Mintbush is associated with *Eucalyptus diversifolia* Mallee and there were several historical records near the Project Area. Vegetation Associations 3 and 4 represent suitable habitat for this species. The plant is small and may be overlooked when not in flower, which are defined by a prominent red colour. An intense targeted search for this species returned no individuals. During the targeted survey *Prostanthera serpyllifolia* was recorded along the coast fringe in a similar preferred habitat. As a result the West Coast Mintbush likelihood of occurrence post the targeted survey was reduced to unlikely.

One species, the Annual Candles was considered possible to occur in the desktop assessment.

Annual Candles

Annual Candles are an annual herb, which may be confused with perennial *Stackhousia aspericocca*. The perennial species of *Stackhousia* was recorded within both *Eucalyptus angulosa* and *E. diversifolia* communities on numerous occasions during the targeted survey however no presence of the annual Threatened species was observed. The Annual Candles likelihood of occurrence post targeted survey was reduced to unlikely.

5.3.1.2 State Listed Species

Three states listed flora species were considered likely to occur in the desktop assessment.

Alcock's Wattle

Alcock's Wattle grows in sand over limestone in Mallee communities. There are known records in the vicinity within Port Lincoln NP and Cathedral Rocks, and suitable habitat was present within the Project Area.

This species is a common component of mallee communities, particularly on the southern side of Port Lincoln where the shallow limestone outcrops associated with *Eucalyptus socialis* and *Eucalyptus conglobata* occur however there are numerous records on the south eastern corner of the Lincoln NP and further west of the Whalers Way area. The record located within Whalers Way near Groper Bay is thought to be incorrect coordinates with two other associated records; (*Eucalyptus gillenii* and

Xanthorrhoea semiplana ssp. tatei) also not being present and the record description does not match the location. This species was not recorded during the targeted survey. This species is more likely north of the Project Area and remains likely to occur within the Whalers Way Heritage Agreement but following surveys is considered unlikely within the Project Area.

Port Lincoln Guinea-flower

The Port Lincoln Guinea-flower grows in a decumbent habit with cane-like branches that scramble into other vegetation. This species can be up to 2m high and usuallygrows on a sandy soil, often with limestone outcrops in more or less coastal scrub to low mallee vegetation on the southern point of Eyre Peninsula. Conservation status: Although restricted in its distribution Port Lincoln Guinea-flower is locally common and conserved in Lincoln NP. The record within Whalers Way is associated with a few other records which appear to be wrong coordinates.

This species was targeted heavily during the targeted flora survey, primarily due to Hibbertia species being flowering prolifically during the survey period. Consistently looking for morphological characteristics of this species as well as regular flower checks and stamen counts, no individuals of this species were observed within any project footprints or road areas. Other records in the regional area are associated with *Gahnia* sedgelands and away from the exposed coastmaking the presence of the Port Lincoln Guinea-flower potentially unlikely within Whalers Way and not present within the Project Area**.**

Western Daddy-long-legs

The Western Daddy-long-legs occurs singly or in small clumps in calcareous sands or in leaf litter on limestone and chiefly coastal. This species is recorded from Fishery Bay to Cape Jervis on light brown sand growing near *Leucopogon parviflorus*, *Caladenia latifolia* and *Asparagus asparagoides*.

This species flowers from August to September. There are only a few records of occurrence on lower Eyre Peninsula with one within 20 km. The habitat description and locations of other records suggests that this species may be present somewhere in the wider Whalers Way area, however only commonly occurring *Caladenia* species such as *C. latifolia* were observed during the targeted surveys. This species presence is possible/likely within wider Whalers Way and unlikely within the Project Area.

Six state listed flora species were considered as possibly occurring within the Project Area in the desktop assessment.

Eyre Peninsula Fringe-lily

The Eyre Peninsula Fringe-lily is a perennial, with small (5-10 mm diam.) rhizome with stiff fibrous non-tuberous roots and is leafless at maturity. The species has been recorded within 10 km, on limestone outcropping with *Eucalyptus angulosa*. Described as occurring with *Eucalyptus angulosa* mallee, all records are well north of Project Area and associated also with *Xanthorrhoea* and *Melaleuca* shrublands. The species was not observed to be present within the Project Area and as a result is unlikely to occur.

Hidden Leek-orchid

The Hidden Leek-orchidoccurs singly or in small groups in well-grassed open forests. Habitats recorded include: mallee-broombush or in low scrub about rock, outcrops in the Lower North wheat-belt, on shallow soils over rock, including limestone, often with other Leek-orchids near Native Pine woodland with mixed shrubs on sandy soil, along with *Prasophyllum occidentale* and *P. pallidum*.

No *Prasophyllum spp.* were recorded within the Project Area or within Whalers Way area associated with the Project in general. Almost all areas had abundant presence of *Microtis sp.* (Onion Orchid) and *Cyrtostylis sp.* (Gnat Orchids) during the targeted surveys.

Leafless Globe-pea

The Leafless Globe-pea is a rush-like shrub usually <50 cm high; stems terete, mostly leafless, sometimes with a few linear leaves. This species occurs in sclerophyll forests, woodlands and heathlands.

The species is described as preferring *Eucalyptus diversifolia* mallee on sandy loams, however records are more associated with distance from exposed coastline and along Proper Bay Road. No

observations made during field surveys despite flowering aligning with survey period. This species is highly unlikely to occur within the Project Area.

Limestone Leek-orchid

The Limestone Leek-orchid flowers from September to early October. Flowering of this species is not dependent on fire or disturbance.This species occurs only in calcareous soils, either in leaf litter on travertine limestone, in calcareous sand or in red-brown loam over limestone, usually within a few kilometres of the sea, either in scrubby heath or under mallee, but uncommonly, usually as single plants or small groups widely spread.

This species is recorded within Lincoln NP as growing with *Eucalyptus diversifolia* and *Acacia rupicola*. This suggests that this species may be present in northern extent of Whalers area, however field survey indicates that this species is very unlikely to be present within the Project areas adjacent the coast.

Scaly Poa

The Scaly Poa is known from dune mallee and gypsum plains and near-coastal sands. Other records on lower Eyre Peninsula have affinity with sand dunes making it unlikely this species is present within Whalers Way. Two records at Fishery Bay highlighted the species however the dune habitat preference is very sparsely present within Whalers Way. This species is not present within the Project areas, and is unlikely to occur within Whalers other than possibly in the Redbanks area on the western side.

Snowdrop Spurge

Most records of the Snowdrop Spurge show the species is located on the eastern side of the peninsula, and while the species has a similar habitat preferences of coastal mallee, most records indicate an association with species such as *Acacia paradoxa* (Kangaroo Thorn) which was not present within the Project areas. This species may have a presence in the northern extent of Whalers Way, but is unlikely to occur in the Project Area

5.3.2 Exotic Flora Species

Exotic flora species were observed occasionally in the Project Area. One Weed of National Significance (WONS) was recorded, namely, Bridal Creeper (*Asparagus asparagoides*) at Launch Site B. The Bridal Creeper is also listed as Declared Weed under the LSA Act.

The most common exotic flora species was the Sea Lavender (*Limonium companyonis*), which is not listed as a WONS or a Declared Weed under the LSA Act. The exotic flora species recorded included:

- Bridal Creeper (*Asparagus asparagoides*), WONS and SA Declared Weed;
- Horehound (*Marrubium vulgare*), SA Declared Weed;
- Onion Weed (*Asphodelus fistulosus*);
- Sea Lavender (*Limonium companyonis*); and
- Stinkweed (*Dittrichia graveolens*).

The highest density of exotic flora was observed at Launch Site B where community structure was noted as highly disturbed.

5.4 Fauna

5.4.1 Fauna Habitat

Three fauna habitats have been defined and mapped for the Project Area based on the results of the field assessment. These habitats are described as follows:

- Coastal Heath: high quality habitat with multiple shrub layers and sedges, grass tussocks, and mat plants with low exposed bare ground area;
- Shrubland on Scree: high quality habitat particularly for small reptiles as it includes plants, rock/stones with cracks, and sand hummocks; and

- Low Mallee: high quality fauna habitat with numerous structural layers of vegetation with moderate to high litter cover.

It is likely that many of the Threatened bird species identified in the desktop assessment will fly over the area. In particular, the 17 species that are present or considered to have a high likelihood of occurring. As these species are highly mobile it is difficult to predict to what extent they utilise an area without completing a comprehensive bird census. The species that are considered most likely to utilise the habitat in the Project Area, based on their habitat preference and foraging behaviour, have been identified in Table 9. Fauna habitats are mapped in Figure 5.

Table 9 Fauna Habitats of the Project Area

Habitat	Description	Threatened Species that may Utilise Habitat	Photo
Coastal Heath	Low Shrubland with overstorey canopy typically around 0.6 m to 1 m range with relatively dense cover provided by shrubs. This was considered high quality fauna habitat due to multiple shrub layers as well as sedges, grass tussocks, and mat plants. Significant fauna habitat characteristics include: • sandy grey soils formed into hummocks or small hills • low area of bare ground • dense plant cover present in patches • numerous plant lifeforms providing high foraging opportunities. Area: 4.8 ha	Foraging, roosting and breeding habitat for: • Southern Emu-wren (Eyre Peninsula) • Mallee Whipbird • Elegant Parrot • Rock Parrot • Purple-gaped Honeyeater • Painted Buttonquail • Diamond Firetail	
Shrubland on Scree	This habitat comprises a very low shrub and sedge layer of <0.3 m with individual shrubs having dense cover. This was considered high quality fauna habitat (particularly for small reptiles) due to complex structural elements such as plant habit/lifeform, stone cover with extensive cracking and sand hummocks. Significant fauna habitat characteristics include: • sandy grey soils formed into hummocks or small hills • small bare ground areas • dense plant cover present in patches • larger flat stones and crevices • Moderate levels of dead and decaying organic matter. Area: 4.3 ha	Foraging habitat for: • Southern Emu-wren (Eyre Peninsula) • Rock Parrot	

Habitat	Description	Threatened Species that may Utilise Habitat	Photo
Low Mallee	Dense Mallee with low overstorey height between 2 –5 m dependent on wind exposure. This was considered high quality fauna habitat due to number of structural layers present and moderate number of lifeforms within most areas. Significant fauna habitat characteristics include: • Moderate to high levels of litter cover • High level of canopy cover • Dense foliage and prickly leaf structure of many plants provides high value refuge habitat • Moderate levels of dead and decaying organic matter. Area: 14.3 ha	Foraging, roosting and breeding habitat for: • Mallee Whipbird • Southern Emu-wren (Eyre Peninsula) • Elegant Parrot • Rock Parrot • Purple-gaped Honeyeater May provide habitat for: • Painted Buttonquail • Diamond Firetail	

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Coordinate System: GDA 1994 MGA Zone 53

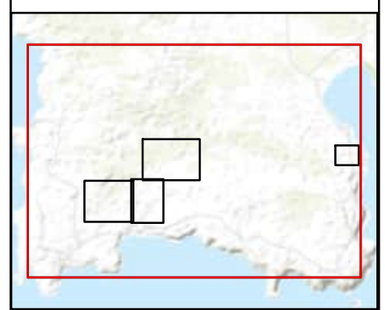
0 140 280 560

metres

1:20,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- Existing Tracks
- Coastal Heath
- Low Mallee
- Shrubland on Scree



Fauna Habitat within the Project Area
Survey Area

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F5a

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F5_Fauna_Habitat.mxd)

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N

Coordinate System: GDA 1994 MGA Zone 53

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metres

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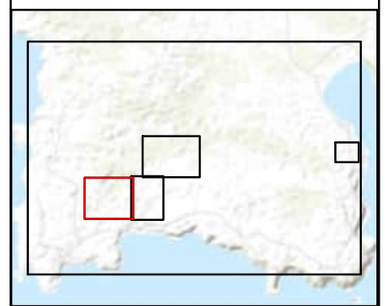
LEGEND

- Project Area
- Construction Zones
- Coastal Heath
- Low Mallee



Fauna Habitat within the Project Area
Lauch Site A

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F5b

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F5_Fauna_Habitat.mxd)

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Coordinate System: GDA 1994 MGA Zone 53

0 20 40 80
metres

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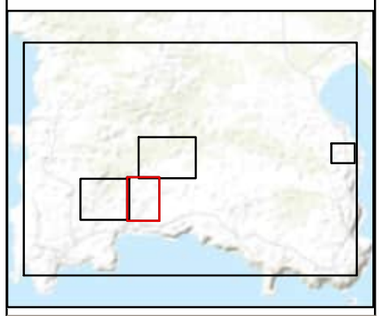
LEGEND

- Project Area
- Construction Zones
- Existing Tracks
- Coastal Heath
- Low Mallee



Fauna Habitat within the Project Area
Launch Site B

Southern Launch Whalers Way

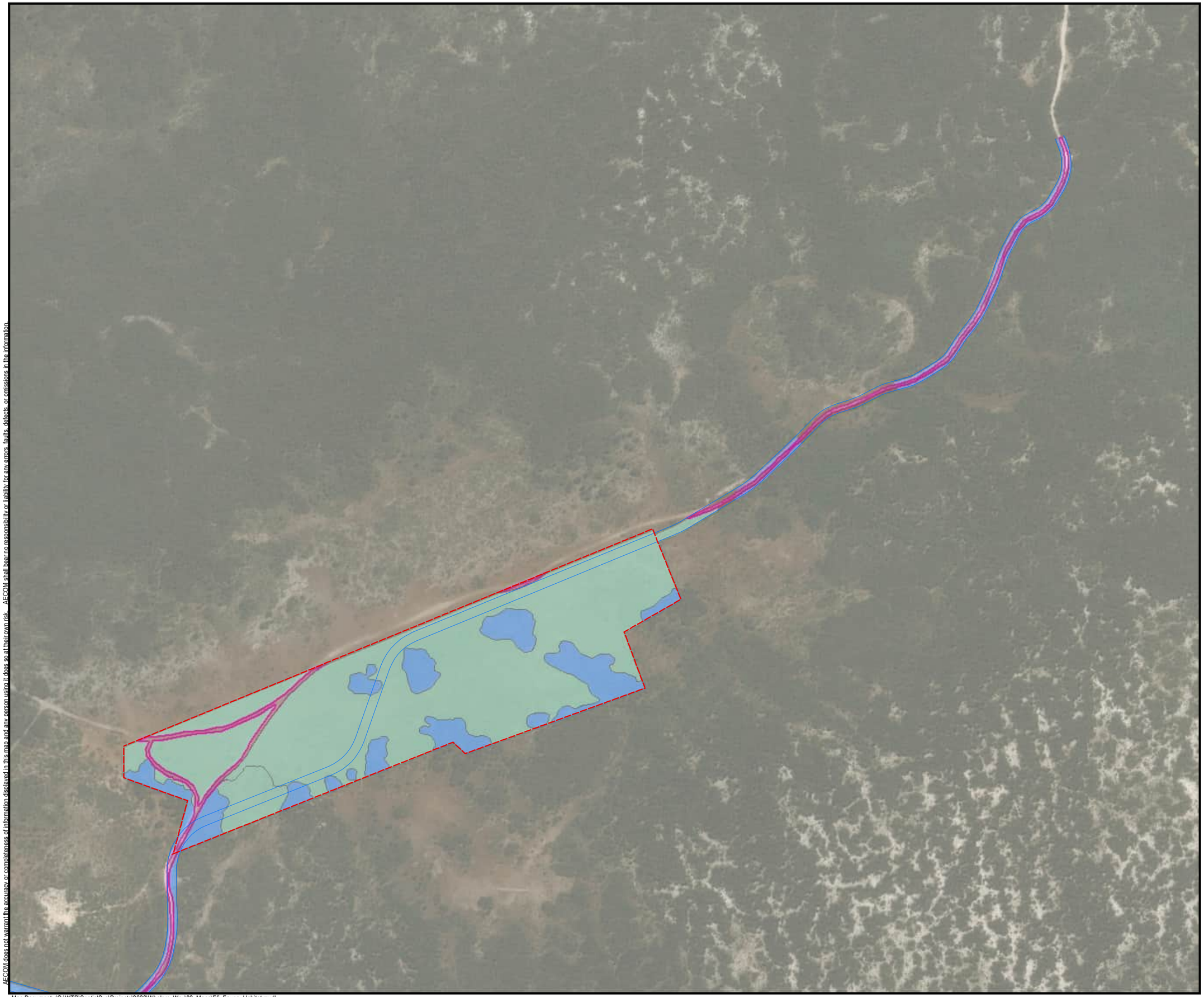
Flora and Fauna Assessment

Whalers Way, SA

Figure

F5c

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F5_Fauna_Habitat.mxd)



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AECOM
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N

Coordinate System: GDA 1994 MGA Zone 53

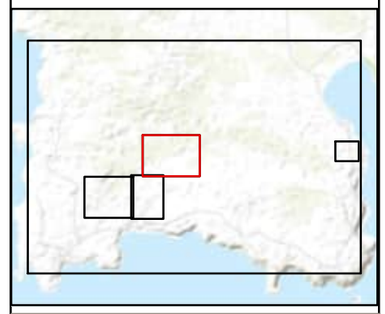
0 20 40 80

metres

1:3,250 (when printed at A3)

LEGEND

- Project Area
- Construction Zones
- Existing Tracks
- Coastal Heath
- Low Mallee
- Shrubland on Scree



Fauna Habitat within the Project Area
Infrastructure Site D

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F5d

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F5_Fauna_Habitat.mxd)

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N

Coordinate System: GDA 1994 MGA Zone 53

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metres

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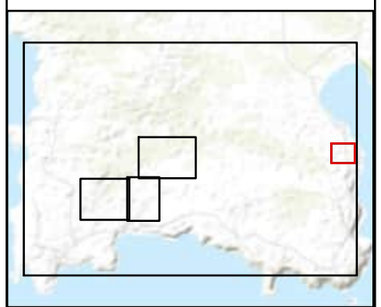
LEGEND

- Project Area
- Construction Zones
- Low Mallee



Fauna Habitat within the Project Area
Range Control Site E

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F5e

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F5_Fauna_Habitat.mxd)

5.4.2 Threatened Fauna Species

A total of six Threatened fauna species have been recorded during the field surveys (baseline and targeted) (Table 10):

- Diamond Firetail (*Stagonopleura guttata*), Vulnerable NPW Act – three records from 2021 survey;
- Eastern Osprey, Migratory and Marine EPBC Act, Endangered NPW Act –birds observed numerous times during field surveys, particularly near Cape Carnot and Cape Willis as a flyover;
- Mallee Whipbird, Vulnerable EPBC Act, Endangered NPW Act – numerous individuals recorded by call and observed during targeted surveys in 2020 and 2021;
- Rock Parrot (*Neophema petrophila*), Rare NPW Act – 14 records in baseline survey and locally common along coastal fringe at different periods;
- Southern Emu-wren (Eyre Peninsula); Vulnerable EPBC Act, Endangered NPW Act – baseline surveys resulted recorded 18 individuals consisting of four pairs, one group of three and seven single individuals. There have been numerous new records since; and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Marine EPBC Act, Endangered NPW Act – recorded frequently in the Cape Wiles area and along the coastal fringe.

Ten other Threatened fauna (bird) species are known to occur at Whalers Way (NatureMaps 2020), described in Table 10. These species are all bird species listed under the NPW Act and include three species listed as vulnerable, one species listed as Migratory and marine, and one species listed as marine under the EPBC Act.

Table 10 Summary of EPBC Act and NPW Act-listed fauna species present or with a high likelihood of occurrence in the Project Area

Taxon	Common Name	Conservation Code		Habitat Type	Source
		EPBC Act	NPW Act		
Ardeotis australis	Australian Bustard	-	V	Ground dweller, common in grasslands, woodland and in agricultural areas (Birdlife 2020).	Three historical records
Cereopsis novaehollandiae (NC)	Cape Barren Goose	-	R	Coastal grasslands and wetlands (Birdlife 2020).	Three historical records and observed as a fly over in 2021.
Falco peregrinus	Peregrine Falcon	-	R	A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and Migratory (Pizzey & Knight 2007).	Three historical records
Falco subniger	Black Falcon	-	R	Sparsely spread across inland Australia where it is found along tree-lined water courses and isolated woodlands. It may move to coastal areas and is known to have regular seasonal movements (Birdlife 2020).	Three historical records
Haematopus fuliginosus	Sooty Oystercatcher	-	R	Occurs over the Southern Ocean. Non-breeding visitor to Australia. Breeds on Campbell Island and Auckland Island (Birdlife 2020).	Four historical records
Haliaeetus leucogaster	White-bellied Sea-Eagle	Ma	E	Occupies all coastal areas extending inland through main waterways, coastal islands, coastal lakes and along some inland rivers. It forages primarily for fish over large areas of open water.	Recorded during field survey, four historical records
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater		R	Inhabits mallee heathlands and sometimes mallee with open understorey (Birdlife 2020).	Five historical records
Neophema elegans	Elegant Parrot	-	R	Inhabits open areas including grasslands, shrublands, mallee, woodlands and thickets, bluebush plains, heathlands, saltmarsh and farmland (Birdlife 2020).	One historical record

Taxon	Common Name	Conservation Code		Habitat Type	Source
		EPBC Act	NPW Act		
Neophema petrophila	Rock Parrot	-	R	Restricted to coastlines and offshore rocky islands, frequenting windswept coastal dunes, mangroves, saline swamps and rocky islets (Birdlife 2020).	Commonly recorded during field surveys and 17 historical records
Pandion haliaetus	Eastern Osprey	Mi, Ma	E	Occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia. Found in coastal areas of open fresh, brackish or saline water for foraging.	Commonly recorded during field survey and four historical records including two known inactive nests at located at Cape Wiles and another between Cape Wiles and Cape Carnot
Psophodes leucogaster	Mallee Whipbird	V	E	Inhabits mallee and thicket vegetation in coastal and inland areas of southern SA. Prefers habitat with an open layer of mallee 3-5m tall with an understorey of dense shrubs at 1.5-2m tall. Occurs in scrub on flats, dunes, and limestone.	Recorded during baseline and targeted surveys. 80 historical records
Stagonopleura guttata	Diamond Firetail	-	V	Found in open grassy woodland, heath and farmland or grassland with scattered trees.	Individuals recorded during field survey and one historical record.
Sternula nereis	Australian Fairy Tern	V	V	Nests in southern Australia on sheltered sandy beaches, spits and banks above the high tide line and below vegetation between October and February. Occupies a variety of habitats including offshore, estuarine or lacustrine islands, wetlands and mainland coastline.	Two historical records
Stipiturus malachurus parimeda	Southern Emu-wren	V	E	This species is confined to the extreme south of the Eyre Peninsula. It occurs in shrubland/heathland, mallee and sedgeland. The population at Whalers Way is considered one of five important populations (DAWE 2020e).	Recorded during baseline and targeted surveys, 74 historical records
Turnix varius	Painted Buttonquail	-	R	Prefer closed canopies with understorey cover in temperate and eastern tropical forests and woodlands	Three historical records

Taxon	Common Name	Conservation Code		Habitat Type	Source
		EPBC Act	NPW Act		
				(Birdlife 2020). Also known from scrub and grassy habitat.	
Zanda (Calyptorhynchus) funerea whiteae	Yellow-tailed Black Cockatoo	-	V	Favours Eucalypt woodland and pine plantations (Birdlife 2020).	Six historical records

Conservation codes:

EPBC Act: CE Critically endangered, E Endangered, V Vulnerable, Mi Migratory, Ma Marine

NPW Act: E Endangered, V Vulnerable, R Rare

5.4.2.1 Commonwealth Listed Species

Species listed under the EPBC Act as Threatened or Migratory and/or Marine that are known, likely or possible to occur are discussed in this Section.

Australian Fairy Tern

The Australian Fairy Tern (*Sternula nereis nereis*) occurs along the coasts of Victoria, Tasmania, SA, and Western Australia; occurring as far north as the Dampier Archipelago near Karratha (DAWE 2020c). The number of mature Australian Fairy Terns has been estimated at 3000–9000 individuals from up to 170 sites with only a few hundred pairs remaining in SA (DAWE 2020c).

The Australian Fairy Tern nests on sheltered sandy beaches, spits and banks above the high tide line on sandy substrate with low sparse vegetation (DEWHA 2011). Nests have been recorded on coral shingle on continental islands or coral cays, sandy islands and beaches inside estuaries, and on open sandy beaches (DAWE 2020c). If breeding fails at one area, the birds will often move to new locations to attempt relaying (DAWE 2020c). Colonies tend to occupy areas rather than specific sites, and nest sites are often abandoned after one year, regardless of success (DAWE 2020c). This species forages on small bait size fish, sometimes plant material, molluscs, and crustaceans in inshore waters and on Australian mainland (NACC 2020).

There have been two sightings of Australian Fairy Tern at Whalers Way, one of which was a potential nest on Red Banks Beach (DEW 2020a) that is located 1.3 km from the Project Area. Due to the proximity of historical records and the presence of suitable habitat, it is likely that this species occurs in the Project Area despite it not being recorded during the field surveys undertaken for this Project.

Bar-tailed Godwit

The Bar-tailed Godwit os a non-breeding visitor to Australia where it occurs in coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. The area is potentially a habitat for the species, however none were sighted during field surveys and it is an infrequent visitor to southern parts of Australia. The Bar-tailed Godwit's likelihood of occurrence post field surveys has been reduced to unlikely.

Black-faced Cormorant

The Black-faced Cormorant prefers coastal waters where they are found in flocks in large bays, deep inlets, rocky headlands and islands. The species was not recorded during surveys and there is no suitable habitat for species within the Project Area. The likelihood of occurrence for this species was reduced to unlikely post field surveys.

Common Greenshank

The Common Greenshank is found in a variety of inland wetlands and sheltered coastal habitats. The species occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass. The species was not recorded during surveys and there is no suitable habitat for the species within the Project Area. The likelihood of occurrence for this species was reduced to unlikely post field surveys.

Eastern Hooded Plover

The Eastern Hooded Plover mainly occurs on wide beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. There is suitable habitat for this species present in the area. This species was sighted 20 times in 2004 comprising 50 individuals within the vicinity of the Project Area. There are no records of this species within Redbanks Bay where the beach has a lack of refuge sites with boulders present at base of the cliff at the high tide mark.

Eastern Hooded Plover ashore the beach on Fishery Bay, approximately 1.6 km from Range Control Site E, were recorded in December 2021 (Landscape Boards South Australia 2021). Infrastructure Site D is located approximately 4 km from Fishery Bay, Launch Site B is located 4.6 km from Fishery Bay, and Launch Site A is located approximately 5 km from Fishery Bay.

Based on noise modelling collected during the baseline noise assessment (refer to Figure 9 and Figure 10) and during Test Launch 1 (refer to Figure 13 and Figure 14) there is not expected to be any

potential noise impacts to the known Eastern Hooded Plover recording at Fishery Bay that is located greater than 4.5 km for the nearest proposed Launch Site B.

The Eastern Hooded Plover likelihood of occurrence within the Project Area post field surveys was reduced to unlikely.

Eastern Osprey

The Eastern Osprey occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia where it forages in fresh, brackish or saline water (DAWE 2020f). Adult Eastern Ospreys are mostly resident or sedentary around breeding territories and typically breed in monogamous pairs from April to February in Australia (DAWE 2020f). They forage more widely but continue to make at least intermittent visits to their breeding grounds in the non-breeding season.

Comprehensive surveys of Osprey distribution in SA are regularly undertaken, with recent surveys being undertaken in 2008-2010 (Dennis et al 2011) and 2015-2017 (Detmar and Dennis 2018). Comparison of the two surveys has revealed a decline in occupied territories from 58 to 43. The greatest decline has occurred at western SA locations and on Kangaroo Island. Of the 43 remaining known territories, only 30 occur on the mainland. Recent studies also considered that the current population is considered to be unstable with a number of nest relocations and 'refugee' pairs relocating to start new territories. Multiple contributing factors are likely to be influencing the instability in the current distribution (Detmar and Dennis 2018).

The Whalers Way Peninsula occurs in an area with known Osprey territories that were still occupied during the most recent surveys between 2015-2017 (Detmar and Dennis 2018). The Project Area is considered to be within the south-eastern extent of the 'western Eyre Peninsula' bioregion. A number of nests in this bioregion, particularly those on 'sea-stacks' were severely damaged in the storms of 2015/2016. A total of 17 occupied territories were located between Wahgunyah Conservation Park (Far West) and Cape Catastrophe (south eastern point of Lincoln NP) during the recent surveys (Detmar and Dennis 2018). It is noted that there were eight territories recorded east of the Project Area, six of which are on offshore islands. Three nearby territories being the near-shore artificial platform at the Port Lincoln Marina, a remote area of Lincoln NP (located in 2015 by sea-based survey) (Detmar and Dennis 2018), and one on Thistle Island.

In SA the breeding habitat is limited to mostly semi-arid open coastal landscapes with low coastal vegetation (Dennis et al 2011a). In such habitats, nests are typically on an exposed cliff, broken terrain, with no visual screening of on near-shore sea- stacks that are vulnerable to damage from storm surge and severe weather (Jacobs 2020).

There is a small and fragmented breeding population on the coast of SA which is known from Head of Bight east to Cape Spencer and Kangaroo Island (Dennis 2007 and DAWE 2020f). Active nests in the Great Australian Bight region were found to be, on average, around 33 km apart, with a range of 3 – 83 km (DAWE 2020f). The Eastern Osprey is known to form long-term pair bonds and use the same nesting locations over long time periods, where preferred nest sites can be used for successive generations (Dennis 2007b cited in Dennis and Detmar 2018). Breeding occurs during May and December.

Key threats and disturbances to the species include:

- Recreation activities within the core territory;
- Landscape scale habitat degradation (e.g. vegetation clearance, fire, land use change, overgrazing, development);
- Proximity to dwellings, tracks, walking trails, drone use areas, marine industry, impacts to prey availability;
- Recreational activities above nest level;
- Access by humans and predators (e.g. fox);
- Surfing, lookouts / carparks (Detmar and Dennis 2018); and
- Interspecies conflicts e.g. kleptoparasitism (food / prey stealing) and spatial competition from White-bellied Sea-Eagle (Dennis 2007a cited in Dennis and Clancy 2014).

Active nests are also known to occur between Whalers Way and Port Lincoln (Jacobs 2020). BDBSA records for 20 km buffer on the Whalers Ways site are summarised as:

- 34 records between 1970 and 2018 (BDBSA and Birdlife records, DEW extract Nov 2020);
- A number of these records would be the same birds /pairs as they are seen at similar locations within a couple days of each other; and
- Of the 34, three Records between 1970 and 1971 and 12 have low spatial reliability and 12 records between 2009 and 2015 have no spatial reliability entered.

One Eastern Osprey was recorded near Cape Carnot during the baseline field survey and follow up surveys onsite have recorded numerous observations. One nest was recorded on a cliffs edge approximately 2000 m from Launch Site B and 2975 m from Launch Site A. Further assessment in the Jacobs (2020) report indicates there is a second nest located near Cape Wiles approximately 4070 m from Launch Site B and 4990 m from Launch Site A (Jacobs 2020).

Recent surveys on 26/11/2020 and 8/12/2020 by NVC Accredited Land and management Consultant Larry Bebbington (Jacobs 2020) did not observe recent activity at the nesting sites. During 2020 surveys observed no recent (past 3+ years) nest building activities or fresh chalk at the inactive Eastern Osprey nest sites and concluded that following attempts to rebuild in 2017, the nests have been inactive due to human disturbance (Jacobs 2020).

The nests are not currently active and have anecdotally not been active for the past five years, however this species has been known to return to inactive nests (DAWE 2020f). The Jacobs (2020) report details examples of Eastern Osprey nests persisting with / habituating to noisy environments at Port Lincoln Wharf and Thistle Island.

These distances to inactive nests are all at or larger than the state-wide buffer (2000m) that is recommended to be avoided during the core breeding period of active nests to avoid human induced disturbance impacts.

Potential indirect impacts to the Osprey are still uncertain and specific mitigation measures for this species is scoped and refined in the EBS Ecology (2022) Whaler's Way Coastal Raptor Review. Refer to Section 7.2 for further details.

Fork-tailed Swift

In Australia, the Fork-tailed Swift mostly occurs over inland plains but sometimes above foothills or in coastal areas. The species often occurs over cliffs and beaches and also over islands and sometimes well out to sea. The speciesalso occurs over settled areas, including towns, urban areas and cities, andmostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. The Fork-tailed Swift are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes, and can sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines. The species was not recorded during the field surveys and suitable habitat was not recorded within the Project Area. The Fork-tailed Swift likelihood of occurrence post field surveys was reduced to unlikely.

Northern Siberian Bar-tailed Godwit

The Northern Siberian Bar-tailed Godwit is a non-breeding visitor to Australia where it occurs in coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. The are has potential to provide habitat for the species, however none were sighted during field surveys and it is an infrequent visitor to southern parts of Australia. The Northern Siberian Bar-tailed Godwit likelihood of occurrence post field surveys was reduced to unlikely.

Pacific Gull

The Pacific Gull prefers sandy beaches or sometimes rocky coasts and/or areas that are protected from ocean swells including estuaries, bays, and harbours. The species has also been seen on farmland and rubbish piles. This species was not recorded during the field surveys. The Pacific Gull's likelihood of occurrence post field surveys was reduced to unlikely.

Sanderling

The Sanderling is a coastal species, occurring in open sandy beaches exposed to open sea-swell and exposed sandbars, and spits and shingle banks where they forage in wave-wash zone amongst rotting seaweed. The species may occur on sheltered sandy shorelines of estuaries, inlets and harbours. This species was not recorded during the field surveys. The Sanderling's likelihood of occurrence post field surveys was reduced to unlikely.

Short-tailed Shearwater

The Short-tailed Shearwater can be found in coastal waters. The species is potentially likely to be present on adjacent offshore islands.. This species was not recorded during the field surveys. The Short-tailed Shearwater's likelihood of occurrence post field surveys was reduced to unlikely.

Southern Emu-wren (Eyre Peninsula)

The Southern Emu-wren (Eyre Peninsula) is restricted to the southern tip of the Eyre Peninsula where it is known from 11 populations estimated at less than 1000 mature individuals that are severely fragmented and isolated with no one population comprising more than 250 individuals (Pickett 2002; DAWE 2020e).

Whalers Way supports one of the 11 populations and is recognised as important for the long-term survival and recovery of the Southern Emu-wren (Eyre Peninsula) (DAWE 2020e).

All three fauna habitats recorded during the baseline field survey are likely to provide breeding and foraging habitat for this species.

Targeted Survey 2020

During the targeted survey all previous records, except for the north western most records off Redbanks track area, were confirmed (Figure 6). At least four locations were recorded as probable new breeding pairs/groups, between Cape Wiles west to Blue Whale Bay. Another potential new pair was recorded west of Cape Carnot. In total 18 individual birds, consisting of four pairs, one group of three and the seven singles were sighted (Table 11).

Based on the availability of habitat it is assumed that groups/individuals inhabit the entire coastal strip from Cape Wiles, west to Redbanks and beyond, linking with the wind farm records which conforms with Pickett (2006). Almost all records occurred within 200-800m from the cliff edge although some records were as little as 115 m from the cliff edge and the average around 300 m.

The south-western section of Whalers Way near the original location of Launch Site A has the highest frequency and broadest geographical section of critical habitat. Based on the broadscale assessment where records were spaced at an average of 300-400 m intervals on average, each containing on average 2 individuals, over the approximately 7.5 km length of the coastal strip and allowing for missed records and areas of higher density. For further information on the species refer to Appendix A.

Table 11 Southern Emu-wren (Eyre Peninsula) observations recorded during June 2020 Targeted Survey

Name	Comment	Ind. Observed	UTM Zone 53H	
			Easting	Northing
WWSEW1	Near pre-existing Cape Carnot records	1M, 1F	557328	6133639
WWSEW2	Near pre-existing Cape Carnot records	1M	557334	6133535
WWSEW3	Near pre-existing Cape Carnot records	1F	557406	6133466
WWSEW4	Near pre-existing Cape Carnot records	1M, 1F	557477	6133947
WWSEW5	Near pre-existing Cape Carnot records	1M	557638	6134098
WWSEW6	Near pre-existing Point du Bastion record	1M	562434	6133039
WWSEW7	New record	1M	561617	6133309
WWSEW8	New record	1M,1F	561326	6133327
WWSEW9	New record	1M	560789	6133447

Name	Comment	Ind. Observed	UTM Zone 53H	
			Easting	Northing
WWSEW10	New record in proximity to pre-existing record	1M, 1F	560561	6133729
WWSEW11	New record west of Cape Carnot	1M	556878	6133739
WWSEW12	Near pre-existing Groper Bay record	2M, 1F	558655	6134055

Test Launch 1

A total of 17 individual Southern Emu-wren's (Eyre Peninsula) (11 at Impact Sites and six at Control Sites) were observed during the Site Selection Survey in June 2021.

A total of 23 individual Southern Emu-wren's (Eyre Peninsula) (16 at Impact Sites and seven at Control Sites) were observed during the Pre-Launch Survey in August 2021.

A total of 19 individual Southern Emu-wren's (Eyre Peninsula) (14 at Impact Sites and five at Control Sites) were observed during the Post-Launch Survey in September 2021. Refer to Appendix J for further details,

Of the 20 sites actively searched for Southern Emu-wren (Eyre Peninsula) individuals were observed at 10 out of the 20 sites (50%) during the Pre-Launch Survey and 11 out of 20 sites (55%) during the Post-Launch Survey.

Across all 60 playback experiment sites Southern Emu-wren (Eyre Peninsula) responded 23 times (38.3%) of the time. Southern Emu-wren (Eyre Peninsula) responded 33.3% of the time at control sites within Lincoln NP compared to 35% of the time at impact sites (Appendix J).

At the impact site (Whalers Way) 7 sites were occupied during the Pre-Launch surveys, while 8 sites were occupied during the Post-Launch survey. At Lincoln NP (control site) 4 sites were occupied during both the Pre-Launch and Post-Launch survey (Appendix J).

No groups of three individuals were observed during the Post-Launch survey. Group size of the secretive cryptic Southern Emu-wren (Eyre Peninsula) is difficult to quantify without detailed behavioural observations over an extended period. Further it was noted that there was not always time available in the field to determine the number of individuals in a group through follow up observations and hence it was possible that other individuals were present at sites where only a single individual was recorded. Additionally, individuals are less responsive to payback stimuli when nesting or juveniles are at a recently fledged cryptic stage. It is likely that the Test Launch 1 survey coincided with this breeding period thus it is possible individuals were not detected at some impact and control sites. This seasonality in the ability to detect Southern Emu-wren (Eyre Peninsula) should be considered in future surveys for this species.

Targeted Survey 2021

During the targeted avian survey in December 2021, Southern Emu-wren (Eyre Peninsula) were detected at Launch Site Options 2, 3, and 4 (Table 12) . No Southern Emu-wren (Eyre Peninsula) were detected at Site Option 5, however previous surveys undertaken in 2020 detected Southern Emu-wren (Eyre Peninsula) in the southern end of this location (see Appendix A for details). Refer to Appendix B for further details of the 2021 targeted survey.

Table 12 Summary of Southern Emu-wren recorded during 2021 targeted survey

Launch Site A Options	Total # of Southern Emu-wren (Eyre Peninsula) recorded at site
Option 1	Not assessed
Option 2	3
Option 3	3
Option 4	4

Launch Site A Options	Total # of Southern Emu-wren (Eyre Peninsula) recorded at site
Option 5	0
Total	10

Mallee Whipbird

The Mallee Whipbird occurs in SA and Victoria, in three widely separated areas – the Murray Mallee region of Victoria and SA, and on the Eyre and Yorke Peninsulas of SA (DAWE 2020d).

The total population is estimated at 6,000 mature birds with the largest sub-population of 5,000 birds is on the southern Eyre Peninsula which is restricted to sites around Coffin Bay NP and Lincoln NP (DELWP 2016).

The Mallee Whipbird prefers mallee scrub on sandy flats, dunes or limestone with an overstorey of mallee eucalypts including *Eucalyptus incrassata, E. socialis, E. leptophylla* and *E. diversifolia*, and a dense species-rich understorey comprising shrubs such as *Melaleuca lanceolata, M. uncinata* and *Baeckea behrii*, *Callitris verrucosa*, *Allocasuarina* spp., *Hakea muelleriana, Leptospermum coriaceum*, and *Triodia irritans*, and also in *Acacia* species thickets (DELWP 2016).

This species builds nests from twigs, bark and grass that is made in dense bush, and forages on the ground and among lower foliage feeding on insects and spiders (DAWE 2020d). The species is largely sedentary and can only make short distance flights which limits its dispersal across areas that have been largely cleared (DAWE 2020d).

All three fauna habitats recorded during the baseline field survey are likely to provide foraging habitat for this species.

Targeted Survey 2020

During the targeted survey the Mallee Whipbird was observed by call and also there was one sighting of the species crossing a road (Figure 7). Seven individual records were recorded by GPS (Table 13) however the number of birds observed by call outweighed these records significantly. The species was and is considered prolific at Whalers Way. Within the Project Area the habitat of the Mallee Whipbird was generally low Mallee trees 1.5 to 2 m tall comprising *Eucalyptus diversifolia* (Vegetation Association 3) and low *Eucalyptus angulosa* (Vegetation Association 4) over an open understorey of low shrubs. The preferred habitat for Mallee Whipbird occurs extensively in the Project Area and surrounds.

For further information on the species refer to Appendix A.

Table 13 Mallee Whipbird observations recorded during June 2020 Targeted Survey

Name	Comment	Ind. Observed	UTM Zone 53H	
			Easting	Northing
WWWWB1	Two birds responding to each other's call	2 (song)	557618	6134086
WWWWB2	Single bird calling	1 (song)	557177	6134694
WWWWB3	Single bird calling near project site footprint	1 (song)	560317	6133916
WWWWB4	Single bird calling near project site footprint	1 (song)	560422	6134448
WWWWB5	Single bird calling recorded during Southern Emu Wren (Eyre Peninsula) survey	1 (song)	560896	6133755
WWWWB6	Single bird calling near project site footprint	1 (song)	562470	6135285
WWWWB7	Single at road edge brief sighting	1 (sighting)	557241	6134935

Test Launch 1

A total of 17 individual Mallee Whipbird's (13 at Impact Sites and four at Control Sites) were observed during the Site Selection Survey in June 2021.

A total of 17 individual Mallee Whipbird's (12 at Impact Sites and five at Control Sites) were observed during the Pre-Launch Survey in August 2021.

A total of 20 individual Mallee Whipbird's (14 at Impact Sites and six at Control Sites) were observed during the Post-Launch Survey in September 2021. Refer to Appendix J for further details.

Of the 21 sites, 20 were actively searched for Mallee Whipbird individuals due to access restrictions and individuals were observed at 17 out of the 20 sites (85%) during both the Pre-Launch Survey and Post-Launch Survey.

At the impact site (Whalers Way) 12 sites were occupied during both the Pre-Launch and Post-Launch surveys, while 5 sites were occupied during the Post-Launch survey. At Lincoln NP (Control site) 4 sites were occupied during both the Pre-Launch and Post-Launch survey (Appendix J).

Targeted Survey 2021

During the targeted avian survey in December 2021, Mallee Whipbird were detected at Launch Site A Options 2 and 3, and not at Launch Site Options 4 and 5 (Table 13). Launch Site Options 4 and 5 have dense and low coastal vegetation that could be considered less suitable (e.g. too low/sparse) for Mallee Whipbird to occupy/utilize frequently. It should be noted that Mallee Whipbird can be difficult to estimate without detailed behavioural observations repeated over an extended period of time and without marking individuals. Furthermore, the survey period was brief, weather conditions were not optimal for avian surveys, and seasonality (i.e. the survey was undertaken in summer) likely impacted on the activity and thus detectability of the species. Mallee Whipbird were not as vocal in December 2021 (summer), compared to surveys undertaken earlier in the year during spring, when Mallee Whipbird could be heard singing throughout the day, with peaks in song activity at dusk and at dawn.

Refer to Appendix B for further details of the 2021 targeted survey.

Table 14 Summary of Mallee Whipbird recorded during 2021 targeted survey

Launch Site A Options	Total # of Mallee Whipbird recorded at site
Option 1	Not assessed
Option 2	2
Option 3	3
Option 4	-
Option 5	-
Total	5

White-bellied Sea-Eagle

White-bellied Sea-Eagle (*Haliaeetus leucogaster*) is listed as Marine under the EPBC Act and Endangered under the NPW Act. The White-bellied Sea-Eagle is a marine species that forages on fish and does not breed in Australia.

The most recent review of White-bellied Sea-Eagle distribution in SA confirmed a total of 73 breeding pairs / occupied territories across a range of habitats; coastal, offshore island and inland river habitats (Dennis and Detmar, 2018). It has been noted there was a decline in previous territories since 2010, due to the following:

- Low fecundity (i.e. ability to produce offspring);
- High rates of nest failure; and
- Human-induced disturbance related to displacement of pairs (Jacobs 2020).

Disturbance during critical phases of breeding are known to result in nest failures and displacement to sub-optimal habitats. 33 territories are known from the Western Eyre Peninsula region where the

proposed Southern Launch Project site occurs. In this region however, there are only seven mainland territories (sparsely distributed) and 26 are located on offshore islands (Jacobs 2020).

Long-term studies of White-bellied Sea-Eagle's from Kangaroo Island that occupy a range of habitats identified a negative relationship between human activities and nest productivity outcomes (i.e. disturbed territories produced eggs less often, fewer young, and higher rates of nest failure than nests located in remote locations with less disturbance) (Jacobs 2020).

The White-bellied Sea-Eagle forms long-term pair bonds and selected nesting locations over long time periods. Favoured nest locations are often used by successive generations (Jacobs 2020). There are times within the breeding period that are more crucial than others (i.e. mid-May to mid-September as per literature from long-term studies and White-bellied Sea-Eagle experts (Dennis et al. 2011a, Dennis et al. 2012, Dennis et al. 2015).

In terms of territory density there is variation and this may be declining. On St. Peters Island there were 4 territories with primary nests spaced an average of 2.4 km apart, whereas on the north coast of Kangaroo Island where there were 10 territories, primary nests were spaced an average on 9 km apart (Jacobs 2020).

Sensitivities to these bird's disturbance are so well documented that there are long-established disturbance avoidance protocols (based on spatial and temporal) approach constraints that are applied to regular raptor surveys (Dennis and Detmar 2018). Recent surveys identified three inactive nests on the Eyre Peninsula; two in NPs with high levels of disturbance and one occupied by a Wedge-tailed Eagle (Dennis and Detmar 2018).

Whilst White-bellied Sea-Eagles have regularly been reported in the Whalers Way region and flying overhead (Jacobs 2020). One pair was spotted during the AECOM 2020 baseline field survey west of Cape Carnot.

White-bellied Sea-Eagles occupy a territory and nest on the offshore Liguanea Island and a recent territory and nest site has been established >5 km to the east of the launch sites (Dennis and Detmar 2018). The exact location of the mainland clifftop nest site remains undisclosed due to potential disturbances. During site surveys on the 26 November and 8 December 2020 by Larry Bennington a pair of White-bellied Sea-Eagle's circling inland coastal heath at Fishery Bay for a duration of 20 minutes prior to flying eastwards were observed. Another pair of White-bellied Sea-Eagles were observed through a spotting scope overflying Liguanea Island and riding thermals to the south-east of the island (Jacobs 2020). White-bellied Sea-Eagles are regularly observed (Bebbington L. pers. com.) overflying the coastline at Whalers Way and well to the east and west of the site. White-bellied Sea-Eagles are also regularly observed well inland preying on juvenile Cape Barren Geese and feeding on sheep carcases or bathing in farm dams (Bebbington L. pers. obs.).

White-bellied Sea-Eagles were not detected at the Project Area (just flying over), however breeding territory would be in proximity to the Project Area (given the regular fly overs) and although proposed (land-based) development are well outside the 2 km non-disturbance buffer zone (buffer distance as suggested in Dennis et al. 2011b, Dennis 2012), the bay and surrounds likely forms part of the foraging zone of the species.

Through the implementation of key mitigation options for avoiding impacts to White-bellied Sea-Eagles detailed in the Whalers Way Eastern Osprey and White-bellied Sea-Eagle Detailed Assessment (Jacobs 2020), significant impacts to the species are deemed unlikely. These include the following:

- Adopting state-wide 2000 m disturbance buffers (based on recommendations in Dennis et al. 2011, Dennis et al. 2012) from known active nests, particularly during the breeding season;
- Where there are known nests or territories, construction should occur from mid-January to May, if construction occurs outside of this period (noting breeding season is May to September) then a precautionary approach would involve receiving confirmation in confidence to understand the exact location and activities (of any eagles) occurring in the area. It is noted that Dennis et al. 2015 and Dennis et al. 2012 distinguishes between White-bellied Sea Eagle critical breeding (mid-May to mid-September) and entire White-bellied Sea Eagle breeding season (May to December);

- Note that line of sight is critical to disturbance to this species. Not conducting disturbance activities within the line of sight of breeding White-bellied Sea Eagles. i.e. as per criteria in Dennis et al. 2012, not within 1000 m of a primary nest;
- Development of a species management plan for specific protection and management of breeding refuge habitat in South Australia; and
- Subsequent ongoing population monitoring in key habitats.

These mitigation measures have been further scoped and refined in the EBS Ecology (2022) Whaler's Way Coastal Raptor Review. Refer to Section 7.2 for further details.

PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 04 FEB 2022

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Coordinate System: GDA 1994 MGA Zone 53

0 250 500 1,000

metres

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LEGEND

- Project Area
- Construction Zones
- EPSEW Monitoring site
- EPSEW Opportunistic Observations
- Historical EPSEW records

Records for Southern Emu-wren

Southern Launch Whalers Way

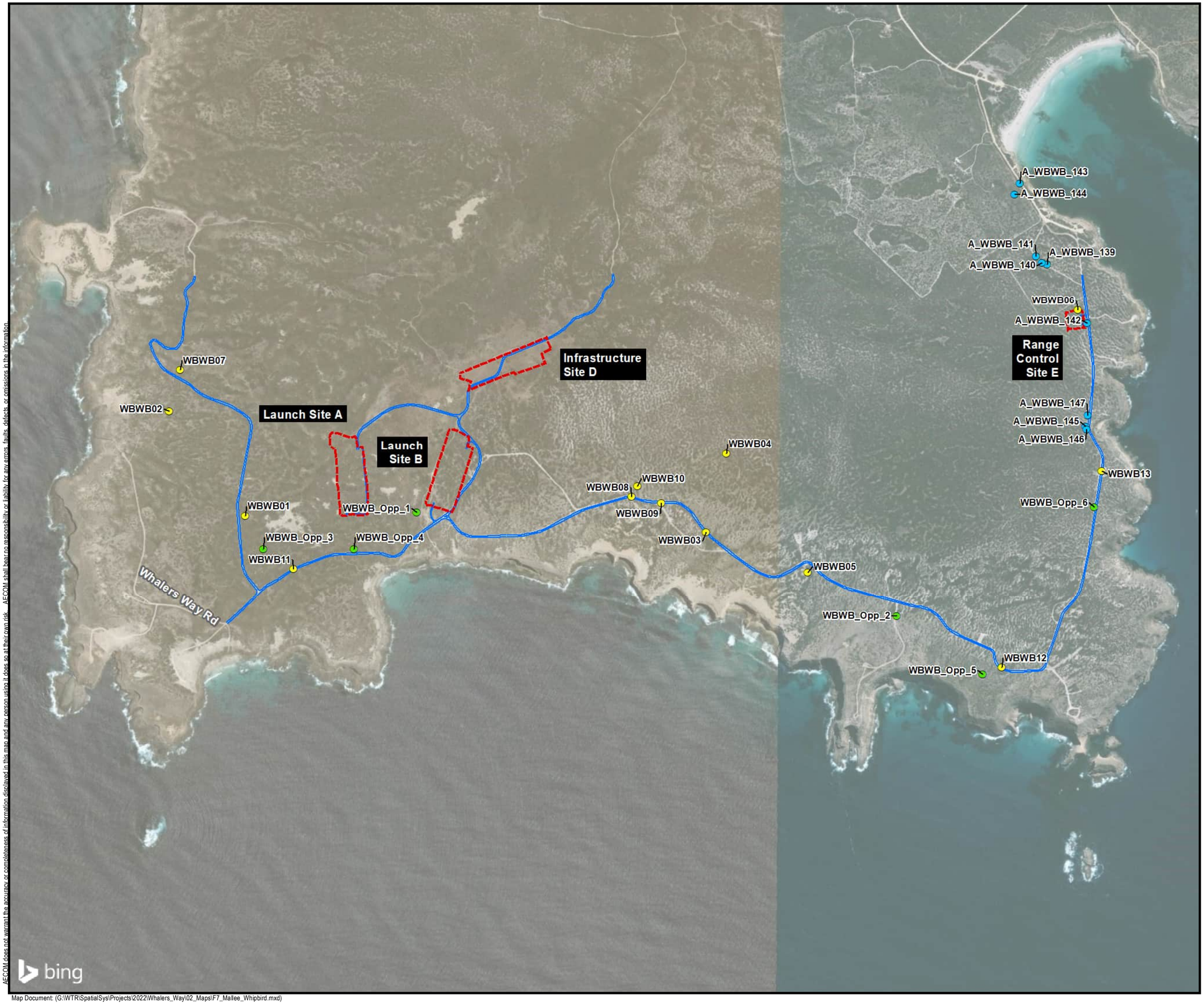
Flora and Fauna Assessment

Whalers Way, SA

Figure

F6

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F6_Southern_Emu_Wren.mxd)



PROJECT ID 60627263
CREATED BY brierej
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Coordinate System: GDA 1994 MGA Zone 53

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LEGEND

- Project Area
- Construction Zones
- WBWB Monitoring site
- WBWB Opportunistic Observations
- Historial WBWB Records

Records for Western Whipbird (eastern)

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F7

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F7_Mallee_Whipbird.mxd)

5.4.2.2 State Listed Species

State listed Threatened species that are known, likely or possible to occur as defined in Table 10 are discussed below.

Australian Bustard

Australian Bustard (*Ardeotis australis)* is likely to be a vagrant visitor to the Project Area when food resources are plentiful. There have been three historical records of the species at Whalers Way, however there was no sightings or evidence of the Australian Bustard utilising the Project Area during the field surveys. This species has a wide habitat range and is unlikely to rely on the coastal habitat for foraging or breeding.

Black Falcon

The Project Area is right on the edge of the range (Pizzey and Knight 2007) for the Black Falcon (*Falco subniger)* which is known to occur within a wide range of habitats. The species was not recorded during the field surveys however there are three historical records at Whalers Way. The species has been seen in coastal habitats however is typically associated with water courses and woodlands. The Black Falcon is likely to be a vagrant visitor to the Project Area.

Cape Barren Goose

Cape Barren Goose (*Cereopsis novaehollandiae* (NC)) are frequently observed in open paddocks where they graze on tussock grasses, spear grass, herbs and succulents (Birdlife 2020). They roost out of reach of predators and lay eggs among tussocks of open grasslands on offshore islands (Birdlife 2020).

Cape Barren Goose were recorded during the Site Selection Survey for the Test Campaign as a flyover in 2021. Three records, totalling 105 individuals, have been recorded at Whalers Way. It is likely that this species inhabits the paddocks north of the Project Area but unlikely to use Whalers as habitat area.

Diamond Firetail

Diamond Firetail occurs in a wide range of Eucalypt dominated vegetation with a grassy understorey (DEH 2008). The largest populations are known from the Great Dividing Ranges with small pockets occurring near the coast (DEH 2008). They require a reliable water source within the vicinity of their foraging and breeding areas (DEH 2008).

This species was recorded at a water trough and within the vicinity of Launch Site B. The species has also been recorded at Whalers Way historically with one record of ten individuals. While the Project Area does not support its favoured grassland habitat, observations over different seasonal periods and times of the year suggest that this species is a semi-permanent resident of the area.

Elegant Parrot

The Elegant Parrot (*Neophema elegans*) is likely to be present during certain times of year when resources are available. This species occurs in a wide range of habitats including grasslands, shrublands, mallee, woodlands and thickets, bluebush plains, heathlands, saltmarsh and farmlands (Birdlife 2020). This species is relatively common in Mallee woodlands and has the ability to cover a wide range. The Elegant Parrot breeds in tree hollows which were largely absent in the Mallee Woodlands of the Project Area.

There is one historical record at Whalers Way. The species was not recorded during field surveys however there is suitable habitat present.

Painted Buttonquail

Painted Buttonquail (*Turnix varius*) prefers Woodlands with dense canopies over shrublands in temperate and eastern tropical forests and woodlands (Birdlife 2020). There are three historical records for the species at Whalers Way representing 23 individuals. The species was not recorded during the field survey and the habitat is considered marginal.

Peregrine Falcon

Peregrine Falcon (*Falco peregrinus*) may nest on cliffs in Whalers Way and are likely to feed on pigeons that also utilise the cliffs for roosting areas. This species is relatively common in the region and has a large home range. This species has not been recorded during the field surveys and the habitat is considered marginal.

Purple-gaped Honeyeater

Purple-gaped Honeyeater (*Lichenostomus cratitius occidentalis)* is likely to utilise Whalers Way when foraging resources are available, this species is likely to come and go dependent on where resources are available at certain times of year. This species was not recorded during the field survey and the habitat is considered marginal.

Rock Parrot

Rock Parrot (*Neophema petrophila)* often occur along the coast, foraging on a range of food resources including samphire shrublands. During the baseline and targeted surveys, the Rock Parrot was commonly recorded throughout coastal shrublands.

Sooty Oystercatcher

Sooty Oystercatchers (*Haematopus fuliginosus)* are restricted to the coastal margins and are a non-breeding visitor to Australia. The four historical records of the species were observed to the east of the Project Area, at Fishery Bay. This species was not recorded during the field survey.

Squared-tailed Kite

In Southern Australia, Square-tailed Kites (*Lophoictinia isura*) mainly inhabit open eucalypt forests and woodlands, often dominated by stringybarks, peppermints or box–ironbark eucalypts, as well as Woollybutt, Spotted Gum, Manna Gum, Messmate, River Red Gums, as well as other trees such as Angophora, cypress-pines and casuarinas. The Squared-tailed Kite was not identified during the desktop assessment and has not been recorded during the baseline or targeted surveys within the Project Area. A sighting of the species occurred in 2021 near the Project Area by a local resident (ABC 2021).

Yellow-tailed Black Cockatoo

The Yellow-tailed Black Cockatoo (*Zanda (Calyptorhynchus) funerea whiteae)* has experienced a historical population decline over the last several decades and habitat loss, with its associated effects, is believed to be the principal cause. The Eyre Peninsula Yellow-tailed Black-Cockatoo has a seasonally and geographically split distribution across Eyre Peninsula. The birds breed during the warmer months (November-April) in the Lower Eyre Peninsula and migrate to north-western Eyre Peninsula for the winter. The summer breeding season is spent in a small area within the Koppio Hills approximately 40 km north-west of Port Lincoln on the Lower Eyre Peninsula. This species utilises sugar gum as a foraging resource. There are only planted examples in the Project Area which are unlikely to provide significant foraging habitat based on their small numbers and size.

5.4.3 Exotic Fauna Observations

Three exotic mammal species listed as Declared Pests under the LSA Act were recorded:

- Domestic Cat (*Felis catus*) tracks were observed frequently;
- European Rabbit (*Oryctolagus cuniculus*), which is an introduced pest species common in all states, was widespread and common; and
- Red Fox (*Vulpes vulpes*) was observed from numerous scats.

6.0 Assessment of Potential Impacts

Potential ecological impacts from the Project were informed by current knowledge of the required Project activities provided by Southern Launch (the proponent), who will ensure opportunities are considered to further avoid and minimise potential impacts such as clearing of native vegetation and habitat as far as practicable during detailed design. This section provides an overview and description of the potential ecological impacts that may occur as a result of the Proposal.

6.1 Overview of Potential Impacts

This section provides a review of the environmental aspects and potential ecological impacts of the Project as they relate to the terrestrial environment including native vegetation, flora, terrestrial birds, terrestrial mammals and terrestrial fauna habitats.

The Project activities in the tables below support a thorough assessment of individual and cumulative direct and indirect impacts (Table 15).

Table 15 Description of Project Activities associated with Construction and Operation

Phase	Project Activity	Description of Activities
Construction	Site Preparation	Vegetation clearing
		Topsoil stripping
		Excavation for the construction of a quarry then to be transformed into a 30 ML dam
		Construction of temporary site compounds including concrete batching plant
		Installation of hardstands and offices
		Stockpiling of topsoil and gravel
	Utility Construction	Excavation
		Trenching
		Installation of utilities and associated infrastructure
	Drainage	Culvert installation and stormwater drains
	Structures	Construction and installation of infrastructure and buildings associated with launch pad facilities including: • Assembly Buildings (temporary and permanent); • Range Control Facilities; • Diesel and / or Hydrogen Fuel Cell Powered Generators; • Helicopter Pad(s) • Solar Arrays; • 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; and

Phase	Project Activity	Description of Activities
		• Excavation and construction of flame trench and the installation of a water deluge system.
	Civil and Road Works	Construction of access roads
		Cutting construction
		Drainage controls
Operation	Rocket Launches	Launch of rockets at a frequency of once a week, for a duration of 1 minute
	Operational Maintenance	• Operations at the Launch complex supporting infrastructure, including buildings, dams and workshops; • Ongoing vehicle movement within access roads and around launch pads.

There are no facilities for fixed wing aircraft to land or take off from the Project Area. Fixed wing aircraft may be used to ensure hazard zone clearance down range, but that is more than 50 km south of the Project and therefore not considered in this Terrestrial Impact Assessment. The only perceived use for rotary wing aircraft is for casualty evacuation in a medical emergency and the Project is not planning to use drones.

6.1.1 Habitat Loss and Degradation from Vegetation Clearing

The removal of vegetation resulting in habitat loss and degradation is likely to pose the largest risk of adverse impacts for terrestrial biodiversity arising from the Project. The impact may be direct in the form of vegetation and habitat clearance, or indirect, such as a reduction in flora and fauna diversity due to shortages in available habitat resources or habitat degradation in areas adjacent to direct impacts. Small-scale clearing within largely intact patches of vegetation can cause localised depletion of some species (Kutt *et al*. 2012). Habitat loss as a result of vegetation clearing is likely to occur during the construction phase activities. Habitats for Threatened species are included in the likely receptors potentially impacted.

Vegetation clearing and habitat loss that cannot be avoided, particularly in high constraint areas, is likely to result in permanent impacts to Threatened biodiversity receptors. This includes a reduction of feed availability for habitat-specialist fauna species which are dependent on native vegetation for food sources, such as Mallee Whipbird and Southern Emu-wren (Eyre Peninsula) that forage actively, hopping through dense vegetation and taking food from reeds, foliage, twigs, and other surfaces of shrubs. The potential effects associated with this impact include direct loss of breeding habitat and loss of foraging habitat which will in turn lead to greater pressure on remining available habitat outside of the Project Area. The resulting increase in pressure on resource availability is likely to increase individual animal stress levels which may result in reduced breeding success, genetic isolation, and population decline over time.

The Project will clear 23.4 ha of native vegetation in four discreet locations (Launch Site A, Launch Site B, Infrastructure Site D and Range Control Site E) and several access tracks detailed in Table 8 and illustrated in Figure 3. No Threatened flora species listed under the EPBC Act and NPW Act are considered likely to occur within the Project Area or within close proximity. Refer to Section 7.0 and Appendix G for further details on vegetation to be cleared and the required SEB offset.

The vegetation provides suitable habitat for the following Threatened fauna species protected under the EPBC Act and NPW Act:

- Australian Fairy Tern;
- Black Falcon;
- Cape Barron Goose;
- Diamond Firetail;

- Eastern Osprey;
- Elegant Parrot;
- Painted Buttonquail;
- Peregrine Falcon;
- Purple-gaped Honeyeater;
- Rock Parrot (known to occur);
- Southern Emu-wren (Eyre Peninsula);
- Mallee Whipbird;
- White-bellied Sea-Eagle; and
- Yellow-tailed Black Cockatoo.

Native vegetation extends further inland on the Whalers Way Peninsula estimated at 2,600 ha of which 95% is mapped as native vegetation. Vegetation and fauna habitat during the field surveys was observed as homogenous in the area. It is likely that the Whalers Way Peninsula and conservation reserves detailed in Section 4.2 contain suitable habitat for the Threatened species listed above.

Specifically, there is a risk that some of the proposed clearing may pose a direct threat to the local viability of the ecosystems and potentially heavily impact upon individual Threatened species, this is discussed further for Commonwealth listed species in Section 6.5.

All vegetation within the Project Area has had an additional 5 m clearance buffer applied for fire safety. The buildings and infrastructure are all located more than 5 m from the Project boundary meaning the 10 m clearance buffer is within the existing fire buffer.

All roads have a 3 m clearance buffer applied to each side of the road however this may be utilised as 6 m on one side of the road as part of upgrades or alternatively as the buffer is stated. Dependent on the bends in roads and terrain encountered. This 3 m buffer on each side of the road is also provided to allow for the addition of power and water easements, the construction method and infrastructure type, which have not been finalised at this stage.

A full assessment of native vegetation clearance has been undertaken against the Principles of Clearance under the NV Act. Refer to Appendix K for further details on the impacts to vegetation clearance. The clearance of 23.4 ha of native vegetation is considered level 4 clearance and is seriously at variance with principle 1a and 1b and at variance with principle 1e of the Principles of Clearance under the NV Act.

When exercising a power or making a decision under Division 5 of the *Native Vegetation Regulations 2017*, the NVC must have regard to the mitigation hierarchy. The mitigation hierarchy has been applied for this Project and is summarised in Section 7.0 and further detailed in Appendix K.

6.1.2 Fauna Species Injury or Mortality

Fauna injury and/or death is a direct impact that may lead to a decline in population size and extent of fauna species. This potential impact is most likely to occur during vegetation clearing, earthworks, trenching and increased labour force in the fields (through the movement of vehicles) during construction, and from vehicle collision during operation.

Earthworks and clearing of native vegetation may lead to interaction of machinery with fauna species, including any of the Threatened bird species listed in Section 6.1.1. This includes clearing vegetation that includes a nesting site, crushing or otherwise harming a fauna species with machinery.

The Project will result in increased vehicle movements that may cause injury or death to fauna by vehicle strike. Mammals, reptiles, and birds are all at risk of vehicle strike, particularly species that utilise roads for movement pathways. Threatened species such as Mallee Whipbird, Southern Emu-wren (Eyre Peninsula) and Rock Parrot that were recorded throughout the Project Area may be impacted as a result of increased vehicle activity.

Entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the Project (e.g. excavations for flame trench and/or water deluge system) may cause physical trauma to individual fauna. Open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality. The Threatened bird species known to occur in the Project Area are mobile species that are likely to be able to fly out of any trench or excavation. As such, it is unlikely that wildlife entrapment would have a significant impact on these species.

6.1.3 Disturbance to Breeding and Foraging Habitat

Many fauna species have specific requirements for breeding and foraging. The two key Threatened bird species recorded during field surveys (Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird) build nests out of twigs, barks and grass that is placed close to the ground in dense vegetation. Both species breed during September and October (spring) (Picket 2006 and DAWE 2020d).

Works associated with the Project will have both direct and indirect effects on specialist habitat. Direct impacts will include the clearance of 23.4 ha of suitable breeding and foraging habitat for fauna species while indirect impacts such as noise during construction works and rocket launch operations may affect where these species choose to nest and feed. Species which may be impacted due to the disturbance of these habitat features include the following EPBC Act and NPW Act listed species with known breeding or foraging habitat within the Project Area:

- Australian Fairy Tern;
- Black Falcon;
- Cape Barron Goose;
- Diamond Firetail;
- Eastern Osprey;
- Elegant Parrot;
- Painted Buttonquail;
- Peregrine Falcon;
- Purple-gaped Honeyeater;
- Rock Parrot (known to occur);
- Southern Emu-wren (Eyre Peninsula);
- Mallee Whipbird;
- White-bellied Sea-Eagle; and
- Yellow-tailed Black Cockatoo.

These impacts are likely to be long term in relation to the removal of suitable habitat and may be short or long term in relation to operational noise depending upon individual species resilience.

6.1.4 Displacement of Flora and Fauna Species from Invasion of Weed and Pest Species

Weed and pest species have the potential to impact on terrestrial biodiversity as native species can become displaced through predation and competition with exotic biota. Pest species can also damage native vegetation by grazing and trampling.

Nine non-native species have been recorded within the Project Area, consisting of five weeds and four pest species. Of these, one weed species (Bridal Creeper) is a listed WONS and a Declared Weed under the LSA Act, and the four pest species are listed as Declared Pests under the LSA Act. Without appropriate management strategies, the Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or occur in low densities.

Project activities also have the potential to introduce new weed species into the Project Area and surrounding area. The most likely causes of weed dispersal and introduction associated with the Project include earthworks, movement and disturbance of soil, and attachment of seed (and other

propagules) to vehicles and machinery during all phases. Weed dispersal by vehicles along access tracks and roads is a key source of weed invasion (Birdsall et al 2012). Weed invasion is an indirect impact that may degrade the quality of habitats, potentially resulting in habitat loss.

Soil disturbance during construction may increase the risk of invasion from weed and/or pest species, which can further reduce habitat quality and compromise the integrity of adjacent areas of native vegetation.

Exotic flora species were observed as sparsely present during the baseline field survey. As the vegetation condition of the Project Area is of a relatively high quality with low weed invasion it is important to ensure exotic weed species are not spread and brought onto site during all phases of the Project. The potential for habitat modification from weed invasion resulting from the Project is highest where Project activities take place in areas of high-quality vegetation condition, such as those identified as containing intact remnant vegetation that currently has low weed diversity and abundance.

Unmitigated Project activities have the potential to disperse pest (animal) species from the Project Area into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operation phases of the Project. Construction of access tracks and the rocket launch pad facilities infrastructure through large patches of intact native vegetation may result in the introduction of pest species (particularly predators such as foxes and cats) into these areas. Unmitigated potential impacts of the displacement of native species through the invasion of non-natives may be temporary or permanent.

6.1.5 Edge Effects

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along habitat edges can promote the growth of different vegetation types (including weed species), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident native animals (Moenting and Morris 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators. The distance of edge effect influences can vary and has been previously recorded from 50 m to greater than 1 km from an edge (Forman et al. 2000; Bali 2005).

Within the Project Area, the vegetation patches are large and have generally not been disturbed from previous clearance or edge effects. There are some areas that have had minor disturbance through the construction of access tracks for tourist activity in the Whalers Way. It is likely that the Project may create edge effects resulting in habitat degradation and a reduction of the habitat available for a range of species through the expansion of access tracks and clearance for the launch pads.

No Threatened flora species listed under the EPBC Act and NPW Act are considered likely to occur within the Project Area of within close proximity.

Edge effects have the potential to adversely impact the following Threatened fauna species known to be or identified as potentially occurring in the Project Area:

- Australian Fairy Tern;
- Black Falcon;
- Cape Barron Goose;
- Diamond Firetail;
- Eastern Osprey;
- Elegant Parrot;
- Painted Buttonquail;
- Peregrine Falcon;
- Purple-gaped Honeyeater;
- Rock Parrot (known to occur);

- Southern Emu-wren (Eyre Peninsula);
- Mallee Whipbird;
- White-bellied Sea-Eagle; and
- Yellow-tailed Black Cockatoo.

6.1.6 Habitat Fragmentation

Habitat fragmentation relates to the physical dividing up of a continuous habitat into separate smaller fragments (Fahrig 2002). The habitat situated between fragments is often artificial and less suitable to the species remaining within these fragments (Bennett 1990).

The landscape in which the Project is situated is relatively undisturbed with significant vegetation cover, with the only fragmentation in fauna habitat occurring through access tracks that have been constructed for tourist access to Whalers Way. The Project activities will contribute to fragmentation of fauna habitat by increasing the number and width of access tracks and clearing four discreet areas. Habitat fragmentation may impact Threatened species, regionally significant vegetation, bioregional corridors and wildlife refugia. This is due to the importance of connectivity, dispersal opportunities and habitat quality for species at a local scale.

Habitat fragmentation as a result of vegetation clearing for the Project is considered localised. The habitat in the local area is contiguous and provides ample connectivity across Whalers Way. It is unlikely that vegetation clearing will result in the inability of any species to become genetically isolated and lead to sub-populations in the local area.

The widening of tracks and the construction of the launch pads may lead to local fragmentation, however the majority of species at Whalers Way are mobile and are able to traverse the distance a track represents (refer to Figure 5). Fragmentation is therefore considered limited and unlikely to be considered significant.

6.1.7 Barrier Effects

Barrier effects occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a barrier. This can include a habitat type that has become unsuitable or a physical barrier such as a fence. Species most vulnerable to barrier effects include those with limited dispersal abilities.

Various Project activities may create barrier effects, particularly those that may create a hard barrier that restricts fauna movement (e.g. cutting or embankments and fences). The Project includes exclusion fencing to prevent unauthorised entry to the launch pad facilities. The fences will also prevent the movement of fauna species, in particular large fauna species (kangaroos, emus). It is unlikely that fencing required for the Project will prevent movement of the Threatened birds that are known to occur in the Project Area.

Human activity and infrastructure are likely to create a barrier as many species are known to avoid areas of human activity resulting in indirect habitat loss. Human presence may affect species in different ways with some species displaying avoidance behaviour while others may habituate and become attracted to areas of human activity. Predators and prey may respond differentially to human activity, causing a disruption of community interaction and potentially disrupting ecological processes (Caro 2005).

Similarly, barrier effects may be experienced by native animals in the form of increased patrolling and predation by pest animals along barriers, such as a cleared corridor. Foxes and wild cats target these barrier areas as prey becomes more exposed and easier to detect and catch.

6.1.8 Dust and Light Impacts

Dust and light are direct impacts that have the potential to occur as a result of the Project activities during all phases and may also have cumulative effects. The likelihood of potential impacts is anticipated to be greatest where the Project activities take place near vegetated areas and known habitat during the construction and rehabilitation phases.

The Project will result in impacts from light spill into adjacent receiving environments (e.g. fauna habitat) due to the operation of plant and equipment throughout the construction phase of the proposal

and installation of lighting on infrastructure required for the operation of the Project. Impacts associated with light spill may include direct impacts (e.g. increased susceptibility to predation from increased light) or indirect impacts related to altered foraging and habituation in areas exposed to increased lighting. Light impacts associated with construction will be temporary in nature, however operational lighting impacts will be long term and localised (e.g. infrastructure) or transient in nature (i.e. vehicle movement).

Ecological receptors affected by these potential impacts include all Threatened fauna species listed under the provisions of the EPBC Act and/or NPW Act. These types of impacts are likely to be short in duration and localised.

6.1.9 Noise and Vibration Impacts

The assessment of noise for this Project has been developing over the extended assessment timeframe time as familiarisation with software modelling packages has increased, updates to software have been released and additional literature has been referenced.

Initially, and due to lack of available rocket vehicle data for modelling purposes, the Space X Falcon 9 was adopted as a worst-case scenario for the assessment of noise impacts from the proposed facility. Whilst, from an impact on sensitive receivers perspective, the Falcon 9 proved that the impacts upon the nearest sensitive receivers were seen as meeting with appropriate acoustic guidelines, the use of the Falcon 9 was not indicative of the size of rockets to be launched from Whalers Way. In fact, the Falcon 9 was approximately four times larger than the largest rocket expected to be launched on the site.

The next largest rocket, the Blue Origin New Shepard was slightly smaller than the largest rocket expected, so represented close to, but not, the upper bounds of the size of vehicle to be launched from the proposed facility. In order to provide a more realistic quantum of the types of rockets to be launched from Whalers Way, further work was undertaken which enabled the software to be tailored for custom rocket vehicles based on size, thrust, tonnage and other technical metrics. This enabled the software to be tailored for custom rocket vehicles based on size, thrust, tonnage and other technical metrics.

A realistic upper bounds vehicle was then inputted into the software which was the 137 tonne Vega Orbital rocket. By comparison the Falcon 9 which was previously used is 549 tonnes. This has provided Southern Launch with a realistic set of noise measurements. The noise modelling results for the different sized rockets has been detailed and compared in this technical document to quantify noise impacts to terrestrial fauna species.

Noise and vibration have the potential to adversely affect wildlife and sensitive habitat located near construction and operational activities. Noise impacts may include changes in behaviour and physical harm, which have the potential to adversely impact sensitive wildlife populations.

Birds have been identified as the primary noise-sensitive receptors for this Project however mammal and reptile species have also been noted within the Project Area.

The potential of anthropogenic noise on birds are commonly identified as follows (Dooling & Popper 2007):

- Physiological effects, such as stress, avoidance, and fright-flight responses;
- Damage to hearing from acoustic over-exposure; and
- Masking of important bioacoustics and communication signals, such as the ability to hear each other or predators, which may also lead to dynamic behavioural and population effects (Shannon, et al. 2016).

In birds, hearing is the second most important sense after vision (Beason 2004). The noise from a rocket launch could elicit a startle response in birds located in the immediate area of the launch. Noise generated during launch activities have the potential to disturb birds, resulting in the potential loss of bird eggs, and abandonment of nesting, breeding or feeding areas (FAA 2009) and (SpaceX 2019).

High levels of disturbance, such as from aircraft operations, can cause sudden nest abandonment, which can lead to a potential loss of eggs or chicks through breakage, trampling, chilling, and predation (Wilson, Culik, Danfeld, & Adelung 1991).

6.1.9.1.1 Key Potential Impacts

The following provides a brief overview of the effects that may occur because of an animal being exposed to noise.

Consideration of this information, together with information on the biological importance of the area as a habitat for the considered species, e.g. breeding and foraging areas, is used to assess the likely impact of a noise source.

- Risk of fatality – When exposed to significant noise levels, either immediate mortality or tissue and/or physiological damage can result. The injury may be sufficiently severe that death occurs sometime later due to decreased fitness. Mortality can also have a direct effect upon animal populations, especially if it affects individuals close to maturity. Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.
- Hearing injury – Short or long term changes in hearing sensitivity (Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS)) may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, as well as cause deterioration in communication between individuals. This may affect growth, survival, and reproductive success.
    - TTS: A temporary reduction in the ability of an animal to perceive sound. Recovery to pre-exposure levels is expected to occur; and
    - Acoustic Injury PTS: Acoustic trauma may result in mortality or injury (namely, PTS). A PTS is a permanent reduction in the ability of an animal to perceive sound. Recovery is not expected to occur.
- Masking – The presence of man-made sounds may make it difficult to detect biologically significant sounds against the noise background. Masking of sounds from predators may result in reduced survival. Masking of sounds used for orientation and navigation may affect the ability to find preferred habitats and in the case of fish, spawning areas, affecting recruitment, growth, survival, and reproduction.
- Behavioural responses – Behavioural responses may cause displacement from preferred habitats, which could affect feeding, growth, predation, survival, and reproductive success.

These dynamic behavioural and population effects are described in increasing severity of effect (Figure 8).

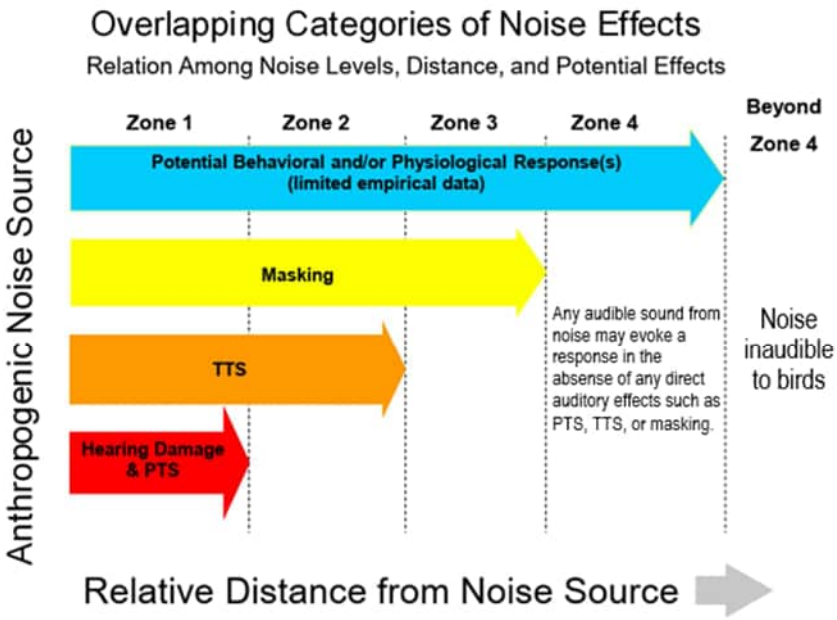


Figure 8 Conceptual relationship between the distances from a noise source and the overlapping effects on hearing and behaviour as applied to a range of bird species (Dooling & Popper 2007)

Noise criteria have been established for PTS and TTS to noise for the general faunal groups.

Noise metrics, such as L_{eq} and L_{max} are used to describe the noise based on the characteristics of the noise source. Noise metrics account for the differences in duration and loudness of sounds. Generally, continuous noise sources are described in terms of time-averaged descriptors, such as L_{eq}. Construction noise for example, is usually a continuous and is described in terms of L_{eq} noise descriptors.

Where noise sources are in motion for example, aircraft/ rocket, the noise level changes over time. For a rocket launch, the maximum noise level (L_{max}) is used to describe the maximum level that would be produced during a launch.

6.1.9.2 Assessment criteria

A desktop study was undertaken of relevant scientific research that describes the impacts of noise on wildlife receptors. This step was considered important as there are limited standards, regulation and guidelines available for assessing airborne noise and ground vibration impacts in on wildlife. As such, information on the hearing sensitivity and acoustic thresholds for the specific birds within the Project Area could not be established. Accordingly, it has been assumed that responses of birds within the Project Area are like those of birds in general.

The California Department of Transportation's *Technical Guidance for the Assessment and Mitigation of the Effects of Traffic Noise and Road Construction Noise on Birds* (Dooling & Popper, 2016) provides a comprehensive summary of the studied effects of noise on birds from the construction and operation of roads. The *Technical Guidance* recommended interim guidelines for potential effects to birds from different noise sources are presented in Table 16.

Table 16 Recommended interim guidelines for potential effects from different noise sources (Dooling & Popper 2016)

Noise source type	Noise effect			
	PTS onset L_{Amax}, dB(A)	TTS onset L_{Aeq}, dB(A)	Masking L_{Aeq}, dB(A)	Potential behavioural effects
Single impulse (for example, starter's	140[1]	Not available[3]	Not applicable[5]	Any audible component of

pistol 6" from the ear)				traffic and construction noise has the potential of causing behavioural and/or physiological effects. These are independent of any direct auditory effects on the auditory system of PTS, TTS or masking.
Multiple impulse (for example, jackhammer and pile driver)	125[1]	Not available[3]	50-60[6]	
Non-strike continuous (for example, construction noise)	Not applicable[2]	93[4]	50-60[6]	
Traffic and construction noise (continuous)	Not applicable[2]	93[4]	50-60[6]	
Alarms (97 dB/ 100 ft)	Not applicable[2]	Not applicable[2]	Not applicable[7]	

1. Estimates based on bird data from Hashino et al. (1988), Dooling & Popper (2016) and other impulse noise exposure studies in small mammals.
2. Noise levels from these sources do not reach levels capable of causing auditory damage and/or permanent threshold shift based on empirical data on hearing loss in birds from the laboratory.
3. No data available on TTS onset in birds caused by impulsive sounds.
4. Estimates based on study of TTS onset by continuous noise in the budgerigar and similar studies in small mammals.
5. Cannot have masking from a single impulse.
6. Conservative estimate based on addition of two uncorrelated noises. Above ambient noise levels, critical ratio data from 14 bird species, well documented short-term behavioural adaption strategies and a background of ambient noise of a quiet suburban area would suggest noise guidelines in the range of 50-60 dB(A).
7. Alarms are non-continuous; therefore, they are unlikely to cause masking effects.

Dooling & Popper (2016) note that the recommended guideline level of 93 dB(A) for TTS in birds is based partly on a study by Dooling (1980) in which budgerigars were exposed to continuous noise for 72 hours (Resonate 2022).

While Dooling & Popper (2016) do not specify an acoustic metric for PTS and TTS thresholds, it is generally appropriate to use a maximum or peak level for impulsive noise, and an equivalent noise level (i.e. Leq,T) for continuous noise where the potential for hearing damage depends on both the level and duration of noise exposure, i.e. the total sound energy received in a given period (Resonate 2022).

An equivalent noise level (Leq,T) is defined as the steady sound pressure level which, over a given period of time (T), has the same total sound energy as a fluctuating or non-steady noise. This allows a direct comparison of hearing loss potential of different noise levels and exposure times. For example, exposure to a steady noise of 107 dB(A) for one hour is equivalent to continuous exposure to 93 dB(A) for 24 hours (i.e. 93 dB LAeq,24hr), as both result in the same total sound energy and therefore same expected potential for hearing injury.

An averaging time of 24 hours (i.e. LAeq,24hr) is considered suitable for assessment of TTS in birds on the basis that this time window is consistent with the cumulative noise assessment period for many other species including marine mammals and fishes, and is conservative since it is less than the 72 hour continuous exposure in the study that the criteria is derived from.

For a bird (based on the median data from masking studies on 14 bird species), Dooling & Popper (2016) suggest an interim guideline threshold of 50 dB(A) to assess where noise may begin to interfere with acoustic communication in birds.

The A-weighting, designed for the response of the human ear to sound is considered acceptable for birds, as humans hear just as well or better than birds over a much wider range of frequencies (Dooling & Popper, The effects of highway noise on birds, 2007). Accounting for variations in ambient noise environments, and variation in hearing sensitivity between individual birds and species, a precautionary threshold of 50 dB(A) has been adopted to identify where birds may be at risk of masking effects.

Noise emissions from construction and ground-based operational activities are expected to fall into the categories of multiple impulse noise, non-strike continuous, and traffic and construction noise, i.e. 93 dB(A).

Noise from a single impulse source is considered relevant to noise associated with the maximum noise produced by a rocket launch. Accordingly, the maximum noise produced by a rocket launch has been compared to the relevant PTS thresholds.

The range of hearing for mammals and reptiles and the consequent sensitivity to anthropogenic noise are not as well researched. However, behavioural, and physical responses like those listed have been noted in available literature. Studies of terrestrial mammals have shown that noise levels of 120 dBA can damage mammals' ears, and levels at 95 dBA can cause temporary loss of hearing acuity (Wyle, 2003). It is likely that the possible impacts to mammals would be like birds noting that mammals would be unable to move away from the noise being produced as quickly and may be exposed to higher levels for longer.

6.1.9.3 Noise Modelling

Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration provides predicted noise level contours for launch of Falcon 9 (549 tonnes) and New Shepard (75 tonne) rockets from Launch Site A and Launch Site B.

It is understood that that the Falcon 9 is considerably heavier than the largest vehicle that is proposed to be launched from Whalers Way Orbital Launch Complex (approximately 110 tonnes), while the suborbital New Shepard rocket is smaller (75 tonnes). Acoustic power is proportional to rocket exhaust mechanical power (thrust), meaning that larger rockets typically generate higher noise levels. Predicted noise levels from a hypothetical Falcon 9 launch are therefore likely to be higher than actual worst-case noise levels, while predicted noise levels from a New Shepard launch may be lower.

As design has progressed and greater data on rockets to be used for the Project has become available, Southern Launch has been able to undertake more realistic and targeted noise modelling for the Project to quantify expected noise levels from a realistic launch expected to take place at the facility. Resonate (2022) have undertaken additional modelling of noise emissions from launch of a 137 tonne Avio Vega rocket at Launch Site A and Launch Site B. This is slightly larger than the nominal largest launch vehicle and therefore expected to provide a conservative representation of worst case noise emissions.

Noise levels from this rocket were predicted using the RUMBLE 3.0 computer modelling package, which has also been used in AECOM's Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration. RUMBLE 3.0 implements a modified version of the 'SP-8072' rocket noise prediction algorithm developed by NASA (Eldred, 1971), and has been approved by the United States Federal Aviation Administration (FAA) as suitable for predicting noise from rocket launch activities.

6.1.9.4 Wildlife Impacts During Construction

Utility construction activities are expected to be the noisiest stage of the Project construction, with ground compaction expected to produce the highest level of noise from the site. Noise levels more than those that have been established to protect birds from temporary hearing damage (L_{Aeq} 93 dB) are predicted to be achieved at distances approximately 10 – 20 metres from the works.

Behavioural effects and masking of communication signals may be impacted temporarily during construction. Ambient sound measured throughout the Project Area was as low as 38 dBA during the day and 30 dBA at night, meaning that construction noise could be up to 20 dB above the ambient level at approximately one kilometre from the proposed construction areas.

Continuous noise levels that are 20 dB above background (50 – 60 dB(A)) in the frequency region of bird hearing and communication can have a detrimental effect on the detection and discrimination of vocal signals by birds (Dooling & Popper, The effects of highway noise on birds, 2007).

Potential behavioural and/or physiological effects are noted as possible in any case where construction noise is audible. This includes both construction activities that produce short bursts of impulsive noise and the continuous noise produced by mobile and fixed machinery.

It would be impossible to reduce construction noise to an inaudible level, particularly for areas located within two km of the works. However, construction noise could be minimised by limiting intensity and duration of high impact activities near sensitive wildlife area where possible.

Construction of the Project will be managed in accordance with a Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) to ensure that all impacts are reduced as far as practicable utilising management measures outlined.

6.1.9.5 Wildlife Impacts During Operation

Supporting infrastructure

The predicted noise level of 62 dB(A) at 25 m from the Project Area is below the continuous noise level threshold of 93 dB(A) for causing TTS in birds. In addition to these fixed operational noise events, up to 16 truck movements per week have been advised. The maximum (LAmax) noise produced by a single truck movement would be approximately 85 dB(A) at 10 m from a pass by. These above truck movements are expected throughout the day and are not expected to cause significant noise impact.

It is considered that the risk of operational noise impacts from general site facilities would be limited to the masking of communication signals and brief behavioural response.

Rocket launches

Noise from launches would temporarily alter the quiet setting of the natural environment for one to two minutes during launches and for up to 15 seconds during testing. These events have the potential to disturb nearby residents and have an adverse physiological or behavioural impact on the wildlife located in the local habitat.

Noise from launches and stationary rocket testing are predicted to temporarily alter the quiet setting of the natural environment with noise briefly above the measured ambient level at distances further than five km from the launch.

The Southern Emu Wren (Eyre Peninsula), Mallee Whipbird and other protected species that inhabit the areas close to the launch sites are at greatest risk increased stress, adverse behaviour reactions and physiological impacts. Coastal species are predicted to generally be exposed to low levels of noise however a brief adverse behavioural response is likely.

The exposure to unmitigated noise levels above the permanent hearing damage threshold of 140 dB(A) is predicted to be limited to 50 – 150 m based on the range of launch vehicles modelled for the Falcon 9 (549 tonnes). Accordingly, a risk of PTS is expected to be limited to areas within a launch site only and the immediate surrounds for the Falcon 9 (549 tonnes).

The maximum instantaneous sound pressure level (L_{Amax}) for the subsonic (velocities below the speed of sound) launch activities assuming the loudest rocket (Falcon 9 (549 tonnes)) in each location has been shown in the noise contour maps Figure 9 and Figure 10. As shown in AECOM (2022) and Figure 9 and Figure 10, predicted noise levels from launch of a Falcon 9 (549 tonnes) are at the recommended PTS guideline criteria of 140 dB at the direct site for Launch Site A and Launch Site B and then reduces quickly from each Launch Site. The exposure to unmitigated noise levels above the permanent hearing damage threshold of 140 dB(A) is predicted to be limited to 50 – 150 m from the Launch Sites based on the Falcon 9 modelling..

As shown in Resonate (2022), predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to birds as a result of a nominal worst case rocket launch. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system. Predicted noise levels from launch of a Vega rocket (137 tonne) at launch Site A and Launch Site B have been shown in noise contour maps Figure 11 and Figure 12.

Information from the studies reviewed could not confirm whether long term behavioural changes would be caused by launch vehicles or if the birds in this area would habituate to the sound of launches and testing. Some birds have demonstrated the ability to habituate to repeated, regular, and predictable flights, such as king penguin studies in Hughes et al. (2008). While it has been studied that some birds

can become accustomed to aircraft, others may become sensitised to aircraft noise and become more easily disturbed (Hoang, 2013).

As noted for human impacts, it is unlikely that there are feasible source controls available in addition to those already incorporated in the Southern Launch design. As the long-term impacts are unknown, it is recommended that a plan to monitor the behaviour of protected wildlife in response to noise be included within the targeted species management plans for the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird that will be prepared for the Project.

A test launch campaign to further assess the potential noise impacts on bird species has been commissioned for the Project, with one launch at Whalers Way and a second static test at Helidon, Queensland having taken place. Refer to Section 6.2 and Section 6.3 for further details and assessment of impacts.

6.1.9.6 Exposure to Shockwaves

The potential impact from sonic booms has been determined by comparing the impact of other launch facilities with a similar planned azimuth, trajectory and rocket size.

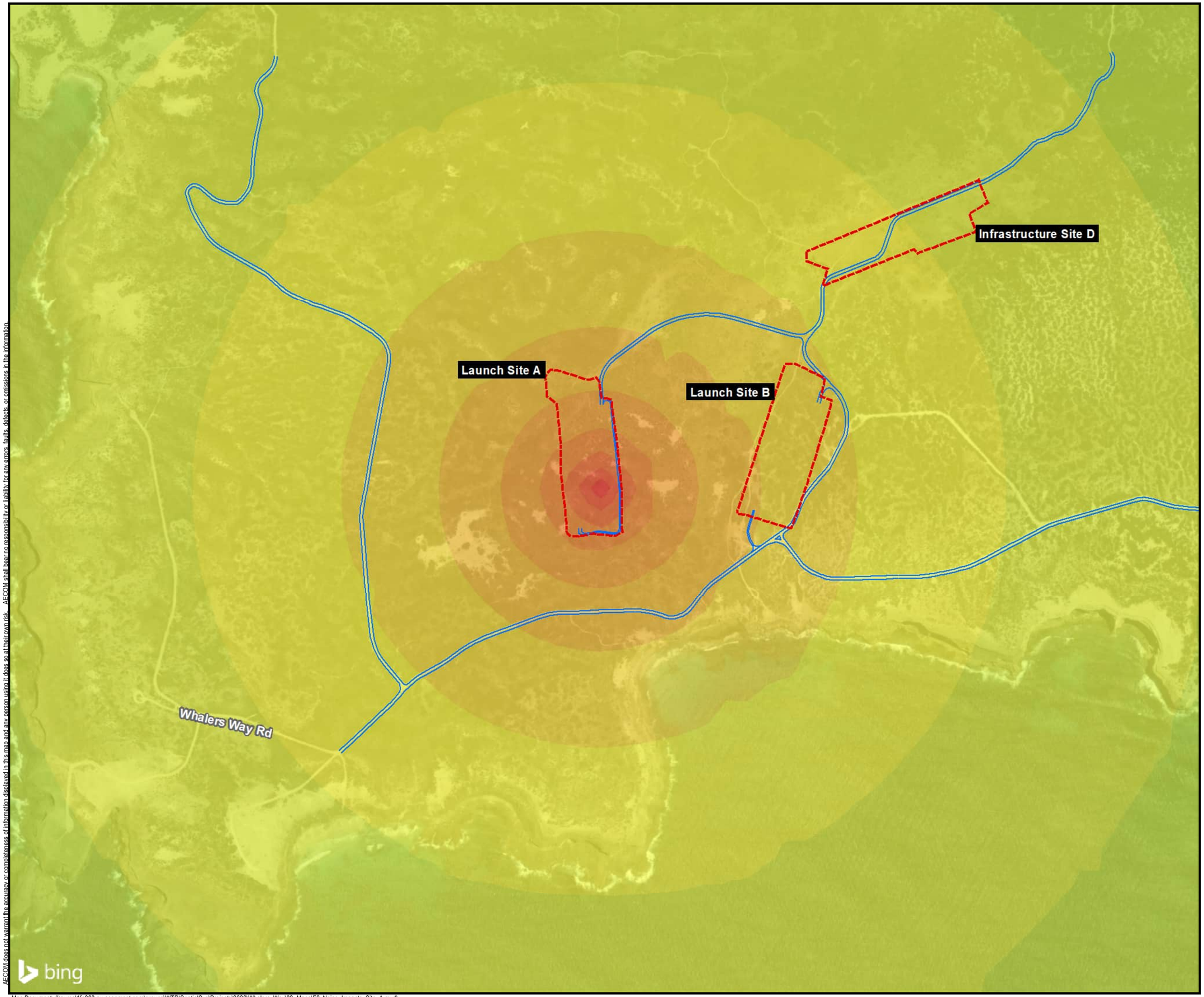
Supersonic speeds are assumed to occur approximately three kilometres from the coast during vehicle ascent over the ocean. Sonic booms produced during vehicle ascent are typically directed in front of the vehicle and the entire boom footprint is usually some distance downrange of the launch site (SpaceX, 2020). The smaller rockets proposed for the Southern Launch facility are also relatively small which would limit the size of sonic boom being created.

Furthermore, impact assessments for suborbital rocket launch facilities in the United States (FAA, 2009) have concluded that sonic booms are less likely to contribute to other noise impacts associated with the launch if they occur over the ocean at a high altitude. Rocket landing events can often result in single or multiple sonic booms as vehicles return to subsonic speeds however this type of activity is not proposed by Southern Launch.

Hence, the overpressure produced by the sonic boom is not expected to exceed the assessment criteria of 133 dBL on land. The audible component of a sonic boom may sound similar to a single distant thunderclap that could result in a short-duration startle response.

6.1.9.7 Ground Vibration

The extent of ground and structural vibration produced by the acoustic environment near the launch vehicle is expected to be limited to the buildings supporting the launch.



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Coordinate System: GDA 1994 MGA Zone 53

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metres

1:10,000 (when printed at A3)

LEGEND

- Project Area
- Construction Zones

LAmax Noise Levels (dBA)

- 100 - 105 dB
- 105 - 110 dB
- 110 - 115 dB
- 115 - 120 dB
- 120 - 125 dB
- 125 - 130 dB
- 130 - 135 dB
- 135 - 140 dB
- 140 - 145 dB
- 145 - 150 dB

Noise impacts on Launch Site A (Falcon 9)

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F9

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F8_Noise_Impacts_Site_A.mxd)

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LEGEND

- Project Area
- Construction Zones

LAmax Noise Levels (dBA)

- 95 - 100 dB
- 100 - 105 dB
- 105 110 dB
- 110 - 115 dB
- 115 - 120 dB
- 120 - 125 dB
- 130 - 135 dB
- 135 - 140 dB

Noise impacts on Launch Site B (Falcon 9)

Southern Launch Whalers Way

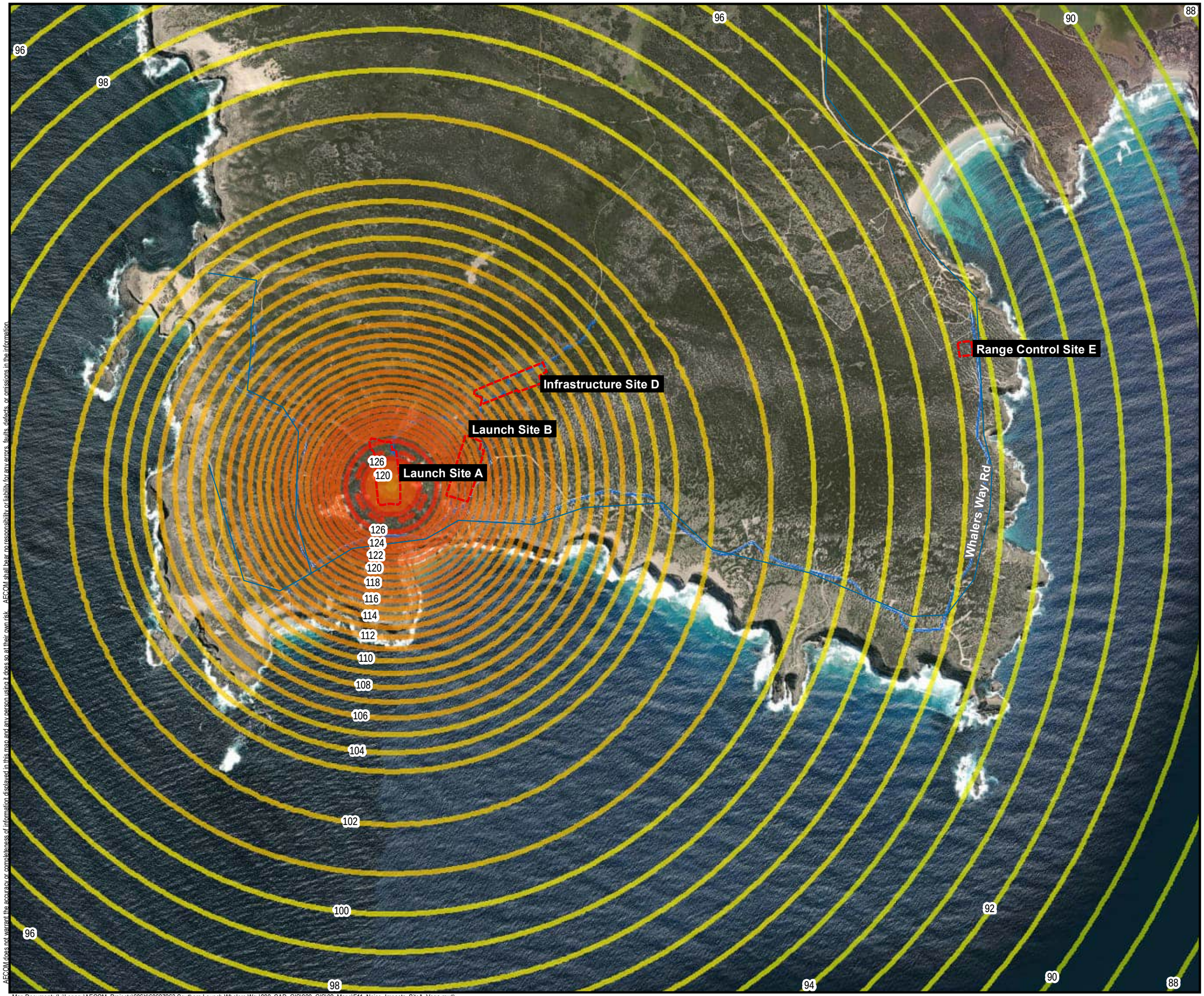
Flora and Fauna Assessment

Whalers Way, SA

Figure

F10

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F9_Noise_Impacts_Site_B.mxd)



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LAST MODIFIED	houghtonr 03 AUG 2022

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Coordinate System: GDA 1994 MGA Zone 53

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LEGEND

- Project Area
- Construction Zones

LAmax Noise Levels (dBA)

- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 - 85
- 85 - 90
- 90 - 95
- 95 - 100
- 100 - 105
- 105 - 110
- 110 - 115
- 115 - 120
- 120 - 125
- 125 - 130

Predicted Noise Contours at Launch Site A (Vega)

Southern Launch Whalers Way

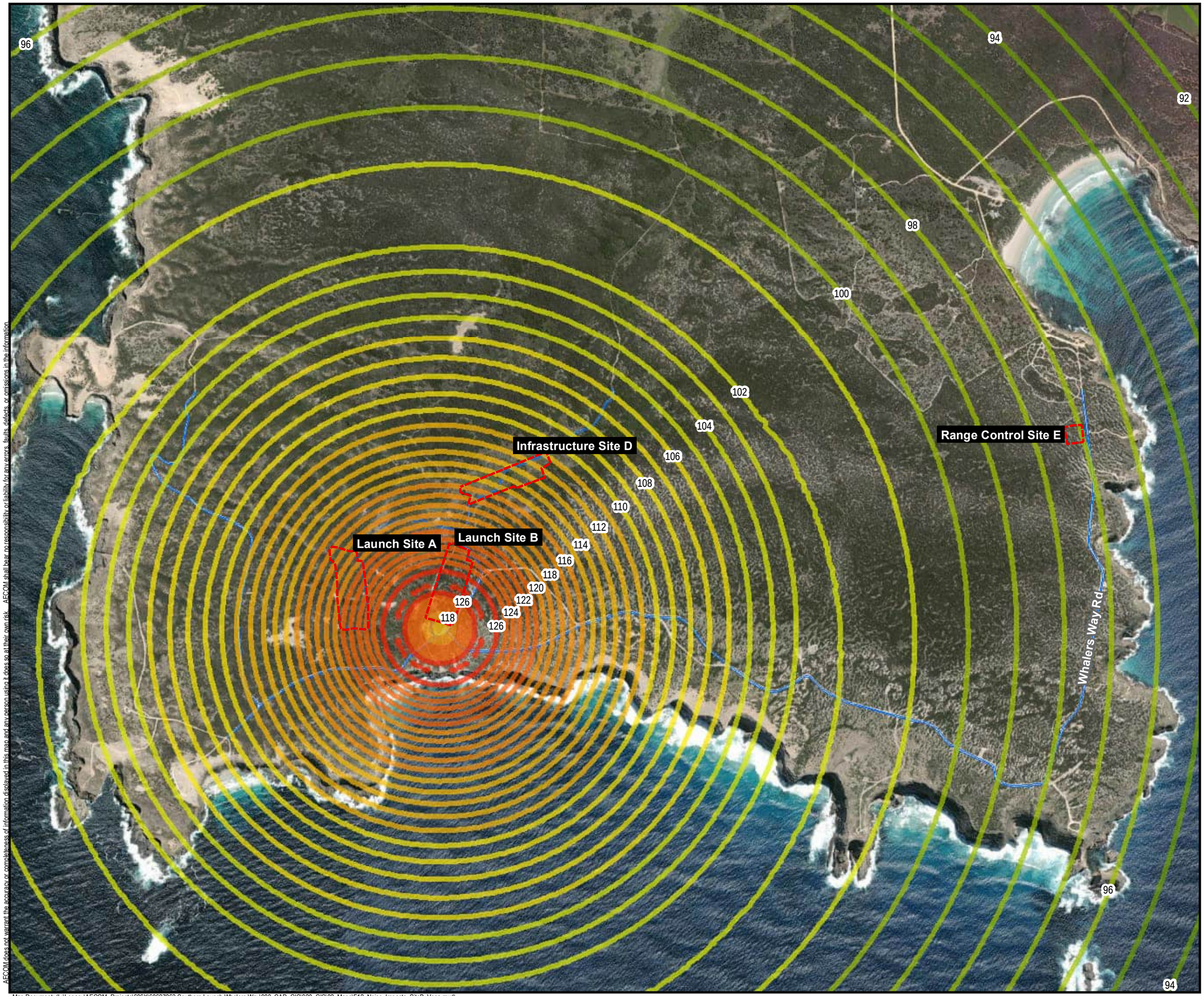
Flora and Fauna Assessment

Whalers Way, SA

Figure

F11

Map Document: (L:\Legacy\AECOM_Projects\606X\60627263 Southern Launch Whalers Way\900_CAD_GIS\920_GIS\02_Maps\F11_Noise_Impacts_SiteA_Vega.mxd)



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LEGEND

- Project Area
- Construction Zones

LAmax Noise Levels (dBA)

- 80 - 85
- 85 - 90
- 90 - 95
- 95 - 100
- 100 - 105
- 105 - 110
- 110 - 115
- 115 - 120
- 120 - 125
- 125 - 128

Predicted Noise Contours at Launch Site B (Vega)

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F12

6.1.10 Dam and Detention Basins

As detailed in the EIS, retention basins will be located at Launch Site A and Launch Site B, and a 30 megalitre capacity dam is to be located at Infrastructure Site D. There is the potential impact that these open water bodies will attract pest species such as cats, foxes, and native species (birds, reptiles and mammals), and increase the presence of weeds. The retention basins will be lined with a polymer lining and an 1800 mm chain mesh fence with three strands of barbed wire will be installed around all the three open water bodies. Weed control will be a regular mitigation measure during the construction and operational phase of the Project as detailed in Table 30. These mitigation measures will ensure pest species and native ground dwelling fauna species are prevented from entering the open water bodies.

The above does not preclude the attraction and risk of native bird species (species detailed in Section 5.4.2) utilising these water bodies as a water source and causing aggregation issues within the Project Area. If water within these water bodies is contaminated from the storage of stormwater from the deluge process and storage of firefighting water, there is a risk bird species that utilise these water bodies become sick, injured and or potential death.

Southern Launch has undertaken water quality analysis of the process of water deluge storage and firefighting water in the Water Quality Report prepared for the Project. The report indicates there is a low risk of contamination in the water to be stored in the three open water bodies. Further to this the water bodies will be covered with a geotextile cover to detract bird species to these water bodies. The covers will be sealed to eliminate accidental entry of fauna to water bodies. The covers will be permeable to allow the transfer of water vapour and/or rainfall but no movement of fauna through these will be possible.

6.1.11 Irrigation

The major threat irrigation poses to the environment is increased salt content in the soil which leads to decline in nutrient in soils and loss of habitat for native flora and fauna species. Irrigation also modifies vegetation structure and composition, likely to facilitate weed invasion and may increase local herbivory Irrigation for the Project is subject to the detailed design phase and an irrigation management plan and water quality monitoring program will be developed to manage irrigation for the Project.

All irrigation will occur within the Project Area footprints. Irrigated areas will be surrounded by gravel areas with a minimum buffer zone of 23 m from native vegetation at one point with most irrigation having a gravel/asphalt buffer zone of greater than 30 m from native vegetation.

The Project will limit the landscaping from a plant perspective using species growing in situ only where possible. Any disturbed topsoil from top 200 mm during construction should be stockpiled in low windrows until construction complete and then used to recover areas post hard landscaping to promote natural regeneration including sticks, litter and detritus. This material carries necessary seedbank, fungal and mycorrhizal material to allow for natural germination of indigenous species.

Through the implementation of these design considerations and the mitigation measures detailed in Table 30 the risks irrigation pose can be managed adequately.

6.1.12 Increased Fire Risk

An increase in fire frequency is likely to disrupt the life cycle of flora and fauna and often results in a change in vegetation structure which includes loss of fallen timber and stags and is often followed by an increase in shrub density. While many Australian flora species have developed mechanisms to cope with fire in the landscape, frequent fires will decrease the resilience of the plant communities. Some flora species may be burnt before they are mature enough to seed thus reducing the diversity of the vegetation community which in turn can further reduce its habitat quality. Excessively hot fires also have the potential to sterilise the ground by killing the seedbank and further altering the vegetation structure.

The loss of fallen timber and stags decreases habitat availability for many native species and is likely to increase stress and resource pressure on fauna species. The loss of these habitat features may also increase the risk of predation of species by both native and introduced fauna.

The Project may increase the risk of fire due to hot works during construction activities and the chance of sparks occurring off the rocket launches during times of hot and dry conditions. Fire protection mitigation measures are detailed in Table 30.

6.1.13 Indirect Impacts

Potential indirect impacts the Project may have on terrestrial ecology values have been detailed above. Through progressed design buffers have been applied in the Project Area footprints of each facility and tracks to limit indirect impacts to vegetation, flora and fauna in the vicinity.

All vegetation within the Project Area has had an additional 5 m clearance buffer applied to the Project Area footprint for fire safety. The buildings and infrastructure are all located beyond the minimum 5 m of the Project Area boundary, in some instances up to 20 m from the boundary dependant on form of batters.

All roads have a 3 m buffer applied to each side of the road however this may be utilised as 6 m on one side of the road as part of upgrades or alternatively as the buffer is stated, dependent on the bends in roads and terrain encountered. This is also provided to allow for the addition of power and water easements, the construction method and infrastructure type not finalised at this stage.

6.2 Whalers Way Test Launch 1

The focus of the Site Selection Survey was establishing Impact and Control Sites, with the aim to find individuals and record individual song of each of the focal species. Known locations within Whalers Way (Impact Sites) were surveyed and previous locations of Southern Emu-wren (Eyre Peninsula) and the Mallee Whipbird records in Lincoln NP were surveyed to establish Control Sites, away from potential impacts of the Test Launch Campaign.

A total of 20 sites were set up for the Southern Emu-wren (Eyre Peninsula) for the test campaign, including 14 Impact Sites at Whalers Way and six Control Sites at Lincoln NP.

A total of 21 sites were set up for the Mallee Whipbird for the test campaign, including 13 Impact Sites at Whalers Way and eight Control Sites at Lincoln NP.

6.2.1 Occupancy and Abundance of Southern Emu Wren (Eyre Peninsula) and Mallee Whipbird

Southern Emu-wren (Eyre Peninsula)

A total of 17 individual Southern Emu-wren (Eyre Peninsula) (11 at Impact Sites and six at Control Sites) were observed during the Site Selection Survey in June 2021.

A total of 23 individual Southern Emu-wren (Eyre Peninsula) (16 at Impact Sites and seven at Control Sites) were observed during the Pre-Launch Survey in August 2021.

A total of 19 individual Southern Emu-wren (Eyre Peninsula) (14 at Impact Sites and five at Control Sites) were observed during the Post-Launch Survey in September 2021. Refer to Appendix J for further details,

Of the 20 sites actively searched for Southern Emu-wren (Eyre Peninsula) individuals were observed at 10 out of the 20 sites (50%) during the Pre-Launch Survey and 11 out of 20 sites (55%) during the Post-Launch Survey.

At the impact site (Whalers Way) 7 sites were occupied during the Pre-Launch surveys, while 8 sites were occupied during the Post-Launch survey. At Lincoln NP (control site) 4 sites were occupied during both the Pre-Launch and Post-Launch survey (Appendix J).

Mallee Whipbird

A total of 17 individual Mallee Whipbird (13 at Impact Sites and four at Control Sites) were observed during the Site Selection Survey in June 2021.

A total of 17 individual Mallee Whipbird (12 at Impact Sites and five at Control Sites) were observed during the Pre-Launch Survey in August 2021.

A total of 20 individual Mallee Whipbird (14 at Impact Sites and six at Control Sites) were observed during the Post-Launch Survey in September 2021. Refer to Appendix J for further details.

Of the 21 sites, 20 were actively searched for Mallee Whipbird individuals due to access restrictions and individuals were observed at 17 out of the 20 sites (85%) during both the Pre-Launch Survey and Post-Launch Survey.

At the impact site (Whalers Way) 12 sites were occupied during both the Pre-Launch and Post-Launch surveys, while 5 sites were occupied during the Post-Launch Survey. At Lincoln NP (Control site) 4 sites were occupied during both the Pre-Launch and Post-Launch Survey (Appendix J).

6.2.2 Call Playback Experiments

6.2.2.1 Pre-Launch

A total of 54 playback experiments were conducted including 29 for Southern Emu-wren (Eyre Peninsula) and 25 for Mallee Whipbird playbacks.

Southern Emu-wren (Eyre Peninsula)

At the Lincoln NP control sites Southern Emu-wren (Eyre Peninsula) responded to playback stimuli 33.3% of the time. Alternatively, at the Whalers Way Impact sites individuals responded 35% of the time.

Mallee Whipbird

At the Lincoln NP control sites Mallee Whipbird responded to playback stimuli 18.2% of the time. Alternatively, at the Whalers Way impact sites individuals responded 21.4% of the time.

6.2.2.2 Post-Launch

A total of 58 playback experiments were conducted including 31 Southern Emu-wren (Eyre Peninsula) and 27 Mallee Whipbird.

Southern Emu Wren (Eyre Peninsula)

At the Lincoln NP control sites Southern Emu-wren (Eyre Peninsula) responded to playback stimuli 35% of the time. Alternatively, at the Whalers Way Impact sites individuals responded 50% of the time.

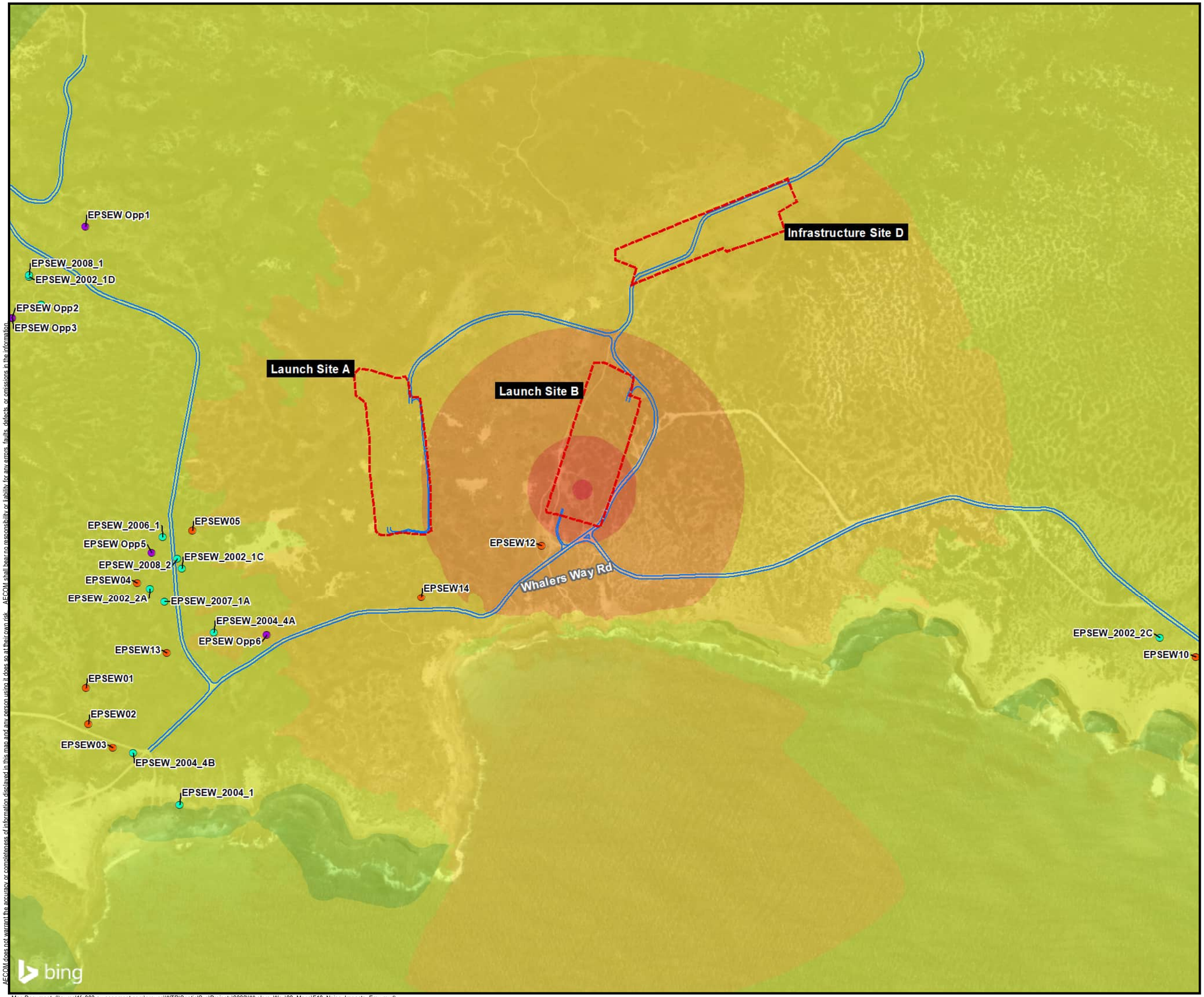
Mallee Whipbird

At the Lincoln NP control sites Mallee Whipbird responded to playback stimuli 9.1% of the time. Alternatively, at the Whalers Way impact sites individuals responded 37.5% of the time.

6.2.3 Noise Assessment

During the Test Launch 1 L_{Amax} levels at Impact Sites varied with the lowest levels (52 - 57dB) recorded at sites EPSEW6, Mallee Whipbird6, and Mallee Whipbird13, which are all located along the most eastern coastline of Whalers Way (Figure 13). The highest L_{Amax} levels (87 – 92 dB and 77-82 dB) were recorded at site EPSEW12 and EPSEW14, which are located directly east and west of the rocket launch pad (Figure 13). The highest L_{Amax} levels at Mallee Whipbird sites was 72-77 dB, which was recorded at Mallee Whipbird11 (Figure 14).

As detailed in Section 6.1.9 the continuous noise level threshold for causing TTS and temporary hearing damage in birds is 93 dB and permanent hearing damage threshold is 140 dB. Noise levels for the Test Launch 1 did not exceed 92 dB. Given that the test launch attempt did not get close to the 140 dB threshold for permanent hearing damage and did not exceed 93 dB threshold shift, it is deemed unlikely that there was permanent or temporary hearing damage to bird species associated to operational noise from the test launch undertaken.



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LEGEND

- Project Area
- Construction Zones
- EPSEW Monitoring site
- EPSEW Opportunistic Observations
- Historical EPSEW records

Predicted LAmax levels (dBA)

- 50 - 60 dB
- 60 - 70 dB
- 70 - 80 dB
- 80 - 90 dB
- 90 - 100 dB
- 100 - 110 dB

Noise contours for the predicted LAmax levels at Southern Emu-wren (Eyre Peninsula) Impact sites at Whalers Way

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F13

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F10_Noise_Impacts_Emu.mxd)

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LEGEND

- Project Area
- Construction Zones
- WBWB Monitoring site
- WBWB Opportunistic Observations
- Historial WBWB Records

Predicted LAmax levels (dBA)

- 40 - 50 dB
- 50 - 60 dB
- 60 - 70 dB
- 70 - 80 dB
- 80 - 90 dB
- 90 - 100 dB
- 100 - 110 dB

A_WBWB_143
A_WBWB_144
A_WBWB_140
A_WBWB_139
A_WBWB_141
WBWB06
A_WBWB_142
Range Control Site E
WBWB07
Infrastructure Site D
WBWB02
Launch Site A
Launch Site B
WBWB04
A_WBWB_147
A_WBWB_145
A_WBWB_146
WBWB13
WBWB10
WBWB08
WBWB09
WBWB03
WBWB_Opp_6
WBWB01
WBWB_Opp_1
WBWB_Opp_3
WBWB_Opp_4
WBWB11
Whalers Way Rd
WBWB05
WBWB_Opp_2
WBWB12
WBWB_Opp_5

bing

Noise contours for the predicted LAmax levels at Mallee Whipbird Impact sites at Whalers Way

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F14

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F11_Noise_Impacts_MalleeWhipbird.mxd)

6.2.4 Avian Diversity

A total of 108 20min/^{2} Ha active searches were undertaken at the Lincoln NP control sites (n= 54) and Whalers Way impact sites (n= 54) during the Pre-Launch and Post-Launch surveys. This included 20 searches at Lincoln NP control sites and 34 at Whalers way impact sites Pre-Launch and 24 searches at Lincoln NP control sites and 30 searches Whalers Way impact sites Post-Launch.

Mean bird diversity of all bird species recorded at control sites was 10.96 (±2.95) during Pre-Launch and 8.46 (±2.14) during Post-Launch surveys. Alternatively, mean bird diversity recorded at impact sites was 9.22 (±1.83) during Pre-Launch and 11.83 (±1.83) during Post-Launch surveys.

6.2.5 Discussion of Impacts from Test Launch 1

Based on the results detailed in the above sections against impact criteria for bird species during the launch shows no immediate short-term impacts from operational noise of rocket launches on the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird from Test Launch 1.

The avian and noise data was collected during the Test Launch 1 attempt only. The results from this short-term study broadly describe site occupancy, and behavioural response of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird, as well as avian diversity at impact and control sites before and after the Test Launch 1 attempt. Only one of the four engines was active during the launch attempt and the rocket did not leave the launch area. As such, noise data presented may not represent noise associated with an actual launch event. It is currently unclear if the full noise and vibration impact of a successful launch was achieved and thus experienced by the local bird community.

The behavioural response data of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer-term impacts of rockets launches on the avian community and focal species remains unknown.

No long-term behavioural data (i.e. occupancy, breeding and recruitment) was collected during the Pre- and Post-Launch surveys of the Test Launch 1 attempt. The collection of such data would require a significant increase in survey time, intensity, and effort (likely multiple months over multiple years).

From the data collected from this first launch of a three test launch campaign definite conclusions can't be drawn at this early stage to quantify the potential short and long-term noise impacts on the local avian community and to the two focal species of interest. Further data collection is required to be collected from the second and third test launch to quantify impacts.

Further analysis of data collected during the second and third test launches are required to quantify impacts to the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird.

6.2.6 Recommendations for further survey work

The results detailed above are based on a limited data set comprising a sample size of 1 test launch. It is recommended that further survey work to determine potential longer-term impacts of launches on avian species is undertaken. Long-term monitoring should consider the deployment of Autonomous Recording Units to gather long-term data on species richness in addition to call frequency of all local avian species in the areas of interest.

6.3 Queensland Hapith I Static Motor Test

Resonate were engaged to undertake noise measurements during a static motor test of a Hapith I rocket at a site in Helidon, Queensland on 9 June 2022 (Resonate 2022). Measurements were undertaken at eight locations at distances ranging from approximately 60 m to 6 km from the test pad. The purpose of measurements was to:

- quantify the Sound Power Level (SWL) of the rocket motor;
- validate noise modelling predictions for a Hapith I rocket (Resonate 2022); and
- estimate the noise attenuation provided by the 'flame trench' and water deluge system.

Noise levels from the static test were predicted using the RUMBLE 3.0 computer modelling package, which has also been used in AECOM's Whalers Way Orbital Launch Complex - Environmental Assessment Report: Noise and Vibration (AECOM 2022).

A comparison between measured and modelled noise levels is presented in Table 17.

Table 17 Comparison between RUMBLE 3.0 predicted noise levels and measured noise levels (dB LAmax). Source Resonate (2022)

Location	Predicted noise level, dB LAmax	Measured noise level, dB LAmax	Difference, dB
N1 - 120 m north from test pad	112	112	0
N2 – 461 m north from test pad	94	97	-3
N3 – 2,990 m north from test pad	71	65	6
N4 – 5,960 m north from test pad	60	52	8
S1 – 62 m south from test pad	118	107	11
S2 – 937 m south from test pad	87	82	5
S3 – 2,060 m south from test pad	77	64	13
S4 – 2,930 m south from test pad	71	-	-

Measured noise levels are most consistent with modelling results at locations near to the test site where there is line of sight between the measurement location and test pad (e.g. N1). At larger distances and/or where there is shielding from topography or noise barriers (shipping containers), the measurement results are consistently less than predicted. This is expected since the RUMBLE model does not account for topography and shielding (Resonate 2022).

Predicted noise levels were equivalent to measured noise levels at N1, 120m to the north of the rocket, while at all other locations noise levels were over-predicted by between 5 and 13 dB(A). This result was expected due to topography, shielding and ground absorption effects not accounted for in the RUMBLE model.

Additional noise monitoring of test launches at Whalers Way is recommended in order to provide further validation of the RUMBLE 3.0 model in conditions specific to the Project site. Indicatively the water deluge system may have reduced noise levels by approximately 10 dB or more at measurement locations to the north, however further investigation and measurements of additional launches are required to confirm this finding and quantify the reduction with a higher level of accuracy.

The shipping containers and quarry face to the south of the rocket provided some degree of noise mitigation. Additional investigation would be needed to quantify this and relate this finding to flame trench arrangements at other launch sites.

This static motor test has provided further evidence that a similar test undertaken at Whalers Way would not exceed the permanent hearing damage threshold of 140 dB L_{Amax} and TTS threshold of 93 dB $L_{Aeq,24hr}$. The maximum measured noise levels at N1, 120m from the test site, were 112 dB L_{Amax} and 67 dB $L_{Aeq,24hr}$ which are below these criteria by a significant margin.

Measurements showed that noise from the test was audible above background noise levels at all measurement locations; however, noise levels were similar or less than noise from truck pass-bys at Locations S2 and S3, 937 m and 2,060 m south of the test site respectively.

Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system. There could be behavioural

response but this would likely be limited to the duration of audible noise from launches (i.e. less than a minute) on an occasional basis.

6.4 Relocation of Launch Site A

As detailed in Section 3.0 and Section 5.0 the results from the Site Selection Survey and Test Launch 1 of the Test Launch Campaign identified that the original location of the Launch Site A contains higher density of records of the Southern Emu-wren (Eyre Peninsula). It was inferred that habitat in within the original location for Launch Site A is critical habitat for the species.

The degree of interaction with critical habitat for Commonwealth Threatened terrestrial avian species at the original Launch Site A was strengthened by ongoing survey work associated with Pre-Launch and Post-Launch surveys established within Whalers Way and the Port Lincoln NP. It became increasingly clear that Launch Site A was situated within an extensive area of significant habitat for Southern Emu-wren (Eyre Peninsula) populations within Whalers Way. Repeat observations of Southern Emu-wren (Eyre Peninsula) at numerous sites within Whalers Way and Port Lincoln NP has resulted in the modelling of qualitative habitat conditions where Southern Emu-wren (Eyre Peninsula) are most likely to be utilising that structure. With relative confidence, if the following qualitative habitat preferences are met within Whalers Way, there is a high likelihood that Southern Emu-wren (Eyre Peninsula) will be present:

- Low coastal heath with average height of 300-400mm with shrubs connected or spacings of less than 300mm on average; and
- *Eucalyptus diversifolia* low mallee individuals of up to 1 m in height with a density of at least 1-2 trees/hectare.

Habitats identified as less preferable occur where either:

- Heath shrub spacings exceed 500mm on average; and
- *E. diversifolia* is not present or is substituted by *E. angulosa;* or
- *E. diversifolia* becomes the dominant overall cover (>50%); or
- *E. diversifolia* dominant cover is greater than 1.2m in height on average.

The original Launch Site A location was located where preferred habitat conditions exist, and subsequently alternative site location options were sought where habitat was less preferable but conformed with other Project limitations. Five options were presented where ecological assessments were made based on avian species diversity and presence/absence of Commonwealth Threatened terrestrial avian species.

This section details an analysis of the five options for the relocation of Launch Site A from an ecology perspective. For full details of the relocation of Launch Site A in terms of heritage, launch trajectories and other components refer to the Response Document. Refer to Figure 15 for locations of the five Options for Launch Site A.

A risk assessment to Threatened species is based on likelihood of direct impact (Table 18) based on presence /absence and severity of impact. The likelihood of impact assessment is based on ecological data compiled during the baseline survey in 2020 and targeted surveys completed in 2020 and 2021 for the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird where opportunistic observations for other species were also recorded. Severity of impacts are included based on the extent of critical habitat within the launch footprints and new and existing access tracks from Launch Site B based on site surveys, qualitative observations and site photographs (Table 19). Table 18 and Table 19 have been utilised to determine overall risk rating (Table 20) for each Launch Site A options which is detailed in Table 21.

Table 18 Likelihood of impact to Threatened terrestrial species

Likelihood of impact to number of Threatened species	Description
3	Likely to directly impact 2 Commonwealth listed threatened species and 2 State listed threatened terrestrial species.
2	Likely to directly impact at least one Commonwealth listed threatened terrestrial species or one or two State listed threatened terrestrial species.
1	Likely to directly impact at least one or two State listed threatened terrestrial species, with no impacts expected to Commonwealth species.

Table 19 Severity of direct impact to number of threatened species

Severity of direct impact to number of threatened species	Description
3	Site footprint and new access roads to site likely to directly impact 100% of critical habitat for Commonwealth and State listed species.
2	Site footprint and new access roads to site likely to directly impact >50% of critical habitat for Commonwealth and State listed species.
1	Site footprint and new access roads to site likely to directly impact <50% of critical habitat for Commonwealth and State listed species.

Table 20 Risk Rating

		Severity		
		1	2	3
Likelihood	1	LOW	LOW	MEDIUM
	2	LOW	MEDIUM	HIGH
	3	MEDIUM	HIGH	HIGH

Table 21 Ecological Constraints of Launch Site A Options

Site A options	Impact Assessment	Likelihood	Severity	Risk
Original Location	• Known habitat for two Southern Emu-wren (Eyre Peninsula); • Largest extent of critical habitat for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird within Whalers Way surrounds this area with numerous observations of both species within the immediate vicinity of original site footprint; • Based on extensive site surveys and photographs of vegetation within the site, 100% of site considered suitable habitat for both Commonwealth listed species and State listed Rock Parrot and Diamond Firetail; and • Existing access to location from Launch Site B located entirely within area of intact habitat for listed commonwealth species.	**3**	**3**	**High**

Site A options	Impact Assessment	Likelihood	Severity	Risk
1	• Known Southern Emu-wren (Eyre Peninsula) records in close proximity to site, no further studies undertaken due to cultural heritage constraints identified prior to targeted survey; and • Based on extensive site surveys and photographs of vegetation within the site, 100% of site considered suitable habitat for listed species.	**N/A**	**3**	**N/A**
2	• Known habitat for three Southern Emu-wren (Eyre Peninsula) and two Mallee Whipbird in southern extent of site; • Approximately half the northern extent of the site has marginal habitat for State listed terrestrial species Diamond Firetail and Rock Parrot; • Approximately half the northern extent of the site has marginal habitat for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird; resulting in impacts to edge of species ranges; • Able to access the site through less valuable vegetation and habitat from northern end associated with the degraded Infrastructure Site D area; and • Based on extensive site surveys and photographs of vegetation within the site, 50% of site considered suitable habitat for listed species.	**3**	**1**	**Medium**
3	• Known habitat for three Southern Emu-wren (Eyre Peninsula) and three Mallee Whipbird within the entire site. • Known habitat for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird likely to remove entire home range of family groups; • Close to coastal edge so this meaning area is surrounded by suitable habitat for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird potentially reducing ability to maintain connectivity to neighbouring territories; • High quality habitat for State listed terrestrial species Diamond Firetail and Rock Parrot; and. • Based on extensive site surveys and photographs of vegetation within the site, 100% of site considered suitable habitat for listed species.	**3**	**3**	**High**
4	• Known habitat for four Southern Emu-wren (Eyre Peninsula) and no known recordings of the Mallee Whipbird within the entire site. • Known habitat for numerous Southern Emu-wren (Eyre Peninsula) and likely habitat for Mallee Whipbird. • High quality habitat for State listed terrestrial species Rock Parrot. • Based on extensive site surveys and photographs of vegetation within the site, 100%	**3**	**3**	**High**

Site A options	Impact Assessment	Likelihood	Severity	Risk
	of site considered suitable habitat for listed species.			
5	• Known habitat for one Southern Emu-wren (Eyre Peninsula) family groups and no known recordings of the Mallee Whipbird. Likely to impact more than one home range of Southern Emu-wren (Eyre Peninsula) and displace numerous individuals of Mallee Whipbird. • Close to coastal edge so this meaning area is surrounded by suitable habitat for Southern Emu-wren (Eyre Peninsula) and Rock Parrot. • Based on extensive site surveys and photographs of vegetation within the site, 100% of site considered suitable habitat for listed species.	**2**	**3**	**High**

During the targeted avian survey in December 2021, Southern Emu-wren (Eyre Peninsula) were detected at Launch Site Options 2, 3, and 4 (refer to Table 12). No Southern Emu-wren (Eyre Peninsula) were detected at Site Option 5, however previous surveys undertaken in 2020 detected Southern Emu-wren (Eyre Peninsula) in the southern end of this location (see Appendix A for details). Refer to Appendix B for further details of the 2021 targeted survey.

During the targeted avian survey in December 2021, Mallee Whipbird were detected at Launch Site A Options 2 and 3, and not at Launch Site Options 4 and 5 (refer to Table 13). Launch Site Options 4 and 5 have dense and low coastal vegetation that could be considered less suitable (e.g. too low/sparse) for Mallee Whipbird to occupy/utilize frequently. Refer to Appendix B for further details of the 2021 targeted survey.

Option 1 was not surveyed due to cultural heritage constraints identified prior to targeted surveys omitting that site. Site selection was then based largely on presence and extent of preferable habitat both within the site footprint and within existing access road options. Based on the likelihood of presence of avian species and using the severity based on habitat extent and quality, Site Option 2 was identified as being the most suitable option available. This was due to the northern extent of Site Option 2 not having coastal heath as the dominant cover and the non-preferred density and height of *E. diversifolia*. Site Option 2 also has the added benefit of not requiring access through preferred habitats where the existing road travels through an extensive area of preferred habitat for both Commonwealth Threatened avian species through to proposed Site Option 5.

PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 07 FEB 2022

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Coordinate System: GDA 1994 MGA Zone 53

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LEGEND

- Project Area
- Construction Zones
- Pad A Options

Pad A Options Locations

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F15

Map Document: (\\aumel1fp003.au.aecomnet.com\groups\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F12_Site_A_Options.mxd)

6.5 Matters of National Environmental Significance

The EPBC Act is administered by the DAWE and provides a legal framework for the protection and management of nationally and internationally important flora, fauna, ecological communities and heritage places, which are referred to as MNES. Specifically, the EPBC Act protects the following MNES:

- World heritage places;
- National heritage places;
- Wetlands of international importance;
- Listed Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- The Great Barrier Reef Marine Park;
- Nuclear actions; and
- A water resource, in relation to coal seam gas development and large coal mining development.

Based on the information collected during the desktop assessment and field surveys the Project has the potential to result in a significant impact to five Threatened species and one Migratory species listed under the EPBC Act. The sections below detail the assessment of these species against the Significant Impact Guidelines (DEWHA 2013).

6.5.1 Threatened Flora

The West Coast Mintbush listed under the EPBC Act as Vulnerable was considered likely to occur in the Project Area post the desktop assessment and bassline field survey. This assessment was determined by its known range and recent records in the area. During the targeted spring survey the West Coast Mintbush was not recorded nor has this species been recorded in follow up surveys for site location amendments.

West Coast Mintbush is a prostrate shrub <50 cm high. It has red flowers that appear between September and December that are 15-25 mm long (DEWHA 2008).

The West Coast Mintbush is mostly restricted to the western half of Eyre Peninsula where it occurs on limestone outcrops in mallee vegetation, with one outlier population that occurs west of the Peninsula at Coorabie (DEWHA, 2008). There are several known records of this species near the Project Area.

Two vegetation associations represent suitable habitat for this species including:

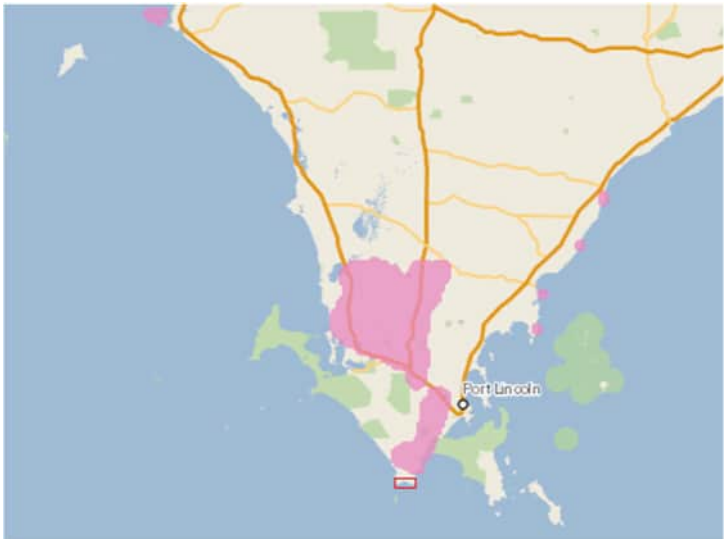
- Vegetation Association 3 Coastal White Mallee (*Eucalyptus diversifolia*) Low Mixed Mallee over sclerophyllous shrubs recorded on stable dunes where grey sandy loams overlay sheet limestone (8.36 ha); and
- Vegetation Association 4 Ridge Fruited Mallee (*Eucalyptus angulosa*) +/- Coastal White Mallee (*Eucalyptus rugosa*) Low Mixed Mallee on calcareous silty loam soils with a surface that formed a thick crust (1.2 ha).

There is limited information available for the West Coast Mintbush in the DEWHA (2008) conservation advice, the DAWE (2020b) publicly available database or NatureMaps. The significance assessment is restricted to available information and the results of the baseline and targeted surveys.

There is no National Recovery Plan for the species. The Project has been assessed against the Significant Impact Guidelines (DEWHA 2013), presented in Table 22.

Table 22 Significant Impact Assessment for the West Coast Mintbush

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will lead to a long-term decrease in the size of an important population of a species.	**Unlikely** No individuals of West Coast Mintbush have been recorded in the Project Area. A review of the extent of occurrence shows that the species occurs north of Whalers Way as shown in the inset below (DAWE 2020b) with the pink polygon representing its current known extent and the red box representing the vicinity of the Project Area. The nearest known record is 13 km northeast of the Project Area along Proper Bay Road near Sleaford Mere (DEW, 2020). It is therefore unlikely that there is an 'important population' within the Project Area. In the absence of known records within the Project Area, it is unlikely that an important population will be cleared.
Possibility the action will reduce the area of occupancy of an important population.	**Unlikely** The Project will result in clearing up to 9.56 ha of potentially suitable West Coast Mintbush habitat within the Project Area. No individuals have been recorded during baseline and targeted surveys, and the species is unlikely to be present. As such, the Project is unlikely to reduce an area of occupancy for this species.
Possibility the action will fragment an existing important population into two or more populations.	**Unlikely** The Project will clear 9.56 ha of potentially suitable habitat. This habitat was observed to extend beyond the Project Area and is considered locally common. The Project Area for the Project will comprise small areas used for the pads and associated infrastructure, and tracks. These are unlikely to be considered large enough to cause any fragmentation in the event that individuals and / or populations are recorded in the vicinity of the Project Area.
Possibility the action will adversely affect habitat critical to the survival of a species.	**Unlikely** West Coast Mintbush is not known to occur within the Project Area, with the nearest record 13 km northeast near Sleaford Mere. However suitable habitat has been mapped for 9.56 ha comprising mallee woodlands on limestone and calcareous soils. Critical habitat is not defined in the DEWHA (2008), and conservation advice to the survival of the species is defined as areas around known occurrences of similar habitat. This is evident on the DAWE (2020b) occurrence map below with pink polygons representing the indicative distribution of the species based on best available knowledge. The red box represents the vicinity of the Project Area.

Significance Criteria	Assessment of Nature and Extent of Impacts
	
Possibility the action will disrupt the breeding cycle of an important population.	**Unlikely**. Important populations are defined as the known records as shown on ALA (2020) and NatureMaps (2020). The nearest population is 13 km from the Project Area and no indirect impacts are anticipated to occur.
Possibility the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely** The Project is 13 km from the nearest known population. This population is not near the access road to Whalers Way. As such, this population will not be directly or indirectly affected by the Project. The Project will result in the removal of up to 9.56 ha of habitat considered suitable for the West Coast Mintbush. This habitat was observed as homogenous at Whalers Way, extending both north, east and west outside the Project Area. The clearing of a portion of this habitat is therefore not considered a significant impact given the extent of habitat available in the local and regional area.
Possibility the action will result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.	**Unlikely** The construction and operation of the Project will be managed in accordance with a CEMP and OEMP which will provide appropriate mitigation measures, measurable targets and contingency actions to prevent the introduction of invasive species in suitable habitat for the West Coast Mintbush.
Possibility the action will introduce a disease that may cause the species to decline.	**Unlikely** The CEMP and OEMP will include appropriate mitigation measures and measurable targets and contingency actions to prevent the introduction of a disease that may cause the species to decline or affect suitable habitat for this species in the surrounding area.
Possibility the action will interfere with the recovery of the species.	**Unlikely**

Significance Criteria	Assessment of Nature and Extent of Impacts
	There is no recovery plan for this species. The main threats to West Coast Mintbush include grazing, lack of recruitment, habitat fragmentation and clearance of habitat resulting from developments and road maintenance (DEWHA 2008). The Project will not exacerbate grazing, lack of recruitment or habitat fragmentation. Clearing of up to 9.56 ha of suitable habitat will occur. No records of the species are within the Project Area, and the habitat is homogenous at Whalers Way and extends beyond the Project Area.

There is 9.56 ha of potentially suitable habitat present with the Project Area for the species. As suitable habitat for this species is homogenous at Whalers Way and extends beyond the Project Area, and that the species was not recorded during baseline surveys or the targeted spring survey has led to the conclusion that the Project is unlikely to have a significant impact on West Coast Mintbush.

6.5.2 Threatened Fauna

The PMST search identified 28 terrestrial fauna likely to occur within the vicinity of the Project. An assessment of likelihood of occurrence was undertaken for these species (Appendix F). Of the 28 Threatened fauna species, two have been recorded within and in close proximity to the Project Area and two are likely to occur:

- Australian Fairy Tern (Vulnerable) – likely to occur;
- Eastern Hooded Plover (Vulnerable) – likely to occur;
- Mallee Whipbird (Vulnerable) – known to occur; and
- Southern Emu-wren (Eyre Peninsula) (Vulnerable) – known to occur.

6.5.2.1 Australian Fairy Tern

There have been two sightings of the Australian Fairy Tern within 5 km of the Project Area, one of which was on Red Banks Beach and was considered to be potentially nesting (DEW 2020). Red Banks Beach is approximately 1.3 km from the Project Area.

The main threats to the Australian Fairy Tern (DAWE 2020c) include:

- Predation by introduced mammals such as the Red Fox, domestic cats, Black Rats (*Rattus rattus*), and native birds such as Silver Gulls (*Larus novaehollandiae*), Pacific Gulls (*Larus pacificus*), Swamp Harrier (*Circus approximans*) and ravens (*Corvus* spp.);
- Disturbance by humans, dogs and vehicles, which can cause the direct destruction of nests or the desertion of nests;
- Increasing salinity in waters adjacent to Australian Fairy Tern colonies, which can lead to a collapse in the numbers of prey fish causing a decline in Australian Fairy Tern numbers;
- Irregular water management, which can result in water levels being too high, flooding nests, or too low allowing predators to walk across to breeding colonies; and
- Weed encroachment, which often leads to nest sites being overgrown by vegetation rendering them unsuitable for breeding.

The Project has been assessed against the Significant Impact Guidelines (DEWHA 2013), presented in Table 23.

Table 23 Significant Impact Assessment of the Australian Fairy Tern

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will lead to a long-term decrease in the size of an important population of a species.	**Unlikely** This species was sighted once near the Project Area in 2004, approximately 1.3 km from the Project Area. NatureMaps (DEW 2020) shows the nearest other location is the southern tip of Liguanea Island. Known records for this species are widely dispersed, however this may be a reflection of survey effort rather than occupancy. There is no breeding habitat within the Project Area. It is possible that the species breeds along the cliffs of Whalers Way, which is 2 km from the Project Area, however direct impacts from clearing of suitable habitat or construction activities are not anticipated to occur in this area. Impacts from noise and lighting may displace individual birds in the area. Noise generated during launch activities have the potential to disturb birds, resulting in the potential loss of bird eggs, and abandonment of nesting, breeding, or feeding areas (FAA 2009) and (SpaceX 2019). These impacts are anticipated to be localised and of short duration therefore should not reduce the area of occupancy for an extended period in the local vicinity. Important populations for this species have not been defined therefore for the purpose of this assessment all breeding locations are considered important populations. This species is highly mobile and has a range that extends around majority of Australia's mainland. It is unlikely that the Project will result in a decrease in size of an important population.
Possibility the action will reduce the area of occupancy of an important population.	**Unlikely** The habitat of the Australian Fairy Tern extends along most of southern Australia's mainland. The Project will not have a direct or indirect impact on breeding or foraging habitat. The clearing of vegetation or indirect impacts associated with noise vibration and lights are unlikely to reduce the area of occupancy significantly.
Possibility the action will fragment an existing important population into two or more populations.	**Unlikely** The Project will not have a direct or indirect impact on breeding or foraging habitat. It is unlikely that the Project will result in fragmentation of an important population.
Possibility the action will adversely affect habitat critical to the survival of a species.	**Unlikely** The baseline survey did not identify habitat that is critical to the survival of this species as defined by DEWPAC (2013). As such, the Project will not adversely affect habitat that is critical to the survival of this species.

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will disrupt the breeding cycle of an important population.	**Unlikely** The species nests on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches (DAWE 2020c). There is no suitable breeding habitat within or in close proximity to the Project Area, as such the Project will not impact on the breeding cycle.
Possibility the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely** The wide-ranging behaviour of this species and availability of extensive habitat in the region means that it is unlikely that the Project will affect habitat to the extent that the species is likely to decline.
Possibility the action will result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.	**Unlikely** Invasive fauna species identified as key threats (Red Fox, domestic cats) harmful to this species are already present in the Project Area and the local region. The Project will not influence the prevalence of invasive species provided active management occurs in keeping with operational phases of the Project. The Project is unlikely to result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.
Possibility the action will introduce a disease that may cause the species to decline.	**Unlikely** There are no known diseases that affect this species defined in relevant information sources (DAWE 2020c; DEWHA 2013). The Project will not lead to the introduction of a disease that will affect the Australian Fairy Tern.
Possibility the action will interfere with the recovery of the species.	**Unlikely** There is no recovery plan for this species however the main threats were considered in this assessment including predation, disturbance of habitat, increasing salinity, irregular water management and weed encroachment. Lacking suitable foraging and breeding habitat in the area, the highest risk posed by the Project is noise impacts from the rocket launches This is not considered a main threat to the species. All indirect impacts including noise, lighting and weeds will be appropriately managed in accordance with a CEMP and OEMP. Given the above, the Project will not impact the recovery of this species in the southern Eyre Peninsula region.

Based on the available information for the Australian Fairy Tern, including its preferred foraging and breeding habitat, and known records, it is unlikely that the Project will have a significant impact on this species.

6.5.2.2 Eastern Hooded Plover

The Eastern Hooded Plover was sighted 20 times in 2004 comprising 50 individuals within the vicinity of the Project Area. There are no records of the species within Redbanks Bay adjoining the Project Area where the beach has lack of refuge sites with boulders present at base of cliff at high tide mark.

Recordings of Eastern Hooded Plover ashore the beach on Fishery Bay, approximately 1.6 km from Range Control Site E, were recorded in December 2021 (Landscape Boards South Australia 2021). Infrastructure Site D is located approximately 4 km from Fishery Bay, Launch Site B is located 4.6 km from Fishery Bay and Launch Site A is located approximately 5 km from Fishery Bay.

The major threats to the Hooded Plover are (National Environmental Science Program Threatened Species Research Hub, 2019):

- Beach use by humans;
- Nest predators including red foxes and other birds i.e Ravens, Silver Gull and Australian Magpie;
- Weed infestations leading to dune geomorphology modification;
- Sea level rise leading to inundation of nests; and
- Urban development.

The potential for the Project to have a significant impact on the Eastern Hooded Plover has been assessed against the Significant Impact Guidelines (DEWHA 2013) and is summarised in Table 24.

Table 24 Significant Impact Assessment of the Eastern Hooded Plover

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will lead to a long-term decrease in the size of an important population of a species.	**Unlikely** The Eastern Hooded Plover was sighted 20 times in 2004 comprising 50 individuals within the vicinity of the Project Area. The species mainly occurs on wide beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. There are no records of the species within Redbanks Bay adjoining the Project Area where the beach has lack of refuge sites with boulders present at base of cliff at high tide mark. The species or suitable habitat for the species has not been recorded within the Project Area during baseline and targeted fauna surveys, therefore no direct impacts to an important population of the specie sis expected. Recordings of Eastern Hooded Plover ashore the beach on Fishery Bay, approximately 1.6 km from Range Control Site E, were recorded in December 2021 (Landscape Boards South Australia 2021). Infrastructure Site D is located approximately 4 km from Fishery bay, Launch Site B is located 4.6 km from Fishery Bay and Launch Site A is located approximately 5 km from Fishery Bay. Based on noise modelling collected during the baseline surveys and from Test Launch 1, indirect impacts to species from noise generated from rocket launches is not going to impact species located greater than 4.5 km from the nearest launch site. It is unlikely that the Project will result in a decrease in size of an important population.

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will reduce the area of occupancy of an important population.	**Unlikely** The habitat of the Eastern Hooded Plover includes wide beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. No such habitat is located within the Project Area. The nearest known population of the species is at Fishery Bay, located approximately 4.6 km from the nearest launch pad. Based on noise modelling collected during the baseline surveys and from Test Launch 1, indirect impacts to species from noise generated from rocket launches is not going to impact species located greater than 4.5 km from the nearest launch site. The Project will not have a direct or indirect impact on breeding or foraging habitat of the species. The Project is unlikely to reduce the area of occupancy of an important population.
Possibility the action will fragment an existing important population into two or more populations.	**Unlikely** The Project will not have a direct or indirect impact on breeding or foraging habitat. It is unlikely that the Project will result in fragmentation of an important population.
Possibility the action will adversely affect habitat critical to the survival of a species.	**Unlikely** The baseline and targeted surveys did not identify habitat that is critical to the survival of this species as defined by DEWPAC (2013) within or adjoining the Project Area. As such, the Project will not adversely affect habitat that is critical to the survival of this species.
Possibility the action will disrupt the breeding cycle of an important population.	**Unlikely** The species nests on wide open beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. There is no suitable breeding habitat within or in close proximity to the Project Area. The nearest known population of the species is at Fishery Bay, located approximately 4.6 km from the nearest launch pad. Based on noise modelling collected during the baseline surveys and from Test Launch 1, indirect impacts to species from noise generated from rocket launches is not going to impact species located greater than 4.5 km from the nearest launch site. As such, the Project is unlikely to disrupt the breeding cycle of an important population.
Possibility the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely** The wide-ranging behaviour of this species and availability of extensive habitat in the region means that it is unlikely that the Project will affect any suitable habitat and thus will not likely lead the species to decline.

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.	**Unlikely** Invasive fauna species identified as key threats (Red Fox, other birds i.e. Ravens, Silver Gull and Australian Magpie) harmful to this species are already present in the Project Area and the local region. The Project will not influence the prevalence of invasive species provided active management occurs in keeping with operational phases of the Project. Furthermore baseline surveys did not identify suitable habitat for the species on the coastline adjoining the Project Area. The Project is unlikely to result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.
Possibility the action will introduce a disease that may cause the species to decline.	**Unlikely** There are no known diseases that affect this species defined in relevant information sources (DAWE 2020c; DEWHA 2013). The Project is unlikely to lead to the introduction of a disease that will affect the Eastern Hooded Plover
Possibility the action will interfere with the recovery of the species.	**Unlikely** The species is covered by the Threatened Species Strategy 2021-20131 (DAWE, 2021). A previous South Australian Recovery Plan was prepared in 2006 (Baker-Gabb and Weston 2006). The Minister approved Conservation Advice (DAWE 2014) included the Eastern subspecies in the vulnerable category listing a number of threats including: • human activities; • crushing and disturbance of eggs by domestic dogs; • entanglements and ingestion of marine debris; • predation by invasive species; • beach wrack harvesting; • invasive coastal weeds; • oil spills; • increasing extreme weather events; • Impacts of seawalls; • future sea level rise; • inappropriate coastal erosion control; and • limits to dune retreat. Lacking suitable foraging and breeding beach habitat in the Project Area and immediate surrounds, the highest risk posed by the Project is noise impacts from the rocket launches. This is not considered a threat to the species given no suitable beach habitat was identified within 4.5 km of the nearest launch pad during baseline and targeted surveys. All indirect impacts including noise, lighting and

Significance Criteria	Assessment of Nature and Extent of Impacts
	weeds will be appropriately managed in accordance with a CEMP and OEMP. Given the above, the Project will not impact the recovery of this species in the southern Eyre Peninsula region.

Based on the available information for the Eastern Hooded Plover, including its preferred foraging and breeding habitat, and known records, it is unlikely that the Project will have a significant impact on this species.

6.5.2.3 Mallee Whipbird

There are three isolated regional populations of the Mallee Whipbird in SA one of which is on the Eyre Peninsula (DAWE 2020d).

The habitat of the Mallee Whipbird was observed as low Mallee, generally *Eucalyptus diversifolia* (Vegetation Association 3) and *Eucalyptus angulosa* low (Vegetation Association 4) Mallee. This habitat is extensive and widespread in the Whalers Way area being the dominant cover for areas interacting with the Project Area particularly within low Mallee vegetation with an average height of 1.5 m and above.

Targeted surveys in 2020 and 2021 observed the Mallee Whipbird regularly by call within and near the Project Area. The Project Area includes 23.4 ha of suitable habitat for this species that will be required to be cleared for the Project.

The major threats to the Mallee Whipbird (DAWE 2020d; DELWP 2016) are:

- Broad-scale clearing of mallee habitats;
- Extensive wildfires which leads to isolation and fragmentation and removal of suitable habitat; and
- Climate change resulting in increased risk of bushfires, heatwaves, floods, and drought which may influence the availability of food resources particularly for populations that are already isolated by broad-scale clearing (DELWP 2016).

The Project has been assessed against the Significant Impact Guidelines (DEWHA 2013), presented in Table 25.

Table 25 Significant Impact Assessment of the Mallee Whipbird

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will lead to a long-term decrease in the size of an important population of a species.	**Potential** The Project will require clearing of 23.4 ha of suitable habitat for this species on the southern Eyre Peninsula which supports the largest sub-population of the Mallee Whipbird (Garnett *et al*. 2011). Targeted surveys observed the Mallee Whipbird regularly by call within and near the Project Area, and the species is likely to utilise the area for foraging and breeding. The Mallee Whipbird has known populations in the nearby Coffin Bay NP and Lincoln NP that will not be affected by the Project. Following clearing for the Project, it is anticipated that the remaining vegetation will be able to support the population that currently resides in the area. The species is sensitive to discrete, unpredictable disturbances such as sudden loud noises that can cause physiological effects, such as stress, avoidance and fright-flight responses, damage to hearing from acoustic over-

Significance Criteria	Assessment of Nature and Extent of Impacts
	exposure, and masking of important bioacoustics and communication signals, such as the ability to hear each other or predators, which may also lead to dynamic behavioural and population effects. Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Mallee Whipbird as a result of a nominal worst case rocket launch. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system. There could be behavioural response but this would likely be limited to the duration of audible noise from launches (i.e. less than a minute) on an occasional basis. Based on the results of the Test Launch 1 the abundances of the Mallee Whipbird post the test launch, the results of playback, and the noise contours modelled against impact criteria for bird species during the launch suggest no immediate short-term impacts from operational noise of rocket launches on the Mallee Whipbird. The behavioural response data of Mallee Whipbird collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer-term behavioural impacts of rocket launches on the avian community and focal species remains unknown. Although there is suitable habitat and known populations in nearby NPs, the clearing of 23.4 ha of suitable habitat for the species and the potential operational indirect behavioural impacts to the species, gives the Project the potential to lead to a long-term decrease in the size of an important population of a species.
Possibility the action will reduce the area of occupancy of an important population.	**Potential** The southern Eyre Peninsula supports the largest known population of Mallee Whipbird in Australia (Higgins & Peter 2002). The Project will result in clearing 23.4 ha of suitable habitat for this species. This will result in direct habitat loss and potentially reduced capacity for the area to support this population. Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket

Significance Criteria	Assessment of Nature and Extent of Impacts
	are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Mallee Whipbird as a result of a nominal worst case rocket launch. Based on the results of the Test Launch 1 the abundances of the Mallee Whipbird post the test launch, the results of playback and the noise contours modelled against impact criteria for bird species during the launch suggest no immediate short-term impacts from operational noise of rocket launches on the Mallee Whipbird. The behavioural response data of Mallee Whipbird collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer-term impacts of rocket launches on the avian community and focal species remains unknown. The clearance of vegetation and operational noise impacts has the potential to reduce the area of occupancy of an important population.
Possibility the action will fragment an existing important population into two or more populations.	**Unlikely** As a sedentary bird that is only able to fly short distances, fragmentation is a key threat for this species. This is particularly relevant for clearing of wide corridors, large scale clearing, or removing small patches of habitat that resemble steppingstones in areas that are largely cleared. Clearing for the Project includes the clearance of two launch pads and some access tracks totalling 23.4 ha. These blocks occur within homogenous native vegetation that extends beyond the cleared areas in all directions. Given the above, the Project is unlikely to fragment an existing important population into two or more populations.
Possibility the action will adversely affect habitat critical to the survival of a species.	**Potential** The Project is located within the area known to support the largest sub-population of the Mallee Whipbird (Garnett *et al*. 2011). All suitable habitat in the region is considered critical habitat, however this habitat is homogenous and considered locally common at Whalers Way and the surrounding Coffin Bay NP and Lincoln NP. Targeted surveys observed the Mallee Whipbird regularly by call within and near the Project Area, and the species is likely to utilise the area for foraging and breeding. No nesting was observed during targeted surveys. Based on results of the Test Launch 1 the abundances of the Mallee Whipbird post the test launch, the results of playback and the noise contours modelled against impact criteria for bird species during the launch suggest no immediate short-term impacts from operational noise of rocket launches on the Mallee Whipbird.

Significance Criteria	Assessment of Nature and Extent of Impacts
	The behavioural response data of Mallee Whipbird collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer-term impacts of rockets launches on the avian community and focal species remains unknown. The Project is likely to affect critical habitat for this species through the direct clearing of approximately 23.4 ha of critical habitat. Although there are known populations and habitat for the species in the greater Whalers Way area and nearby NPs, the removal of 23.4 ha of critical habitat has the potential to adversely affect habitat critical to the survival of a species.
Possibility the action will disrupt the breeding cycle of an important population.	**Potential** The Project is located within the area known to support the largest sub-population of the Mallee Whipbird (Garnett *et al*. 2011). Targeted surveys observed the Mallee Whipbird regularly by call within and near the Project Area, and the species is likely to utilise the area for foraging and breeding. No breeding was observed during the targeted survey. It should be noted that the survey was undertaken outside the known breeding period, therefore breeding may occur within or in close proximity to the Project. Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Mallee Whipbird as a result of a nominal worst case rocket launch. Based on the results of the Test Launch 1 the abundances of the Mallee Whipbird post the test launch, the results of playback and the noise contours modelled against impact criteria for bird species during the launch suggest no immediate short-term impacts from operational noise of rocket launches on the Mallee Whipbird. The behavioural response data of Mallee Whipbird collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer-term impacts of rocket launches on the avian community and focal species remains unknown. Any activity that disrupts the breeding of the largest sub-population of this species is likely to be significant. Therefore, the Project has the potential to have a significant impact on the breeding cycle of an important population.

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely** The Project will clear 23.4 ha of suitable habitat in an area where this species is known to occur. As detailed above, there is known habitat and records of the species in the greater Whalers Way area and nearby NPs. It is unlikely that the clearance of vegetation is likely to be of an extent that would cause the decline of the species due to the small area of proposed footprint in comparison to remaining vegetation. There is a large extent of suitable habitat within and surrounding the Project Area.
Possibility the action will result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.	**Unlikely** Invasive fauna species identified as key threats (Red Fox, domestic cats) to the Mallee Whipbird are already present in the Project Area. The Project will not influence the prevalence of invasive species provided active management occurs in keeping with operational phases of the Project. The Project is unlikely to result in invasive species that are harmful to a critically endangered, endangered or vulnerable species' becoming established in the critically endangered, endangered or vulnerable species' habitat.
Possibility the action will introduce a disease that may cause the species to decline.	**Unlikely** Disease is not listed as one of the key threats for this species. A decline of vegetation condition through secondary impacts associated with pathogens such as *Phytophthora cinnamomi*, a water borne mould, has the potential to reduce the habitat quality. The habitat within the Project Area does not include flora species that are susceptible to this pathogen (i.e. Proteaceae). The Project is unlikely to introduce a disease that may cause the species to decline.
Possibility the action will interfere with the recovery of the species.	**Unlikely** The recovery objectives for this species (DELWP, 2016) includes: • Retention of all existing subpopulations; • Reduce rate of decline; • Expand core populations; and • Initiate longer-term measures to ensure their persistence in south-eastern Australia. The population on the southern Eyre Peninsula will continue to occur in the region. The Project will implement measures that are likely to reduce the potential for wild bush fires in the local area. The expansion of core populations and longer-term measures to ensure persistence is beyond the scope of the Project. Given the above, the Project is unlikely to impact on the recovery of this species in the southern Eyre Peninsula region.

The Project includes clearing 23.4 ha of Mallee Whipbird habitat, with potential ongoing impacts from noise and lighting during operation. In consideration of the criteria, the Project has the potential to have a significant impact to the Mallee Whipbird.

6.5.2.4 Southern Emu-wren (Eyre Peninsula)

The Southern Emu-wren (Eyre Peninsula) is endemic to the southern tip of the Eyre Peninsula in SA. The Project includes clearing of 23.4 ha of suitable habitat for this species. Targeted surveys in 2020 identified 18 individual birds, consisting of four pairs, one group of three and the seven singles. A further targeted survey in 2021 identified three individual birds at newly proposed Launch Site A.

The main identified threats to the Southern Emu-wren (Eyre Peninsula) (DotE 2013a) are:

- Bushfire causing widespread habitat loss;
- Land clearance/fragmentation due to poor dispersal ability;
- Predation by European Red Foxes (*Vulpes vulpes*) and likely also feral cats (*Stipiturus malachurus parimeda*);
- Climate change due to exposure to increase in frequency and intensity of fires;
- Grazing by kangaroos (*Macropus* spp.) and emus (*Dromaius novaehollandiae*); and
- Land development.

The potential for the Project to have a significant impact on the Southern Emu-wren (Eyre Peninsula) was assessed against the Significant Impact Guidelines (DEWHA 2013) and is summarised in Table 26.

Table 26 Significant Impact Assessment for the Southern Emu-wren

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will lead to a long-term decrease in the size of an important population of a species.	**Likely** The Project will result in clearing 23.4 ha of Southern Emu-wren (Eyre Peninsula) habitat within an area known to be populated by this species. The targeted surveys confirmed the presence of this species. This species is likely to utilise the area for foraging and breeding. The sub-population of Southern Emu-wren (Eyre Peninsula) at Whalers Way is considered one of five important populations to ensure the long-term survival of the species (DAWE 2020e). Targeted surveys in 2020 identified 18 individual birds, consisting of four pairs, one group of three and the seven singles. A further targeted survey in 2021 identified 3 birds at two locations (a pair and single bird) within the newly proposed Launch Site A (Option 2). The species is sensitive to discrete, unpredictable disturbances such as sudden loud noises that can cause physiological effects, such as stress, avoidance and fright-flight responses, damage to hearing from acoustic over-exposure, and masking of important bioacoustics and communication signals, such as the ability to hear each other or predators, which may also lead to dynamic behavioural and population effects. Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise

Significance Criteria	Assessment of Nature and Extent of Impacts
	at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Southern Emu-wren (Eyre Peninsula) as a result of a nominal worst case rocket launch. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system. There could be behavioural response but this would likely be limited to the duration of audible noise from launches (i.e. less than a minute) on an occasional basis.. Based on the results of the Test Launch 1 the abundances of the Southern Emu-wren (Eyre Peninsula) post the test launch, the results of playback and the noise contours modelled against impact criteria for bird species during the launch suggest no immediate short-term impacts from operational noise of rocket launches on the Southern Emu-wren (Eyre Peninsula). The behavioural response data of Southern Emu-wren (Eyre Peninsula) collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer-term behavioural impacts of rockets launches on the avian community and focal species remains unknown. Any mortality or reduction in available habitat through vegetation clearance or construction activities may lead to a long-term decrease in the size of an important population. The Project is likely to lead to a long-term decrease in the size of an important population of the Southern Emu-wren (Eyre Peninsula).
Possibility the action will reduce the area of occupancy of an important population.	**Likely** The Project will result in clearing 23.4 ha of critical habitat known to support foraging and likely breeding habitat for the Southern Emu-wren (Eyre Peninsula). It is uncertain what impacts the noise and lights would have on the ongoing occupancy of this species at Whalers Way. Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Southern Emu-wren (Eyre Peninsula) as a result of a nominal worst case rocket launch.

Significance Criteria	Assessment of Nature and Extent of Impacts
	Based on the results of the Test Launch 1 the abundances of the Southern Emu-wren (Eyre Peninsula) post the test launch, the results of playback and the noise contours modelled against impact criteria for bird species during the launch show no immediate short-term impacts from operational noise of rocket launches on the Southern Emu-wren (Eyre Peninsula). The behavioural response data of Southern Emu-wren (Eyre Peninsula) collected thus far is considered to be short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer term impacts of rocket launches on the avian community and focal species remains unknown. The Project is therefore likely to reduce the area of occupancy of this species.
Possibility the action will fragment an existing important population into two or more populations.	**Unlikely** One of the key threats to Southern Emu-wren (Eyre Peninsula) is fragmentation (Pickett 2002; DotE 2013a). Habitat fragmentation as a result of vegetation clearing for the Project is considered localised. The habitat in the local area is contiguous and provides ample connectivity across Whalers Way. The widening of tracks and the construction of the launch pads may lead to local fragmentation for the species, however the species is relatively mobile and is able to traverse the distance a track represents. Given the above, the clearing of 23.4 ha of habitat for the Project is unlikely to fragment an existing important population into two or more populations.
Possibility the action will adversely affect habitat critical to the survival of a species.	**Likely** The Project Area has been mapped as suitable habitat for the Southern Emu-wren (Eyre Peninsula). The Whalers Way population is considered to be one of the five populations that is considered to be important for the long-term survival and recovery of the Southern Emu-wren (Eyre Peninsula). Habitat critical to the survival of the Southern Emu-wren (Eyre Peninsula) includes all suitable habitat where there are known records, including the 23.4 ha that will be cleared for the Project. The Project is likely to adversely affect habitat critical to the survival of a species.
Possibility the action will disrupt the breeding cycle of an important population.	**Potential** The species is widespread within the Lincoln and Coffin Bay NPs as well as other privately held reserves however many of these are likely to be separate breeding populations. Targeted surveys in 2020 identified 18 individual birds, consisting of four pairs, one group of three, and the seven singles. A further targeted survey in 2021 identified 3 individual birds at newly proposed Launch Site A and it is

Significance Criteria	Assessment of Nature and Extent of Impacts
	estimated the overall population is under 100 individuals in the Whalers Way area from Cape Wiles to Cape Carnot making the Whalers way Peninsula population tenuous to the impacts detailed above. Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Southern Emu-wren (Eyre Peninsula) as a result of a nominal worst case rocket launch. Based on the results of the Test Launch 1 the abundances of the Southern Emu-wren (Eyre Peninsula) post the test launch, the results of playback and the noise contours modelled against impact criteria for bird species during the launch suggest no immediate short-term impacts from operational noise of rocket launches on the Southern Emu-wren (Eyre Peninsula). The behavioural response data of Southern Emu-wren (Eyre Peninsula) collected thus far is considered to be a short-term behavioural response data. While no immediate impacts on avifauna as a result of the Test Launch 1 attempt was detected, the longer term impacts of rocket launches on the avian community and focal species remains unknown. The Project has the potential to have a significant impact on the breeding cycle of an important population of this species.
Possibility the action will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Potential** The sub-population of Southern Emu-wren (Eyre Peninsula) at Whalers Way is considered one of five important populations to ensure the long-term survival of the species (DAWE 2020e). Targeted surveys in 2020 identified 18 individual birds, consisting of four pairs, one group of three, and the seven singles. A further targeted survey in 2021 identified three individual birds at newly proposed Launch Site A. It is estimated the overall population is under 100 individuals in the Whalers Way area from Cape Wiles to Cape Carnot making the Whalers Way Peninsula population tenuous to the impacts detailed above. Any mortality or reduction in critical habitat through vegetation clearance or construction activities has the potential to be of an extent that would cause the decline of the species.
Possibility the action will result in invasive species that are harmful to a critically endangered, endangered, or	**Unlikely**

Significance Criteria	Assessment of Nature and Extent of Impacts
vulnerable species' becoming established in the critically endangered, endangered, or vulnerable species' habitat.	The Project will not influence the prevalence of invasive species provided active management occurs in keeping with operational phases of the Project. The proponent will consider removal of feral species in the local area as part of an offsets package which may reduce the impact of invasive species at Whalers Way.
Possibility the action will introduce a disease that may cause the species to decline.	**Unlikely** Disease is not listed as one of the key threats for this species. The Project is not considered likely to act as a vector for any diseases or pathogens. The Project is unlikely to introduce a disease that may cause the species to decline.
Possibility the action will interfere with the recovery of the species.	**Unlikely** There is no National Recovery Plan for this species. The Project is unlikely to impact on the recovery of this species.

The Project is located at Whalers Way which supports a large population of the Southern Emu-wren (Eyre Peninsula), recognised for its size and importance (DAWE 2020e; Pickett 2016). Any clearing of vegetation or risk of increased mortality is likely to be considered a significant impact. There is potential for indirect impacts from construction and operational activities may lead to behavioural changes which may disrupt the breeding cycle or cause further reduction in habitat availability.

In consideration of the criteria, the Project is likely to have a significant impact to the Southern Emu-wren (Eyre Peninsula).

6.5.3 Migratory Species

One Eastern Osprey was recorded near Cape Carnot during the baseline field survey and follow up surveys onsite have recorded numerous observations. One nest was recorded on a cliffs edge approximately 2000 m from Launch Site B and 2975 m from Launch Site A. Further assessment in the Jacobs (2020) report indicates there is a second nest located near Cape Wiles approximately 4070 m from Launch Site B and 4990 m from Launch Site A (Jacobs 2020).

The nests are not currently active and have anecdotally not been active for the past five years, however this species is known to return to return to inactive nests.

The current main threat to the Eastern Osprey in Australia is loss, degradation, or alteration of habitat for urban or tourism development (DAWE 2020f).

The Project has been assessed against the Significant Impact Guidelines (DEWHA, 2013), presented in Table 27.

Table 27 Significant Impact Assessment of the Eastern Osprey

Significance Criteria	Assessment of Nature and Extent of Impacts
Possibility the action will lead to substantial modification (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy, or isolate an area of important habitat for a Migratory species.	**Unlikely** No nesting pair is currently known from the Project Area; two inactive nests that are > 2km from the Project Area are near the site. There are no recent records (BDBSA or Birdlife data) for these nest locations, nor are they mentioned /shown in Detmar and Dennis (2018). In addition, recent surveys November and December 2020 (Larry Bebbington) did not observe recent

Significance Criteria	Assessment of Nature and Extent of Impacts
	activity at the nesting sites. Bebbington L. during 2020 surveys observed no recent (past 3+ years) nest building activities or fresh chalk at the abandoned Osprey nest sites and concluded that following attempts to rebuild in 2017, the nests have been abandoned due to human disturbance (Jacobs 2020). Whilst it is acknowledged that coastline habitat is important for the species, there are vast areas of coastline habitat available. The current coastline habitat (2km from the Project site) provides sub optimal habitat for potential Eastern Osprey given the cliff top tracks and viewing platform that are frequently used by the public at the unmanaged Heritage site. There will be no direct disturbance through vegetation clearance or construction activities to breeding or foraging habitat for the Eastern Osprey. The Project aims to reduce public access, particularly to the clifftop tracks and Eastern Osprey viewing area (above an abandoned nest site). The Project has the potential to benefit the local population by reducing the current level of human disturbance, and it is anticipated that Osprey may return to the coastline. Based on this it is considered the Project is unlikely to substantially modify, destroy, or isolate an area of important habitat.
Possibility the action will result in an invasive species that is harmful to the Migratory species becoming established in an area of important habitat for the Migratory species.	**Unlikely** There are no invasive species known to be harmful to the Eastern Osprey. As a big predatory bird that nests in trees or cliffs, predation by foxes and cats are unlikely. No additional invasive species harmful to this species will be introduced as a result of this Project.
Possibility the action will seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a Migratory species.	**Unlikely** The fragmentation of current breeding pairs along the Great Australian Bight suggests that disturbance to a nest may reduce their area of occupancy in SA which has already suffered sizeable contraction in range and size during the 20th century (DAWE 2020f). In Australia the species occurs in coastal and estuarine northern temperate and subtropical regions, with the isolated SA population considered to be on the extreme southern edge of the species preferred bioclimatic range (Dennis and Clancy 2014). The current SA population is considered to be unstable with a number of nest relocations and 'refugee' pairs relocating to start new territories. Multiple contributing factors are likely to be influencing the instability in the current distribution, including human disturbance (Detmar and Dennis 2018). It is acknowledged that there is potential for at least one Osprey territory to overlap the Project Area, however given the lack of known active nests it is unlikely a core nest territory occurs within 2 km of the Project Area. The Project is not considered to directly impact the habitat of local individuals of the species

Significance Criteria	Assessment of Nature and Extent of Impacts
	through vegetation clearance, but noise impacts are expected as detailed in Section 6.1.9. Construction noise and operations noise (non-launch) are not expected to have an impact on the Eastern Osprey (Section 6.1.9). Operational noise through the launching of rockets at a frequency of once every three weeks for a duration of 1 minute and 15 seconds has the potential to generate noise at a level that may impact behavioural changes to the species. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to the Eastern Osprey as a result of a nominal worst case rocket launch. Noise levels from Launch Site A would dissipate to 100 dB dB LA_{max} (nest site 2), 95 dB dB LA_{max} (nest site 1 and northern end of Liguanea Island); noise levels from Launch Site B would dissipate to 105 dB dB LA_{max} (nest site 2) and 98 db dB LA_{max} (nest site 1), < 95 dB (Liguanea Island). Potential impacts up to 5 km may cause brief behavioural response to Eastern Osprey. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system. There could be behavioural response but this would likely be limited to the duration of audible noise from launches (i.e. less than a minute) on an occasional basis. In summary, whilst there is potential for at least one pair to utilise the habitat near the site, the SA population is already in decline, the Project location does not have a known nesting pair and the specific location is not key to the whole SA population. Potential impacts are related to noise disturbance, noting that an active nest persist at the nearby busy Port Lincoln Marina (27 km away) and that the noise impacts that may occur for the Southern Launch operations would occur at infrequent and irregular intervals at the project site. Noise impacts would be most significant to an individual nesting pair (if located within 2 km of the launch pads) during the critical breeding period. In addition, the launch pad and other infrastructure location are not within the line of site of a known nesting pair. Based on this it is considered that the Project is unlikely to seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a Migratory species, in this case Eastern Osprey.

Based on the available information for the Eastern Osprey, including its preferred foraging and breeding habitat, and known records, it is unlikely that the Project will have a significant impact on this species. Potential indirect impacts to the Osprey are still uncertain and specific mitigation measures for this species is scoped and refined in the EBS Ecology (2022) Whaler's Way Coastal Raptor Review. Refer to Section 7.2 for further details.

6.6 State Matters

This section provides an impact assessment on terrestrial biodiversity values, and address these in context of SPC's formal development assessment guidelines for the Project. The impact assessment is detailed in Table 28 and includes cross-references to sections in the report where these have already been addressed to avoid duplication.

Table 28 DIT Assessment Guidelines Compliance

Terrestrial Biodiversity		Justification
A Fauna and Flora Assessment and Management Plan, (including a Native Vegetation Clearance Data Report) prepared by an Accredited Consultant approved by the Native Vegetation Council. The assessment should undertake a survey of the vegetation and fauna (including EPBC Act Listed Threatened species and communities), detail compliance with the mitigation hierarchy, and describe the means by which the significant environmental benefit would be achieved. The Report should identify any changes required to the Native Vegetation Heritage Agreement currently in place for the site.		This technical report is a Flora and Fauna Assessment and does not include a Management Plan. Mitigation measures to be considered in a flora and fauna management plan are detailed in Section 7.0. The Native Vegetation Clearance Data Report (Ecosphere 2020) is provided in a separate deliverable to this technical report, that details compliance with the mitigation hierarchy and describes the means by which the significant environmental benefit would be achieved.
Assessment Requirement 2: The proposed development is located on land which currently holds significant stands of native vegetation within the Coastal Conservation zone.		
2.1	Describe the location, condition, and significance of native vegetation on the subject site, including individual species and communities. Include reference to areas that have Heritage Agreements under the NV Act and any proposed alterations to or implications for the Heritage Agreement.	The location, condition, and significance of native vegetation located within the Project Area has been detailed in Section 5.2 and Section 5.3.
2.2	Describe the location, condition, and significance of native vegetation species and communities that may need to be cleared or disturbed during both the construction and maintenance phases. This should include clearing for all buildings, structures, hazardous zones and access arrangements.	The location, condition, and significance of native vegetation required to be cleared within the Project Area has been detailed in Section 5.2 and the potential impacts discussed in Section 6.1. The Project will require clearing 23.4 ha of native vegetation for construction including launch pads, access tracks, and associated laydown areas. The Project Area has been refined during the design phase to reduce the amount of native vegetation to be cleared in areas of lower condition rating as far as practicable. During development and construction further effort will be made to reduce clearing footprint wherever possible The clearance of 23.4 ha will be offset through a biodiversity offset program developed in accordance with NVC outlined in Table 30 and Section 7.2. Construction and operation of the Project will be managed in accordance with a CEMP and OEMP to ensure that all impacts are reduced as far as practicable utilising management measures outlined in Table 30.

Terrestrial Biodiversity		Justification
2.3	Describe the potential impacts on native vegetation fragmentation and the ability of communities or individual species to recover, regenerate, or be rehabilitated during all phases of development.	Section 6.1 details the potential impacts on native vegetation fragmentation. Once native vegetation is cleared, there is minimal opportunity for individual species and communities to naturally regenerate and recover. The clearance of native vegetation will require an offset through a biodiversity offset program developed in accordance with NVC outlined in Table 30 and Section 7.2.
2.4	Identify the habitat value of native vegetation and the potential for habitat fragmentation during both construction and maintenance (and decommissioning). Include a description of the effects of any fragmentation that may occur over the life of the project.	Section 5.4.1 details the fauna habitats present with the Project Area. Section 6.1.6 details the potential impacts on habitat fragmentation during both construction and operation phases of the Project.
2.5	Detail any likely changes in remaining vegetation surrounding the launch pads which may be impacted by the proposed operations. Mitigation measures should be documented to minimise the impact on remaining species and communities in the immediate vicinity of the launch pads.	Section 6.1.5 and Section 6.1.7 detail the potential impacts the Project will have on edge effects and barrier effects. Native vegetation not to be cleared for the Project will be protected and managed in a CEMP and OEMP that will include management measures proposed in Table 30.
2.6	Outline any compensatory activities proposed, making reference to guidelines produced by the Native Vegetation Council.	The clearance of native vegetation will require an offset through a biodiversity offset program developed in accordance with NVC outlined in Table 30 and Section 7.2.
2.7	Identify the potential impact of fire on native vegetation, and the effects of fire risk management processes during both construction and operation.	Section 6.1.10 details the potential impact of fire on native vegetation. Fire risk management processes are to be incorporated into a CEMP and OEMP with mitigation measures proposed in Table 30.
2.8	Describe the location, extent, condition, and significant of native vegetation species and communities in the marine environment within the impact area of spent (discarded) launch vehicles.	This is discussed in the Marine Biodiversity Technical Report.
Assessment Requirement 3: The proposed development will be constructed on land but will also operate in the airspace and over adjoining waters with potential impacts on terrestrial and marine habitats which support significant populations of native fauna.		
3.1	Describe the location, extent, condition, and significance of native terrestrial and marine fauna populations, including individual species	The location, extent, condition, and significance of native terrestrial fauna populations is detailed in Section 5.4 and Section 6.5.

Terrestrial Biodiversity		Justification
	and communities in the surrounding area, including on land, cliffs, and in adjoining waters, including Liguanea Island.	Marine fauna is discussed in Marine Biodiversity Technical Report.
3.2	Describe the nature and extent of the impacts likely to affect native terrestrial and marine fauna species and populations during both construction and operation. Describe the ability of communities and individual species to recover, especially Threatened or significant species (including those listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and *National Parks* and *Wildlife Act 1972*). Specifically consider the impact of marine debris.	The nature and extent of the impacts likely to affect native terrestrial fauna species and populations during both construction and operation is detailed in Section 6.0 It is expected there will be direct impacts to State listed fauna species through the clearance of 23.4 ha suitable habitat and indirect impacts from noise during operations of rocket launches. Direct impacts to State listed species are to be offset through a biodiversity offset program developed in accordance with NVC outlined in Table 30 and Section 7.2. Indirect impacts detailed in Section 6.0, will be managed through the implementation of a CEMP and OEMP to ensure that all impacts are reduced as far as practicable utilising management measures outlined in Table 30. The ability of communities and individual species to recover, especially Threatened species listed under the EPBC Act and NPW Act, is discussed in Section 6.0 and Section 6.5 more specifically for EPBC Act listed species. Marine fauna is discussed in Marine Biodiversity Technical Report.
3.3	Identify the effect of the proposal on terrestrial habitat fragmentation including the ability of populations or individuals to recover during both construction and operation.	This is detailed in Section 6.1.6 and Section 6.5.
3.4	Identify the potential impact of fire and explosion on native fauna, and the effects of fire risk management processes during both construction, operation, and maintenance.	This is detailed in Section 6.1.10 and Section 7.0.
3.5	Identify the potential impact of noise and vibrations on terrestrial, coastal, and marine native fauna, and the mitigation and monitoring strategies during both construction and maintenance.	This is detailed in Section 6.1.9 and Section 7.0 Marine fauna is discussed in Marine Biodiversity Technical Report.
3.6	Detail appropriate buffer distances that would be required between proposed development (including coastal access points) and Threatened terrestrial and marine species, including feeding areas, nesting sites, and roosting sites.	This is detailed in Section 7.0. Marine fauna is discussed in Marine Biodiversity Technical Report.

Terrestrial Biodiversity		Justification
3.7	Outline measures to avoid, minimise, mitigate, and monitor the effects on native fauna, including any compensatory activities.	This is detailed in Section 7.0.
Assessment Requirement 10: The proposed development has the potential for the spread of introduced or nuisance plants and animals and soil pathogens such as Phytophthora.		
10.1	Identify the potential for the introduction or dispersal of new pest or nuisance plant and animal species, and soil pathogens and the associated implications for native species and habitat.	Section 6.1.4 details the potential for the introduction or dispersal of new pest or invasive plant and animal species, and soil pathogens and the associated implications for native species and habitat.
10.2	Identify the potential for increased distribution and abundance of existing pest or nuisance plants, and soil pathogens and the associated implications for terrestrial and coastal environments.	Section 6.1.4 details the potential for increased distribution and abundance of existing pest or nuisance plants, and soil pathogens and the associated implications for terrestrial and coastal environments.
10.3	Outline the mitigation measures and their effectiveness in reducing or avoiding the introduction or spread of pest or nuisance plant and animal species.	Weeds and pests will be managed through the implementation of a CEMP and OEMP that details mitigation measures proposed in Table 30.

7.0 Management and Mitigation

7.1 Mitigation Measures

The mitigation hierarchy as devised by the NVC (NVC 2017) has been applied during the design of the Project. This included reducing the footprint as far as practicable to avoid clearing native vegetation and implementing a CEMP and OEMP to manage direct and indirect impacts. Refer to Table 29 for a summary of the mitigation hierarchy applied for the Project.

Table 29 Mitigation Hierarchy Application for the Project

Criteria	Assessment
a) Avoidance – outline measures taken to avoid clearance of native vegetation such as making adjustments to the location, design, size, or scale of the activity in order to reduce the impact.	The Whalers Way area provides a number of benefits to operating an orbital launch complex at this location. The availability of suitable sites is extremely constrained: • Southern Launch undertook an extensive site selection process; • The process was underpinned by a weighted multi-criteria analysis; and • The process ultimately led to the selection of Whalers Way. Critical criteria included: • Latitude – between -30 and -40 degrees; • Launch Trajectories – support launches from 60 to 180-degree with respect to the equator; • Coastal Access – site to be on the coast with open ocean due south; • Weather – support year-round launches with no temperature extremes; • Land Size – min 500 Ha to support 2 launch pads and buffer zones; • Critical National Infrastructure – no critical national infrastructure in buffer zones or on trajectory; • Population – Need to be capable of exclusion from buffer zones; and • Environment – Impact on environmental values. The existing cleared land is located several kms to the north of Whalers Way and is not suitable for the proposal due to the constraints on achieving exclusion zones under national legislative requirements. Internal site selection within Whalers Way was based on criteria including: • Existing degraded areas; • Existing cleared areas; • Topography; • Blast radius; • Existing road access; • Proximity to coast; • Proximity to residential dwelling; and • Security requirements. Refer to the Site Selection Chapter of the EIS for further details. Avoidance of vegetation wherever possible has occurred within the engineering constraints of a highly technical Project. Reduction of the footprint as far as practicable to avoid clearing native vegetation with the size of the Project Area reduced in size from 70.58 ha to 23.4 ha from concept design.

Criteria	Assessment
	As a result of the comments received from the SA Government, public submissions provided, and further analysis undertaken by Southern Launch's ecology and cultural heritage advisors, an alteration to proposed Launch Site A has been made. This launch site will be moved 700 m to the north-east to Site Option 2 as detailed in Section 6.3 and illustrated in Figure 15. Launch Site A was originally closer to the coast. Assessment of the original site suggested the disturbance to this vegetation would negatively impact upon listed species such as the Mallee Whipbird and Southern Emu-wren (Eyre Peninsula) found in the Whalers Way Area. Further analysis was therefore undertaken to identify a more suitable location from an ecology point of view and from a cultural heritage point of view. Further targeted surveys were undertaken in December 2021 to assess the options for the presence of Mallee Whipbird and Southern Emu-wren (Eyre Peninsula). Refer to Appendix B, Section 5.4.2 and Section 6.3 for further details. Several launch option sites were identified and subsequently ruled out based on ecological constraints. The selected preferred option is more suitable from an ecological and cultural heritage standpoint. Physical limitations associated to launch trajectories exist around the placement of sites further to the north within the Project Area, in areas of slightly poorer vegetation. Refer to the EIS for full details. The majority of the existing access track, commonly known as Whalers Way Drive, will be retained in its current condition. Localised grading and re-sheeting will not affect the existing road alignment, and will not require an expansion of the existing footprint, as required to maintain all weather access.
b) Minimization – if clearance cannot be avoided, outline measures taken to minimize the extent, duration, and intensity of impacts of the clearance on biodiversity to the fullest possible extent.	The clearance footprints have been minimized to the minimum area possible and located adjacent to existing roads where possible. Existing access roads are being utilised to ensure minimum disturbance and implementing a CEMP and OEMP to manage direct and indirect impacts during construction and operation of the Project. Each launch site will have a clearance footprint which is larger than the site to accommodate batter slopes and enable suitable external access to the fencing and a nominal 10 m width buffer beyond this for fire protection. It is on this basis that the clearance envelopes for the site have been calculated. Notwithstanding the calculated clearance envelopes, these are conservative figures as the clearance required for each site will be minimised through the design and construction process, and it is likely that the final clearance envelopes can be reduced further from those indicated on the proposal plans in the Response Document and the supporting technical reporting. Refer to Table 30 for further details of clearance minimisation through the design phase and construction phase.
c) Rehabilitation or restoration – outline measures taken to rehabilitate ecosystems that have been degraded, and to	Southern Launch are enthusiastic about incorporating the restoration and conservation of the Whalers Way area as a critical part of the Project lifecycle. Avoiding and mitigating impacts is at the forefront of the company ethos. Some measures that are in planning phases include: • Predator Proof fencing and eradication of predators including cats and foxes from the Whalers Way HA;

Criteria	Assessment
restore ecosystems that have been degraded or destroyed by the impact of clearance that cannot be avoided or further minimized, such as allowing for the re-establishment of the vegetation.	• Firebreaks incorporated along fences to protect and mitigate one of the primary threats to EPBC listed species present; • Weed and Pest control; and • Ongoing studies into risks associated with the project which have no precedent such as funding PhD studies in association with state universities. Rehabilitation of tracks that are remnants of previously visited but closed areas or unnecessary are proposed to be rehabilitated as a stage approach utilising clearance material from clearance areas. The tracks proposed are shown below in Figure 16, and include (east to west); the closed track to the southern tip of Whalers Way; a former track aligned south of the existing main track which has partially self-regenerated; the old track alignment previously used prior to formation of the sinkhole; and the small loop track to Blue Whale Bay which is significantly degraded due to wind erosion and ongoing off road vehicle damage. Rehabilitation will consist of ripping of the existing base material where present, spreading of topsoil from other clearance areas which will provide the seedbank, and placement of organic material on top to stabilise and prevent erosion until natural regeneration occurs. These rehabilitation areas will act in reducing fragmentation of vegetation within the primary Southern Emu-wren (Eyre Peninsula) habitat.
d) Offset – any adverse impact on native vegetation that cannot be avoided or further minimized should be offset by the achievement of a significant environmental benefit that outweighs that impact.	Southern Launch will provide a SEB in the form of an inground offset provided by SEB credit providers within the region. This is currently subject to ongoing negotiations and pending final footprints and offsetting requirements. SEB offsets will be like-for-like with habitat cleared.

PROJECT ID	60627263
CREATED BY	brierej
LAST MODIFIED	brierej 01 FEB 2022

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Coordinate System: GDA 1994 MGA Zone 53

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LEGEND

- Project Area
- Construction Zones
- Tracks to Maintained Rehabilitated

Proposed rehabilitation sites associated with existing tracks

Southern Launch Whalers Way

Flora and Fauna Assessment

Whalers Way, SA

Figure

F16

Map Document: (G:\WTR\SpatialSys\Projects\2022\Whalers_Way\02_Maps\F13_Rehabilittion_Sites.mxd)

In order to avoid (where possible), manage and mitigate project risks and potential impacts during all phases of the Project mitigation measures have been proposed in Table 30. These proposed mitigation measures respond to Project specific issues and opportunities, address legislative requirements, and incorporate industry standard best practice. The measures have been presented separately for each phase of the Project.

These proposed mitigation measures have been segregated by implementation phase:

- Detailed design;
- Pre-construction;
- Construction;
- Post Construction rehabilitation of disturbed areas from construction activities where not required for ongoing operations such as temporary laydown areas and hardstands. Land will be returned to a pre-disturbance condition that is safe, stable, non-polluting and able to sustain the proposed land use with only minor maintenance required into perpetuity; and
- Operation.

Table 30 Proposed Mitigation Measures

Delivery Phase	Aspect	Proposed Mitigation Measures
Detailed design	Minimisation of impacts to biodiversity - flora and fauna values	• Portions of the Project are located within existing access tracks and wherever possible, have been aligned to be co-located with existing access tracks to limit the amount of native vegetation and fauna habitat to be cleared. Tracks will be formalised initially into gravel roads and upgraded to asphalt in the future, which will minimise the generation of dust and potential impacts to surrounding vegetation and fauna habitat.
		• Disturbance footprints will be limited to those areas required to construct and operate the works, as practical for safety, especially in regard to the clearing of native vegetation.
		• As Detailed Design progresses it will define temporary and permanent storm water, erosion and sediment/pollution control measures in a Soil Erosion and Drainage Management Plan (SEDMP), that complies with regulatory requirements. Temporary and permanent measures will be appropriate to the site conditions, responding to environmental receptors, climatic zone and seasonal factors. The SEDMP will also establish and specify the monitoring and performance objectives for handover on completion of construction.
		• Fencing around the Launch Sites A and B, Infrastructure Site D and Range Control Site E as detailed in the EIS and Response Document and Section 6.1.10 will be incorporated into the design to minimise risk to fauna and channel fauna toward safe movement opportunities. A 1800 mm chain mesh fence with three strands of barbed wire will be installed to ensure Threatened bird species can't fly through or get caught in the fencing.
		• Firebreaks incorporated along fences to protect and mitigate one of the primary threats to EPBC listed species present.
		• All buildings and facilities are sited within the Project Area to achieve suitable clearance from vegetation for fire mitigation purposes. The siting of all buildings and facilities within the Project Area footprint achieves the minimum fire clearance requirements under the National Construction Code. • Assembly building, Fuel Pad and Oxidiser pad will have firefighting services as per legislation.
		• The Project will be designed to only support micro-lift and small-lift rocket vehicles not requiring the development of large infrastructure that may have a greater impact on the surrounding environment.
		• Where necessary and possible geo-barriers will be employed to limit the potential damage from a spill or leak of liquids.
		• The proposed detention basins located at Launch Site A and Launch Site B, and dam located at Infrastructure Site D will be lined with a polymer lining. A 1800 mm chain mesh fence with three strands of barbed wire will be installed around all the three open water bodies and they will be covered with a

Delivery Phase	Aspect	Proposed Mitigation Measures
		geotextile tarp or shade cloth to detract bird species, and keep pest species and native ground dwelling fauna species out of the open water bodies.
		• The CEMP and OEMP will require the inclusion of any Commonwealth and State approval conditions stipulated for vegetation clearing with regards to fauna management. This may include a relocation program, pre-clearance surveys, presence of qualified wildlife spotters onsite during clearing, and clearing being undertaken from disturbed areas toward undisturbed areas to encourage fauna to move away from the clearing operation. • Specific Management plans will be prepared for the ongoing protection of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird during construction and operation of the Project.
		• The CEMP and OEMP to be prepared for this Project will incorporate mitigations measures proposed in this table, and further progressed mitigation measures that are developed as the Project progresses through approval pathways.
	Weeds and pests	• A Weeds and Pests Sub-plan will be developed as a component of the CEMP and OEMP in accordance with the PDI Act, the NV Act and relevant LSA board recommendations. • The Weeds and Pests Sub-plan will ensure weed control methods for Threatened species will be done in accordance with the relevant Recovery Plan for the species (i.e. the Mallee Whipbird National Recovery Plan).
	Water quality	• Stormwater is to be captured on each launch pad site and no stormwater is to leave any site. Launch Site A, Launch Site B, and Range Control Site E will have swales along the site boundaries. Infrastructure Site D has a large catchment area and it is planned to install a dam (possibly 30 ML) to supply the site's water needs. The dam would utilize the quarry site established to supply engineered road materials.
		• Initially, all water needs will be supplied by water trucked onto the individual sites and stored in 25,000L tanks on site. Once the dam is constructed, water would be supplied in each site's stormwater detention basin from Infrastructure Site D via direct pumped mains. This water would then be used for deluge, fire and irrigation.
	Noise	• A water deluge system and flame trench has been included in the design to mitigate noise impacts, which reduce the noise level by approximately 5-10dB.
	Post construction - rehabilitation	• A Rehabilitation Management Sub-plan will be developed for the Project, as a component of the CEMP and OEMP. As a minimum it will establish the following: - Location-specific objectives for rehabilitation of temporarily disturbed areas, reinstatement and/or stabilisation - Timeframes for rehabilitation and/or reinstatement/stabilisation works to be achieved

Delivery Phase	Aspect	Proposed Mitigation Measures
		- Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the agreed objectives - Include rehabilitation requirements such as: ▪ Tyning and ripping of base and sub-base material; ▪ Application of soil ameliorants; ▪ Topsoiling and/or compost blanket; ▪ Stabilisation and rehabilitation (e.g. planting and or seeding). - Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas - Where temporary construction facilities are required, land shall be returned to a stable condition that complies with the conditions of applicable regulatory approvals.
	Offsets	• Restriction of the Project Area as far as practical, to that required to safely and efficiently construct and operate the Project. In doing so, avoid areas of MNES, NPW Act listed receptors and their associated habitat, where possible, thereby minimising significant adverse residual impacts to these matters.
		• A biodiversity and native vegetation offset strategy will be developed in consultation with the NVC (SA) and DAWE (Commonwealth).
Pre-construction/ Construction	Native vegetation and flora	• All contractors are to be briefed on clearing requirements and restrictions (including fines) to prevent over-clearing of these areas.
		• Clearing extents will be limited to the area of the permanent and temporary works, avoiding impacts to native vegetation and habitats as far as practicable.
		• Ensure all necessary permits and approvals are in place prior to the commencement of construction.
		• Topsoil stockpiles will be a maximum of 3 m in height to avoid heat sterilisation of the seed bank. Further information will be detailed in the CEMP.
		• Topsoil stockpiles will be managed to maintain the viability of soil seed banks for flora species. Further information will be detailed in the CEMP.
		• Use vegetation clearing methods that encourage natural regeneration of rootstock, minimise land disturbance and maintain soil stability.
		• Vegetation clearing to be undertaken in a sequential manner to allow fauna present sufficient time and space to move out of the area of their own accord. Pre-clearance surveys by a qualified fauna handler will be implemented to ensure all fauna still present are appropriately handled and relocated and any injured fauna are immediately transported to appropriate veterinary care.

Delivery Phase	Aspect	Proposed Mitigation Measures
		• Apart from initial earthworks to construct access tracks and hardstand areas, ensure all vehicles and construction equipment always utilise dedicated access tracks and hardstands within the Project Area and do not travel outside of these areas.
		• Construct windrows (small soil berms) on the edge of access tracks and hardstands to delineate the boundary and prevent vehicles and construction equipment damaging vegetation beyond the construction impact zone.
		• Ensure all physical flora control measures, such as windrows, signage and exclusion barriers/bunting are checked and maintained on a regular basis (weekly as a minimum).
		• Where construction work (e.g. excavation) is required beneath the canopy of a tree, ensure that it is carried out carefully and by hand to avoid damage to the root mass by equipment • This is to be guided by best practice and, where relevant, as per Tree Protection Zones detailed in *AS4970 2009 Protection of Trees on Development Sites*. This may require that an arborist is present during excavation works in the close vicinity of trees.
		• Cease work immediately in relevant areas if any previously unidentified Threatened flora species are encountered.
		• Display a fact sheet on Threatened flora species on site notice boards and in lunchrooms.
		• Do not disturb the ground beneath the canopy of any tree that is not in the approved clearance footprint and ensure that vehicles, construction equipment, materials or waste are not located beneath the canopy of any tree.
	Fauna	• Scheduling of clearing activities will be done to avoid breeding seasons as far as reasonably practical. Where this is not practical, and where breeding sites are identified within the corridor during pre-clearance surveys, a suitably qualified person will provide mitigation measures for hazardous zones/ relocation requirements relevant to the specific species identified.
		• Any required fauna fencing will be installed in accordance with the fencing strategy which will be finalised and documented in the detailed design.
		• A suitably qualified ecologist to complete a pre-clearance survey prior to the commencement of clearing to identify and mark high-value fauna habitat trees which are not to be removed with flagging tape (or other appropriate marking method), trees that are not to be felled without the presence of a spotter-catcher (where clearing cannot be avoided and the tree is an identified habitat trees), and to identify habitat features suitable for relocation to no disturbed areas immediately adjacent to the disturbance footprint.

Delivery Phase	Aspect	Proposed Mitigation Measures
		• Display a fact sheet on expected fauna on site notice boards and in lunch rooms, in particular Threatened species such as the Mallee Whipbird and Southern Emu-wren (Eyre Peninsula).
		• Site induction to include information and protection measures for significant flora and fauna species, that all construction personnel will be required to undertake prior to starting works.
		• Install signage and exclusion barriers/bunting around areas of known fauna habitat prior to the commencement of any construction works. This includes identify and fence or mark buffer areas around protected species nests that are known in the area.
		• A qualified ecologist/fauna handler to check all vegetation (trees, bushes, shrubs and grassland) for fauna, immediately prior to any vegetation removal or clearing and grubbing works.
		• Construct windrows (small soil berms) on the edge of access tracks and hardstands to delineate the boundary and prevent vehicles and construction equipment damaging habitat beyond the construction impact zone.
		• All trenches will be closed/backfilled as soon as possible and will not remain open for more than 48 hours, where possible.
		• All trenches and excavations left open will have an escape route (e.g. soil ramp) to allow entrapped fauna to escape, where practicable.
		• All trenches and excavations will be checked by a qualified ecologist/fauna handler to for trapped fauna first thing in the morning and again in the afternoon prior to works finishing for the day and any trapped fauna will be released.
		• All cable junction pits (which may be required to stay open for extended amounts of time) will be covered and/or fenced off to prevent inadvertent trapping of fauna.
		• If any Threatened fauna species are observed during construction, work will cease in the immediate vicinity of the sighting until it has relocated, or it has been removed by a suitably qualified ecologist/fauna handler. The ecologist/fauna handler will provide a suitable record to the Site Supervisor
		• Any fauna that require relocation shall be relocated using appropriate animal hygiene. These include: - Wash hands between handling of different animals; - Handling of frogs will be done with the use of disposable and pre-rinsed vinyl gloves. Do not handle multiple individuals wearing the same gloves; and - Animals are to be immediately bagged in a suitably sized calico bag or plastic zip lock bag for amphibians. Do not reuse bags or use a single bag for multiple individuals.

Delivery Phase	Aspect	Proposed Mitigation Measures
		• Any fauna which are relocated will be documented throughout the course of construction and operation. This record will include: - Species; - Location found; - Location of relocation area; and - Condition of the animal. • Any injured fauna discovered will be immediately transported to the nearest available veterinary clinic for treatment and/or euthanasia.
		• Ensure all physical fauna control measures, such as windrows, sediment fencing, signage, and exclusion barriers/bunting are checked and maintained on a regular basis (weekly as a minimum).
		• Speed limits to be reduced in the areas close to Launch Site A and Launch Site B to limit the likelihood of vehicle strike with wildlife.
		• If fauna is accidentally killed, in particular Mallee Whipbird, Southern Emu wren (Eyre Peninsula) or Rock Parrot bodies are collected, reported to DEW and immediately frozen and offered to the SA Museum.
	Weeds and pests	• The Weeds and Pest Sub-plan, as a component of the CEMP and OEMP, will be implemented (refer above).
		• Undertake a weed survey within and immediately adjacent to the construction impact zone prior to construction commencing, to understand existing weed conditions and potential impacts (e.g. spread) during construction.
		• Remove or destroy all WONS and Declared and/or environmental weeds located within the construction impact zone, prior to construction commencing.
		• Undertake weed control such as (but not limited to) slashing, spraying, or physical removal, prior to the weeds setting seed. Ensure weed control methods within Threatened species habitat areas are in accordance with the relevant National Recovery Plan for the species.
		• Display a fact sheet on Declared and environmental weeds known to occur within the construction impact zone, on site notice boards and in lunch rooms.
		• Site induction to include information on pest and weed control, that all construction personnel will be required to undertake prior to starting works.
		• Ensure all vehicles and construction equipment are clean and free of soil material containing weed seed or propagules, prior to arriving on site. If vegetative material or earth is present, ensure that the equipment is

Delivery Phase	Aspect	Proposed Mitigation Measures
		taken away and washed down at an appropriate facility to prevent vegetative material or earth potentially containing weed seeds being brought into the site.
		• Install a designated wash-down bay to clean vehicles and construction equipment during construction works and prior to leaving site.
		• Ensure all earthmoving equipment is clean and free of soil material prior to commencing earthworks within known Threatened species habitat.
		• Ensure all fill materials (e.g. sand, aggregate) imported to site are sourced from certified weed and pathogen free sites.
		• Locate stockpiles of clean, weed free soil or fill material away from areas of weed infestation.
		• If stockpiling of weed infested material is required, ensure it is stored on a constructed hardstand and separated from clean, weed free materials and covered at all times.
		• If soil or fill material stockpiles become infested with weeds, undertake weed control (spray with herbicide) as soon as practicable and at least 10 – 14 days prior to moving material.
		• Store construction vehicles and equipment on constructed hardstands, away from areas of weed infestation.
		• Ensure construction compounds are kept neat and tidy at all times, to prevent pest animals from inhabiting the area.
		• Ensure food waste is placed in enclosed / covered bins, to prevent pest animals from accessing it.
		• Report and record rabbit / hare / fox / feral cat sightings.
	Noise	• Locate haul routes and construction laydown areas away from sensitive receptors. This should include known populations of nearby fauna within vicinity.
		• Use off-site construction or other alternative processes that eliminate or lessen resulting noise.
		• Avoid blasting.
		• Limit construction activities to daytime unless they are unavoidable.
		• Plan for quieter working methods, i.e. bored piles rather than driven piles.
		• Consider using site structures as a method of acoustic screening.

Delivery Phase	Aspect	Proposed Mitigation Measures
	Water Quality	• Water in the basins will be tested (every 6 months) to ensure that the water meets the standard where it presents no risk to animals or other contamination issues. If there is evidence of contamination, the water will be treated to remove that contamination.
Post Construction	Rehabilitation of disturbed areas	• All disturbed land will be rehabilitated to achieve stable and sustainable conditions of soil cover and vegetation.
		• Identify stockpile locations for retaining soil and vegetation for rehabilitation purposes.
		• Topsoil and vegetation temporarily disturbed to support the construction of temporary laydown areas, hardstands and utilities trenching activities will be temporarily stockpiled separately to subsoil material and will be utilised to support the reestablishment of the soil profile and rehabilitation of these locations. Soil and vegetation removed for these activities will be supported to remain along the length of the disturbance footprint where the placement of the excavated material does not impact on remnant areas.
		• Selected logs and branches from the cleared trees (where not otherwise habitat features) are to be stockpiled in designated stockpile areas for use in rehabilitation in areas with existing tree cover (where practicable, e.g. where the action of stockpiling does not create a fire risk).
		• Original stockpiled materials are to be utilised to reinstate the natural soil profile in disturbed areas, being: 1. Subsoil; 2. Topsoil; and 3. Vegetation (where available).
		• The areas disturbed for construction but not forming part of the operational footprint, will be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features. Site specific stabilisation measures will be necessary to prevent slumping or erosion. Erosion and sediment control is to be completed in accordance with the SEDMP. Where practicable, temporary erosion control measures will be left in place until bare soil has stabilised, and other natural material dragged over as cover until vegetation cover has re-established.
		• Revegetation is to occur through natural regeneration to create a vegetated buffer between the disturbance footprint and adjacent values.
		• All rehabilitation works to be consistent with bushfire and operational safety requirements.
Operation	Minimisation of impacts to ecology	• Manage visitors to the site through formalisation of tracks and signage. Rubbish management through clearly defined public waste receptacles at key launch vantage sites will be provided.
		• Engage with LSA boards to join region wide initiatives.

Delivery Phase	Aspect	Proposed Mitigation Measures
	- flora and fauna values	• Bush fire risks will be mitigated through the installation of Southern Launch firefighting equipment at every launch event. Initial firefighting capabilities during rocket launch attempts will be augmented by local Country Fire Service (CFS) crews. Sufficient water will be located onsite to successfully control and contain any unexpected fire. There will also be a fire truck on site during launches and a bulk water carrier to transport water between water storage and potential fire location.
		• Annual investigations into the effect rocket launch activities have on the local fauna and flora with subsequent recommendations on the best methods to protect the regional fauna and flora. Southern Launch is currently in negotiations with University of Adelaide and University of SA with a view to sponsoring up to 2 PhD candidates to undertake their thesis on the Project site in respect of impacts on flora/fauna. This study/s will take approximately 4 years. This will result in a strong understanding of the impacts of operations on local flora/fauna. In respect of baseline information - the detailed studies already undertaken on the Project site as part of the Development Approval process forms that baseline.
	Flora	• Display a fact sheet on Threatened flora species West Coast Mintbush on site notice boards and in lunchrooms.
		• Site induction to include information and protection measures for significant flora species, that all operational personnel will be required to undertake prior to starting works.
		• Do not disturb the ground beneath the canopy of any tree that is not in the approved clearance footprint and ensure that vehicles, construction equipment, materials or waste are not located beneath the canopy of any tree through establishment of Tree Protection Zones (TPZs).
		• Maintenance activities and refuelling must be carried out a minimum of 50 m from vegetation and waterways, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater.
	Fauna	• Any fauna that requires relocation shall be relocated by a qualified and licenced Ecologist/fauna handler using appropriate animal hygiene. These include: - Wash hands between handling of different animals; - Handling of frogs will be done with the use of disposable and pre-rinsed vinyl gloves. Do not handle multiple individuals wearing the same gloves; and - Animals are to be immediately bagged in a suitably sized calico bag or plastic zip lock bag for amphibians. Do not reuse bags or use a single bag for multiple individuals.
		• Any fauna which are relocated will be documented throughout the course of construction and operation. This record will include: - Species;

Delivery Phase	Aspect	Proposed Mitigation Measures
		- Location found; - Location of relocation area; and - Condition of the animal.
		• Ensure all physical fauna control measures, such as windrows, sediment fencing, signage and exclusion barriers/bunting are checked and maintained on a regular basis (weekly as a minimum) and are designed to minimise the potential for animal entanglement.
		• If any fauna needs to be destroyed this is to be undertaken under a Permit to Destroy Wildlife Permit and done humanely in accordance with the *Animal Welfare Act 1985* and codes of best practice.
		• Speed limits to be reduced in the areas close to Launch Site A and Launch Site B to limit the likelihood of vehicle strike with wildlife.
		• If fauna is accidentally killed, in particular Mallee Whipbird, Southern Emu wren (Eyre Peninsula) or Rock Parrot bodies are collected, reported to DEW and frozen for the SA Museum.
	Weeds and pests	• Prevent establishment of new weed species and/or infestations during the operational phase by implementing standard hygiene practices when bringing equipment, vehicles and other materials which have the potential to harbour weed seed or propagules, onto the site (e.g. for maintenance purposes) and by practicing minimal disturbance methods.
		• Conduct an annual survey to identify and monitor the location, extent and abundance of weed species, particularly WONS and Declared weed species.
		• Control pest animal species (especially rabbits, foxes and feral cats) that may proliferate as a result of site activities. Ensure rabbit control is in accordance with the *Threat abatement plan for competition and land degradation by rabbits* (DotEE 2016).
		• All waste is to be stored and collected within the fenced off Launch Site and Infrastructure site compounds to ensure waste is unable to be accessed by pest animals.
	Noise	• Use earth bunds to reduce noise during rocket take-off.
		• Use site structures as a method of acoustic screening for noisy equipment.
		• Implementation of a water deluge and flame trench, which reduce the noise level by approximately 5-10dB.
		• Locate launch sites as far away from residential and other sensitive areas as possible.
		• Development of a stakeholder engagement plan with procedures for notifying residents of all planned launch events in advance.

Delivery Phase	Aspect	Proposed Mitigation Measures
		• Develop a noise monitoring and reporting program to verify noise impacts of rocket launches.
	Water Quality	• The captured deluge water and firefighting water will be tested after every launch. If it meets the required quality standard, it will be pumped into the water detention basins. If it does not, it will be pumped into trucks and taken off site to be disposed of in a manner that meets legislative requirements
		• Water in the basins will be tested (every 6 months) to ensure that the water meets the standard where it presents no risk to animals or other contamination issues. If there is evidence of contamination, the water will be treated to remove that contamination.
	Offsets	• Ensure all monitoring, auditing and reporting requirements detailed in the biodiversity and native vegetation offset strategy are implemented during the operation phase of the Project and during any required monitoring period past operation phase of the Project.

7.2 Mitigation Measure for Raptor Species

The following actions have been developed to address the coastal raptor specific issues raised through the submissions associated with the consultation period for the EIS. Both public submissions and agency submissions have been taken into account whilst developing the required actions (EBS Ecology 2022).

1. A systematic Eastern Osprey and White-bellied Sea Eagle nest survey is to be carried out prior to the commencement of construction of WWOLC (Survey 1) with the aim of identifying the status of any Eastern Osprey or White-bellied Sea Eagle nest within a 6 km radius of the proposed Project. Refer to EBS Ecology 2022 for further details of the parameters of the survey.
2. If an active nest, of either species, is recorded within the survey area during Survey 1, repeat the systematic Eastern Osprey and White-bellied Sea Eagle nest survey (as detailed in Action 1) for the first two years of facility operation (post-construction) (Surveys 2 and 3).
3. If an active nest, of either species, is recorded within the survey area prior to construction (Survey 1), a detailed construction management plan for coastal raptors will be required. The management plan will include adaptive management measures to ensure impacts during construction are avoided and/or minimised. The management measures will be dependent on the construction program, timing of works, and the proximity of the active nest to the construction areas. Management measures may include times when certain construction activities are not permitted to reduce potential impacts to breeding birds. This management plan will need to be submitted to DEW.
4. If an active nest, of either species, is recorded within the survey area prior to construction (Survey 1), a detailed operational management plan for coastal raptors will be required. Specific adaptive management measures for the operation of the launch facility will need to be included in the plan. Management measures will be based on the proximity of the nest to the launch sites and the time of year of planned activities. This management plan will need to be submitted to DEW.
5. If an inactive nest becomes active after the commencement of the operation phase of the Project or a new nest is constructed after the commencement of the operation phase of the Project, there is no requirement for the development operational management plan.
6. At the completion of the second post construction survey (Survey 3), the results need to be collated, analysed and presented to DEW. The results of the post construction surveys will assist in determining if the Project has had a negative impact on the breeding success of either species. If the results suggest that this has occurred, a detailed review of the operations and management of the Project will be required. In addition to any changes to operational management measures, further monitoring will be required to determine if the changes to the operations have alleviated the negative impacts on the nesting success of the Project.

7.3 SEB Offset Calculation

A SEB is required for approval to clear under Division 5 of the *Native Vegetation Regulations 2017*. The NVC must be satisfied that as a result of the loss of vegetation from the clearance that a SEB will result in a positive impact on the environment that is over and above the negative impact of the clearance.

The SEB obligation is quantified by multiplying the geographical area in hectares by the Unit Biodiversity Score (UBS) (refer to Section 3.1.2.1 for how UBS is determined to give a total biodiversity score). The total maximum area of clearance is 23.4 ha.

The individual hectares represented by each vegetation association is multiplied by the UBS, resulting in subsequent points of loss and overall hectare requirement. Table 31 below shows the outcome of the bushland assessment sheets and resulting calculation of a SEB offset amount of 2606.94 SEB points in total.

The overall SEB requirement for this Project currently stands at $1,816,951.65 plus an administration fee of $99,932.34. The total SEB payment as calculated is $1,916,884.01. Southern Launch will

provide a SEB in the form of an inground offset provided by SEB credit providers within the region. SEB offsets will be like-for-like with habitat cleared.

Table 31 SEB Calculations

Block	Site	Native species diversity score	TEC Score	Threatened plant score	Threatened fauna score	UBS	Area (ha)	Total Biodiversity score	Loss factor	Loadings	Reductions	SEB Points required	SEB payment	Admin Fee
Launch Site A	3	22	1	0	0.1	66.23	7.652	506.79	1	1		1064.26	$741,756.80	$40,796.62
Launch Site A	5	12	1	0	0.1	30.66	0.080	2.45	1	1		5.15	$3,590.00	$197.45
Launch Site A access track	3	22	1	0	0.1	66.23	0.466	30.86	1	1		64.81	$45,172.33	$2,484.48
Launch Site A access track	5	12	1	0	0.1	30.66	0.179	5.49	1	1		11.53	$8,032.62	$441.79
Launch Site B	1	16	1	0	0.1	51.65	0.684	35.33	1	1		74.19	$51,708.06	$2,843.94
Launch Site B	3	24	1	0	0.1	53.43	5.996	320.37	1	1		672.77	$468,898.26	$25,789.40
Launch Site B	6	24	1	0	0.1	70.84	0.495	35.07	1	1		73.64	$51,323.42	$2,822.79
Launch site B emergency egress	6	24	1	0	0.1	70.84	0.044	3.12	1	1		6.55	$4,562.08	$250.91
Launch Site B to infrastructure Site D track	3	12	1	0	0.1	55.71	0.404	22.51	1	1		47.26	$32,941.73	$1,811.79
Infrastructure Site D	1	22	1	0	0.1	62.72	0.265	16.62	1	1		34.90	$24,326.73	$1,337.97
Infrastructure Site D	3	12	1	0	0.1	38.97	1.158	45.13	1	1		94.77	$66,049.69	$3,632.73
Infrastructure Site D	5	12	1	0	0.1	30.66	4.582	140.48	1	1		295.02	$205,617.02	$11,308.94
Site D Northern Access	2	18	1	0	0.1	55.89	0.076	4.25	1	1		8.92	$6,216.98	$341.93

Block	Site	Native species diversity score	TEC Score	Threatened plant score	Threatened fauna score	UBS	Area (ha)	Total Biodiversity score	Loss factor	Loadings	Reductions	SEB Points required	SEB payment	Admin Fee
Site D Northern Access	3	12	1	0	0.1	50.23	0.233	11.70	1	1		24.58	$17,129.75	$942.14
Site D Northern Access	5	12	1	0	0.1	30.66	0.048	1.47	1	1		3.09	$2,154.00	$118.47
Range control Pad (E)	4	20	1	0	0.1	57.41	0.999	57.35	1	1		120.44	$83,943.07	$4,616.87
Range control access (E)	4	20	1	0	0.1	57.41	0.042	2.41	1	1		5.06	$3,529.14	$194.10
						Total	**23.4**	**1241.39**				**2606.94**	**$1,816,951.65**	**$99,932.34**

8.0 Conclusion

The terrestrial biodiversity assessment included a desktop assessment, baseline field survey, targeted fauna surveys, test launch campaign- Test Launch 1, and quantifying the total biodiversity score and SEB score.

A summary of the terrestrial biodiversity assessment is presented below:

- No TECs were likely to occur and none were recorded. Seven vegetation associations were described and mapped.
- 33 flora species listed under the EPBC Act and/or NPW Act were identified in the desktop assessment. None were recorded during the baseline survey and targeted spring survey. The EPBC and NPW listed West Coast Mintbush has suitable habitat present in the Project Area.
- A total of 112 fauna species listed under the EPBC Act and/or NPW Act were identified in the desktop assessment. This included 45 Marine species (fish, whales, dolphins) which were not further considered as part of this terrestrial assessment. Seventeen of these species (all bird species) were known or likely to occur. During the baseline field survey five of these were recorded and a further one species was recorded during the targeted survey including:
  - Diamond Firetail (*Stagonopleura guttata*), Vulnerable NPW Act – three records from 2021 survey;
  - Eastern Osprey, Migratory and Marine EPBC Act, Endangered NPW Act –birds observed numerous times during field surveys, particularly near Cape Carnot and Cape Willis as a flyover;
  - Mallee Whipbird, Vulnerable EPBC Act, Endangered NPW Act – numerous individuals recorded by call and observed during targeted surveys in 2020 and 2021;
  - Rock Parrot (*Neophema petrophila*), Rare NPW Act – 14 records in baseline survey and locally common along coastal fringe at different periods;
  - Southern Emu-wren (Eyre Peninsula); Vulnerable EPBC Act, Endangered NPW Act – baseline surveys resulted recorded 18 individuals consisting of four pairs, one group of three and seven single individuals. There have been numerous new records since; and
  - White-bellied Sea-Eagle (*Haliaeetus leucogaster*), Marine EPBC Act, Endangered NPW Act – recorded frequently in the Cape Wiles area and along the coastal fringe.
- Three fauna habitats were defined and mapped. This habitat is likely to be utilised by all 17 Threatened fauna species identified as known or likely to occur. A review of habitat complexity and fauna foraging behaviour identified seven of these fauna species are more likely to depend on this habitat.

An impact assessment was completed for the Project. The potential impacts the Project will have on flora and fauna values include:

- Habitat loss and degradation from vegetation clearing;
- Fauna species injury or mortality;
- Disturbance to breeding and foraging habitat;
- Displacement of species from invasion of weed and pest species;
- Edge effects;
- Habitat fragmentation;
- Barrier effects;
- Dust and light;
- Noise; and

- Increased fire risk.

The Project will require clearing of 23.4 ha of native vegetation that includes habitat that may be considered critical for two fauna species, including the Mallee Whipbird and the Southern Emu-wren (Eyre Peninsula).

Significant impact assessments were completed for EPBC listed species with the potential to occur within the Project Area. The significant impact assessments determined the Project is unlikely to have a significant impact on the West Coast Mintbush, Australian Fairy Tern, Eastern Hooded Plover and Eastern Osprey, while there is the potential to have a significant impact on the Mallee Whipbird, and the project is likely to have a significant impact on the Southern Emu-wren (Eyre Peninsula).

Given the above assessment outcomes, it was recommended that the Project was referred under the EPBC Act to DAWE. The Project has been referred to the Commonwealth Department of Agriculture, Water and Environment (DAWE) under the EPBC Act (EPBC Ref: 2021/9013). On 10 September 2021, a delegate of the Minister for the Environment decided that the proposed action is a controlled action and that it will be assessed by preliminary documentation.

The desktop assessment and field survey identified 11 State listed Threatened bird species that may utilise the area. There are potential impacts from construction and operation activities to these species, particularly the Rock Parrot that was recorded during the targeted survey. Impacts to State listed species are not expected to be major and can be managed through a CEMP and OEMP.

Noise from launches would temporarily alter the quiet setting of the natural environment for one to two minutes during launches and for up to 15 seconds during testing. Predicted noise levels from launch of a Vega rocket are less than the recommended PTS and TTS guideline criteria of 140 dB LA_{max} and 93 dB $LA_{eq,24hr}$ respectively, even in very close proximity to the launch sites. On this basis there is low risk of hearing injury to birds as a result of a nominal worst case rocket launch. Dooling & Popper (2016) note that any audible noise has the potential of causing behavioural effects in birds, independent of any direct TTS or PTS effects on the auditory system.

The Southern Emu Wren (Eyre Peninsula), Mallee Whipbird and other protected species that inhabit the areas close to the launch site are at greatest risk of increased stress, adverse behaviour reactions, and physiological impacts. Coastal species are predicted to generally be exposed to low levels of noise, however a brief adverse behavioural response is likely.

Avian surveys of multiple control sites were undertaken, within the Lincoln NP and also multiple sites within the impact area at Whalers Way, in August 2021 (Pre-Launch) and September 2021 (Post-Launch) of Test launch 1 to collect short-term behavioural response data of the local avian community. No immediate short-term impacts on local avian community and particularly the two focal species, Southern Emu Wren (Eyre Peninsula) and Mallee Whipbird were concluded from Test Launch 1. Despite this, it is highly recommended that further survey work to determine potential longer-term impacts of launches is undertaken. In proposing future avian surveys for the two focal species breeding and non-breeding season should be considered a factor in the likelihood of observing the actual number of birds at sites of interest. Long-term monitoring should consider the deployment of Autonomous Recording Units to gather long-term data on species richness in addition call frequency of all local avian species in the areas of interest.

A static motor test was undertaken at Helidon, Queensland on 9 June 2022 where Resonate collected noise data at eight locations between 60 m and approximately 6 km from the test site. This static motor test has provided further data that noise levels did not exceed the permanent hearing damage threshold of 140 dB L_{Amax} or the 93 dB $L_{Aeq,24hr}$ TTS threshold shift for temporary hearing loss in birds, at any of the measurement locations.

Measured noise levels were compared to predicted noise levels (using RUMBLE 3.0 modelling software) which showed that measured levels were less than or equal predicted levels at all locations, with the exception of one location. At this location measured levels were 3 dB higher than predicted; however this was likely caused by reflection of noise from topographic features and structures specific to the test site. In general the comparison to modelling showed that the model tended to over-prediction noise levels and is therefore conservative, although this finding may be limited to static tests. Further noise monitoring of launch events is recommended to provide additional model validation data.

The noise data also showed noise from the static test was audible above background levels at all monitoring locations, however noise levels were of a similar magnitude or less than noise from vehicle pass-bys at monitoring locations 937 m and 2,060 m from the test site. Based on Dooling & Popper (2016) a similar test at Whalers Way has the potential for a brief behavioural response in bird species.

The mitigation hierarchy as devised by the NVC (NVC 2017) has been applied during the design of the Project. This included reducing the footprint as far as practicable to avoid clearing native vegetation and implementing a CEMP and OEMP to manage indirect impacts during construction and operation. They also include:

- Reduction of the footprint as far as practicable to avoid clearing native vegetation with the size of the Project Area reduced in size from 70.58 ha to 23.4 ha from concept design. This clearance area may be further reduced through refinements made during final design and construction;
- The results from the Site Selection Survey and Test Launch 1 of the Test Launch Campaign identified the original location of the Launch Site A contains high density of records of the Southern Emu-wren (Eyre Peninsula) and it was inferred that habitat within the original location for Launch Site A is critical habitat for the species. Considering the data collected during the Test Launch Campaign and the submissions received during the public exhibition period of the EIS a further targeted bird survey for both the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird at multiple site options for Launch Site A was undertaken. The key objective was to identify a new location for Launch Site A to minimise impacts to both species as much as possible, with consideration of ecology, heritage and launch trajectories constraints. A new proposed site location for Launch Site A has been identified that will have a lower impact on the Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird compared to the original Launch Site A option. Full details of this relocation of Launch Site A is provided in the Response Document;
- Proposed access tracks have been aligned with existing public access tracks where possible;
- The Project incorporates micro-lift and small-lift rocket vehicles that do not require large areas for infrastructure;
- Areas that will be temporarily cleared for lay-down areas will be rehabilitated in accordance with a rehabilitation plan;
- Rehabilitation of tracks that are remnants of previously visited but closed areas or unnecessary are proposed to be rehabilitated as a stage approach utilising clearance material from clearance areas. Rehabilitation will consist of ripping of the existing base material where present, spreading of topsoil from other clearance areas which will provide the seedbank, and placement of organic material on top to stabilise and prevent erosion until natural regeneration occurs. These rehabilitation areas will act in reducing fragmentation of vegetation within the primary Southern Emu-wren (Eyre Peninsula) habitat;
- Mitigation measures outlined in the CEMP and OEMP will include monitoring and contingency actions to ensure that the proposed management measures are effective and fit-for-purpose;
- Specific Management plans will be prepared for the ongoing protection of Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird during construction and operation of the Project; and
- Indirect impacts to the Eastern Osprey and White-bellied Sea-eagle to be managed and monitored through surveys and monitoring detailed in the EBS Ecology (2022) Whaler's Way Coastal Raptor review.

The clearance of 23.4 ha of native vegetation equates to 2606.94 SEB points, which results in a $1,816,951.65 offset plus an administration fee of $99,932.34 to the NVC under the SA NV Act. Southern Launch will provide a SEB in the form of an inground offset provided by SEB credit providers within the region. SEB offsets will be like-for-like with habitat cleared.

Southern Launch will implement management measures detailed in a CEMP and OEMP to avoid, minimise, or mitigate impacts on terrestrial flora and fauna values. Where impacts to native vegetation, Threatened flora and fauna species cannot be avoided by the Project, they will be offset through State and or Commonwealth requirements.

9.0 Limitations Statement

AECOM has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Southern Launch and only those third parties who have been authorised in writing by AECOM to rely on this Report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the contracts dated 14 February 2020, 28 May 2020 and 26 November 2020.

The methodology adopted and sources of information used by AECOM are outlined in this the Report.

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information.

This Report was prepared between prepared over numerous revisions after field surveys and the EIS initial submission from February 2020 to January 2022, and is based on the conditions encountered and information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time.

This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, AECOM must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Except as required by law, no third party may use or rely on this Report unless otherwise agreed by AECOM in writing. Where such agreement is provided, AECOM will provide a letter of reliance to the agreed third party in the form required by AECOM.

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It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the site.

References

ABC 2021. Rare raptor photographed at rocket test site in Eyre Peninsula. Viewed 04 February 2022 at https://www.abc.net.au/news/2021-10-09/square-tailed-kite-sighting-eyre-peninsula/100518052.

AECOM 2022. Whalers Way Orbital Launch Complex - Environmental Assessment Report - Noise Assessment.

Atlas of Living Australia (ALA), 2020. Open access to Australia's biodiversity data. Available at: ala.org.au.

Bali, R. 2005. Discussion Paper – Compensating for Edge Effects, Ecosense Consulting for the NSW Roads and Traffic Authority, Sydney.

Barrett, G., A. Silcocks, S. Barry, R. Cunningham & R. Poulter 2003. *The New Atlas of Australian Birds*. Melbourne, Victoria: Birds Australia.

Beason, R. C. 2004. What can birds hear? *21st Vertebrate Pest Conference* (pp. 92-96). Visalia, California: University of California, Davis.

Blakers, M., S.J.J.F. Davies & P.N. Reilly 1984. *The Atlas of Australian Birds*. Melbourne, Victoria: Melbourne University Press.

Birdlife, 2020. Birdlife Australia. Online resource http://birdlife.org.au/.

Birdlife, 2021a. Survey Techniques - 2-ha, 20 min Search. Accessed in June 2021: https://birdata.birdlife.org.au/survey-techniques

Birdsall, J.L., McCaughey, W. and Runyon, J.B. 2012. Roads Impact the Distribution of Noxious Weeds More Than Restoration Treatments in a Lodgepole Pine Forest in Montana, U.S.A, *Restoration Ecology*, *vol. 20*, no. 4, pp. 517 – 523.

Brandle R, 2010. Biological Survey of the Eyre Peninsula South Australia. Department for Environment and Heritage, South Australia.

Bureau of Meteorology (BOM), 2020. Climate Data Online. Online resource accessed 25-Mar-2020 http://www.bom.gov.au/climate/data/

Carpenter, G., A. Black, D. Harper & P. Horton, 2003. Bird Report, 1982-1999. *South Australian Ornithologist*. *34*:93-151.

Coffin, A.W. 2007. From roadkill to road ecology: A review of the ecological effects of roads, Journal of *Transport Geography*, *vol. 15, no. 5*, pp. 396 – 406.

Conn, BJ 1986, *Prostanthera* in Jessop, J & Toelken, HR (eds) 1986, *Flora of South Australia*, *Government Printer, Adelaide*, pp. 1209-1219, viewed 5 May 2008, <http://www.flora.sa.gov.au/cgibin/texhtml.cgi?form=speciesfacts&family=Labiatae&genus=Prostanthera&species=calycina>.

Dennis TE and Clancy G P (2014). The status of the Osprey (*Pandion haliaetus cristatus*) in Australia. *Journal of Raptor Research 48*: 408-414.

Dennis, T.E. 2007a. Distribution and status of the Osprey *(Pandion haliaetus)* in South Australia. *107*:294-299.

Dennis TE, Detmar SA, Brooks AV and Dennis HM 2011a. Distribution and status of White-bellied Seaeagle, *Haliaeetus leucogaster*, and Eastern Osprey, *Pandion cristatus*, populations in South Australia. *The Journal of The South Australian Ornithological Association Inc. V37 (Part 1).*

Dennis TE, McIntosh RR and Shaughnessy PD 2011b. Effects of human disturbance on productivity of White-bellied Sea-Eagles (*Haliaeetus leucogaster*). *Emu 111*:179-185.

Dennis TE, Detmar S and Patterson C 2015. The White-bellied Sea Eagle as a key indicator species by which to measure the health and stability of coastal biodiversity in South Australia. Prepared for Kangaroo Island Natural Resources Management Board 2014, updated 2015).

Dennis TE, Fitzpatrick GJ and Brittain RW 2012. Phases and Duration of the White-bellied Sea-Eagle *Haliaeetus leucogaster* breeding season in South Australia and the implications for habitat management. *Corella 36*:63-68.

Dennis TE and Detmar SA 2018. A review of White-bellied Sea Eagle distribution and population stability over time in South Australia. November 2018. In *South Australian Ornithologist* Pp.55-71.

Department of Agriculture, Water and the Environment (DAWE), 2020a. Protected Matters Search Tool. Online resource accessed 14-Feb-2020 https://www.environment.gov.au/epbc/protected-matters-search-tool

Department of Agriculture, Water and the Environment (DAWE), 2020b. Species Profiles and Threats Database. Online resource accessed 24-Mar-2020 https://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Department of Agriculture, Water and the Environment (DAWE) 2020c. Species Profile and Threats Database - Australian Fairy Tern - *Sternula nereis nereis* Available at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82950

Department of Agriculture, Water and the Environment (DAWE) 2020d. Species Profile and Threats Database – for Mallee Whipbird - (*Psophodes leucogaster leucogaster*). Available at https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64448

Department of Agriculture, Water and the Environment (DAWE), 2020e. Species Profile and Threats Database - Southern Emu-wren (Eyre Peninsula) (*Stipiturus malachurus parimeda*) —. Available at https://environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26006

Department of Agriculture, Water and the Environment (DAWE 2020f). Species Profile and Threats Database - Eastern Osprey - *Pandion cristatus*. Available at https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=952

Department for Environment and Heritage (DEH), 2006. Threatened Species of the South Australian Murray-Darling Basin Western Whipbird (eastern subspecies) *Psophodes nigrogularis leucogaster* Fact Sheet.

Department for Environment and Heritage, 2008. Adelaide and Mount Lofty Ranges South Australia Threatened Species Profile – *Stagonopleura guttata*. Biodiversity Conservation Unit, Adelaide Region.

Department for Environment and Water (DEW) 2017. Southern South Australia Soil Group Map, Department of Environment Water and Natural Resources, SA.

Department for Environment and Water (DEW), 2020a. Biological Database of South Australia (BDBSA) for threatened flora and fauna species listed under the South Australian *National Parks and Wildlife Act 1972* (NPW Act). http://www.environment.sa.gov.au/Science/Information_data/Biological_databases_of_South_Australia.

Department for Environment and Water (DEW), 2020b. NatureMapss Vegetation Mapping. Online resource accessed 15/02/2018 at http://spatialwebapps.environment.sa.gov.au/NatureMapss/?locale=en-us&viewer=NatureMapss

Department of Planning, Transport and Infrastructure (DPTI) 2020. Terrestrial Biodiversity Assessment Guidelines for Whalers Way Orbital Launch Complex.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) 2011. Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/82950-conservation-advice.pdf

Department of the Environment, Land, Water and Planning (DELWP), 2016. National Recovery Plan for the Mallee Emu-Wren *Stipiturus mallee*, Red-lored Whistler *Pachycephala rufogularis*, Western Whipbird *Psophodes nigrogularis leucogaster.*

Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008. Approved Conservation Advice for *Prostanthera calycina* (West Coast Mintbush). Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/9470-conservation-advice.pdf.

Department of the Environment, Water, Heritage and the Arts (DEWHA), 2013. Significant Impact Guidelines 1.1 – Matters of National Environmental Significance, Department of the Environment, Water, Heritage and the Arts.

Department of the Environment (DotE) 2013a. Conservation advice for Southern Emu-wren (Eyre Peninsula) (*Stipiturus malachurus parimeda*) —. Available from https://environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26006

Department of the Environment (DotE), 2013b. Approved Conservation Advice for *Pleuropappus phyllocalymmeus* (silver candles). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/21123-conservation-advice.pdf

Department of the Environment and Energy (DotEE) 2016. Threat abatement plan for competition and land degradation by rabbits. Available from https://www.environment.gov.au/system/files/resources/bf9352c2-35ae-4a80-8828-96de630731a9/files/tap-rabbit-2016.pdf

Dooling, R. J. (1980). Behavior and psychophysics of hearing in birds. In Comparative studies of hearing in vertebrates (pp. 261-288). Springer, New York, NY.

Dooling, R. J., & Popper, A. N. 2007. *The effects of highway noise on birds.* Sacramento, CA: California Department of Transportation Division of Environmental Analysis.

EBS Ecology 2022. Whaler's Way Coastal Report Review

Ecosphere 2020. Native Vegetation Clearance – Southern Launch Whalers Way Data Report.

Ecosphere 2021. Whalers Way Orbital Launch Complex. Test Launch Campaign- Avian Survey Report Test Launch 1. December 2021

Eldred, K. M. (1971). Acoustic loads generated by the propulsion system. National Aeronautics and Space Administration

EPA 2007. SA EPA Environmental Noise Guidelines – Audible Bird Scaring Devices.

Fahrig, L. 2002. Effect of habitat fragmentation on the extinction threshold: a synthesis, *Ecological Applications, vol. 12,* no. 2, pp. 346 – 351.

Federal Aviation Administration (FAA). 2009. *Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications*.

Forman, R.T.T., Sperling, D., Bissonette, J.A., Clevenger, A.P., Cutshall, C.D., Dale, V.H., Fahrig, L., France, R., Goldman, C.R., Heanue, K., Jones, J.A., Swamson, F.J., Turrentine, T. and Winter, T.C. 2000. Road Ecology. Science and Solutions., Island Press, Washington.

Garnett, S., ed. 1993. Threatened and Extinct Birds of Australia. *RAOU Report 82*. Melbourne: Royal Australasian Ornithologists Union, and Canberra: Australian National Parks and Wildlife Service.

Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). The Action Plan for Australian Birds 2010. CSIRO Publishing, Collingwood.

Garnett, S.T. & G.M. Crowley 2000. *The Action Plan for Australian Birds 2000*. Canberra, ACT: Environment Australia and Birds Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/birds2000/index.html.

Geological Survey of South Australia, 2017. Lincoln Sheet – Digital Edition. Department of State Development, SA.

Higgins PJ, Peter JM, (Eds). 2002. Handbook of Australian, New Zealand and Antarctic Birds. Volume 6. Pardalotes to Spangled Drongo. Oxford University Press, Melbourne.

Hoang, T.2013. A literature review of the effects of aircraft disturbance on seabirds, shorebirds and marine mammals. *(Presented to NOAA, Greater Farallones National Marine Sanctuary and The Seabird Protection Network).*

Hughes. R., Inouye. B.D., Johnson, M.T., Underwood. N, and Vellend. M. 2008. Ecological consequences of genetic diversity. *Ecology Letters, vol 11*, issue 6, pp. 609-623.

Interim Biogeographic Regionalisation for Australia (IBRA), 2012. Interim Biogeographic Regionalisation for Australia, Version 7. Department of the Environment and Energy, Canberra.

International Union for Conservation of Nature (IUCN), 2001. Categories & Criteria (version 3.1). Online resource accessed 7/03/2018 at http://www.iucnredlist.org/static/categories_criteria_3_1.

Jacobs 2020. Whalers Way Eastern Osprey and White-bellied Sea Eagle Detailed Assessment.

Kutt, A.S., Vanderduys, E.P., Ferguson, D. and Mathieson, M. 2012. Effect of small-scale woodland clearing and thinning on vertebrate fauna in a largely intact tropical savanna mosaic, *Wildlife Research, vol. 39, no. 4*, pp. 366 – 373.

Landscape South Australia 2021. Latest STAR news – Hooded Plovers nesting at Fishery Bay – a first in 8 years. Online resource accessed 19/01/2022 at https://www.landscape.sa.gov.au/ep/stewardship-priorities/landscape-management/star-project/latest-star-news

Loyn, R.H., Runnalls, R.G., Forward, G.Y. and Tyers, J. 1983. Territorial bell miners and other birds affecting populations of insect prey, *Science, vol. 221*, pp. 1411 – 1412.

Maguire G. S. 2005. Behavioural Ecology of the Southern Emu-wren (*Stipiturus malachurus*) Phd thesis. Department of Zoology, University of Melbourne.

McNamara, D. 1966. The Western Whipbird on Eyre Peninsula. *South Australian Ornithologist*. *24*:93.

Moenting, A.E. and Morris, D.W. 2006. Disturbance and habitat use: is edge more important than area?, *Oikos, vol. 115*, no. 1, pp. 23 – 32.

National Environmental Science Program Threatened Species Research Hub (2019. Threatened Species Strategy Year 3 Scorecard- Hooded Plover. Australia Government, Canberra. Available from:

Native Vegetation Council 2017. Guide for applications to clear native vegetation Under the Native Vegetation Act 1991 and Native Vegetation Regulations 2017. Native Vegetation Management Unit, Govt. of South Australia.

Native Vegetation Council, 2019. Bushland Assessment Manual, Native Vegetation Management Unit, Govt. of South Australia.

NatureMaps, 2020. Enviro Data SA. Online resource: https://data.environment.sa.gov.au/NatureMapss/Pages/default.aspx.

Northern Agricultural Catchments Council (NACC), 2020. Threatened Species of the Week: *Sternula nereis nereis* (Australian Fairy Tern). Available at: https://www.nacc.com.au/threatenedspecies-week-sternula-nereis-nereis-australian-fairy-tern/.

Pickett M, 2002. Status Review and Action Plan for the Eyre Peninsula Southern Emu-wren i *malachurus parimeda*. Southern Eyre Birds Inc. and National Parks and Wildlife, South Australia.

Pickett, M. 2003. Status and Distribution of the Eyre Peninsula Southern Emu-wren at the Proposed Cathedral Rocks Windfarm Site. Unpublished report prepared for Hydro Tasmania, Hobart.

Pickett, M. 2004a. Recovery Planning for the Eyre Peninsula Southern Emu-wren - 2004 Survey. Unpublished report prepared for the Department for Environment and Heritage, South Australia.

Pickett, M. 2004b. Draft Recovery Plan for the Eyre Peninsula Southern Emu-wren (*Stipiturus malachurus parimeda*) 2005 - 2009. Unpublished draft prepared for the Department for Environment and Heritage, South Australia.

Pickett, M. 2004c. Eyre Peninsula Southern Emu-wren and Western Whipbird Monitoring at the Cathedral Rocks Wind Farm Heritage Agreement Area - Spring 2004. Unpublished report prepared for Hydro Tasmania, Hobart.

Pickett, M. 2005. Eyre Peninsula Southern Emu-wren and Western Whipbird Monitoring at the Cathedral Rocks Wind Farm Heritage Agreement Area - Spring 2005. Unpublished report prepared for Hydro Tasmania, Hobart.

Pickett M, 2006. Habitat Management Guidelines for the Eyre Peninsula Southern Emu-wren. Port Lincoln, South Australia. Department of Environment and Heritage, Port Lincoln South Australia.

Pizzey G, Knight F, 2007. The Field Guide to the Birds of Australia. Harper Collins Publishers, Sydney Australia.

Radford A, Morley E, Jones G, 2012. The Effects of Noise on Biodiversity (NO0235). Department for Environment Food and Rural Affairs, United Kingdom.

Resonate, 2022. Southern Launch - Whalers Way Orbital Launch Complex Environmental Noise Advice

Resonate, 2022. Southern Launch – Hapith I Motor Static Test.

Rogers, C. 2003. Bird report 2001. *South Australian Ornithologist*. *34*:57-69.

Rowden, P., Steinhardt, D. and Sheehan, M. 2008. Road crashes involving animals in Australia, *Accident Analysis and Prevention, vol. 40*, no. 6, pp. 1865 – 187

SARIG, 2020. South Australian Resources Information Gateway. Online resource: https://map.sarig.sa.gov.au/.

Shannon, G., McKenna, M. F., Angeloni, L. M., Crooks, K. R., Fristrup, K. M., Brown, E., . . . Wittemyer, G. 2016. A synthesis of two decades research documenting the effects of noise on wildlife. *Biological Reviews*, 91:982-1005.

SpaceX. 2019. Draft Environmental Assessment for the SpaceX Starship and Super Heavy Launch Vehicle at Kennedy Space Centre (KSC).

Threatened Species Scientific Committee (TSSC), 2015. Conservation Advice *Halobaena caerulea* blue petrel. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1059-conservation-advice-01102015.pdf

Threatened Species Scientific Committee (TSSC), 2016a. Conservation Advice *Limosa lapponica baueri* Bar-tailed godwit (western Alaskan). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86380-conservation-advice-05052016.pdf

Threatened Species Scientific Committee (TSSC), 2016b. Conservation Advice *Limosa lapponica menzbieri* Bar-tailed godwit (northern Siberian). Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/86432-conservation-advice-05052016.pdf

Threatened Species Scientific Committee (TSSC), 2019. Conservation Advice Botaurus poiciloptilus Australasian Bittern. Canberra, ACT: Department of the Environment and Energy. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-conservation-advice-18012019.pdf.

Vella, G., Rushforth, I., Mason, E., Hough, A., England, R., Styles, P., . . . Thorne, P. (2001). *Assessment of the effects of noise and vibration from offshore wind farms on marine wildlife.* Centre for Marine and Coastal Studies Ltd (CMACS).

VicFlora, 2020. Flora of Victoria. Online resource. https://www.rbg.vic.gov.au/

Way SL, van Weenen J, 2008. Eyre Peninsula Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus whitei*) Regional Recovery Plan. Department for Environment and Heritage, South Australia.

Webster, H.O. (1966). The western whipbird at Two Peoples Bay. *Western Australian Naturalist*, 10:25 28.

Wilson RP, Culik WB, Danfeld R, Adelung D (1991) People in Antarctica-how much do Adélie penguins *Pygoscelis adeliae* care? *Polar Biol* 11:363–370

Wyle. 2003. Noise Basics and the Effect of Aviation Noise on the Environment. USA: Wyle.

Appendix A

Targeted Survey for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird 2020

ECOSPHERE
Ecological Solutions

Broadscale Distribution and Status of the Eyre Peninsula Southern Emu-wren (*Stipiturus malachurus parimeda*) and Western Whipbird (eastern) (*Psophodes leucogaster leucogaster*) at Whalers Way, June 2020

11 September 2020

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Ecosphere Ecological Solutions Pty Ltd
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1 Introduction

Southern Launch are an Adelaide-based company who are proposing to construct an orbital launch facility at Whalers Way on the southern tip of the Eyre Peninsula in South Australia. The Southern Launch Project has both State and Federal support in constructing and delivering space technologies and facilities within South Australia, and Whalers Way has been identified as a suitable location. The Southern Launch project consists of the design and delivery of two separate types of facilities, and includes supporting infrastructure such as road upgrades, installation of transmission lines and various tourist facilities. The current proposal has planned for the design and construction of various infrastructure to support three (3) launch facilities (The Project site, Figure 1). The design scope will include provision of infrastructure, design review and delivery support to ensure compliance with all Australian legislative requirements. The Project site will need to be prepared to accept the facility including appropriate supporting infrastructure.

Whalers Way is a parcel of land which is largely intact native remnant coastal Mallee vegetation that has been managed by the Theakstone family since 1887. In 1969 Robert Theakstone commenced work to secure the 1,052 hectares of privately owned land as a Historic Reserve and Wilderness Sanctuary, to which it remains to this day under Heritage Agreement (HA 148). Whalers Way primary land use is as a tourist destination, whereby access to the site is gained by paying a fee and deposit for a key to the main gate with the deposit refunded upon return of the key.

In April 2020, AECOM Australia undertook a desktop and onsite broad ecological assessment on behalf of Southern Launch (AECOM 2020).

1.1 Objectives

The findings of the desktop assessment highlighted the need to gather more information regarding the presence and distribution for nationally conservation significant avian species, Western Whipbird (eastern) (*Psophodes leucogaster leucogaster*) and the Southern Emu-wren Eyre Peninsula subspecies (subsp.) (*Stipiturus malachurus parimeda*), both of which have historical observations and suitable habitat within and surrounding the Project site. Ecosphere Ecological Solutions Pty Ltd (Ecosphere) was engaged by AECOM on behalf of Southern Launch to review and update information currently held on these species.

The specific objectives of survey were to:

- Review existing information related to the previous records and presence of critical habitat within the Project site
- undertake on ground broadscale surveys to verify the presence and extent of Western Whipbird and Southern Emu-wren
- report on the findings of the on ground survey.

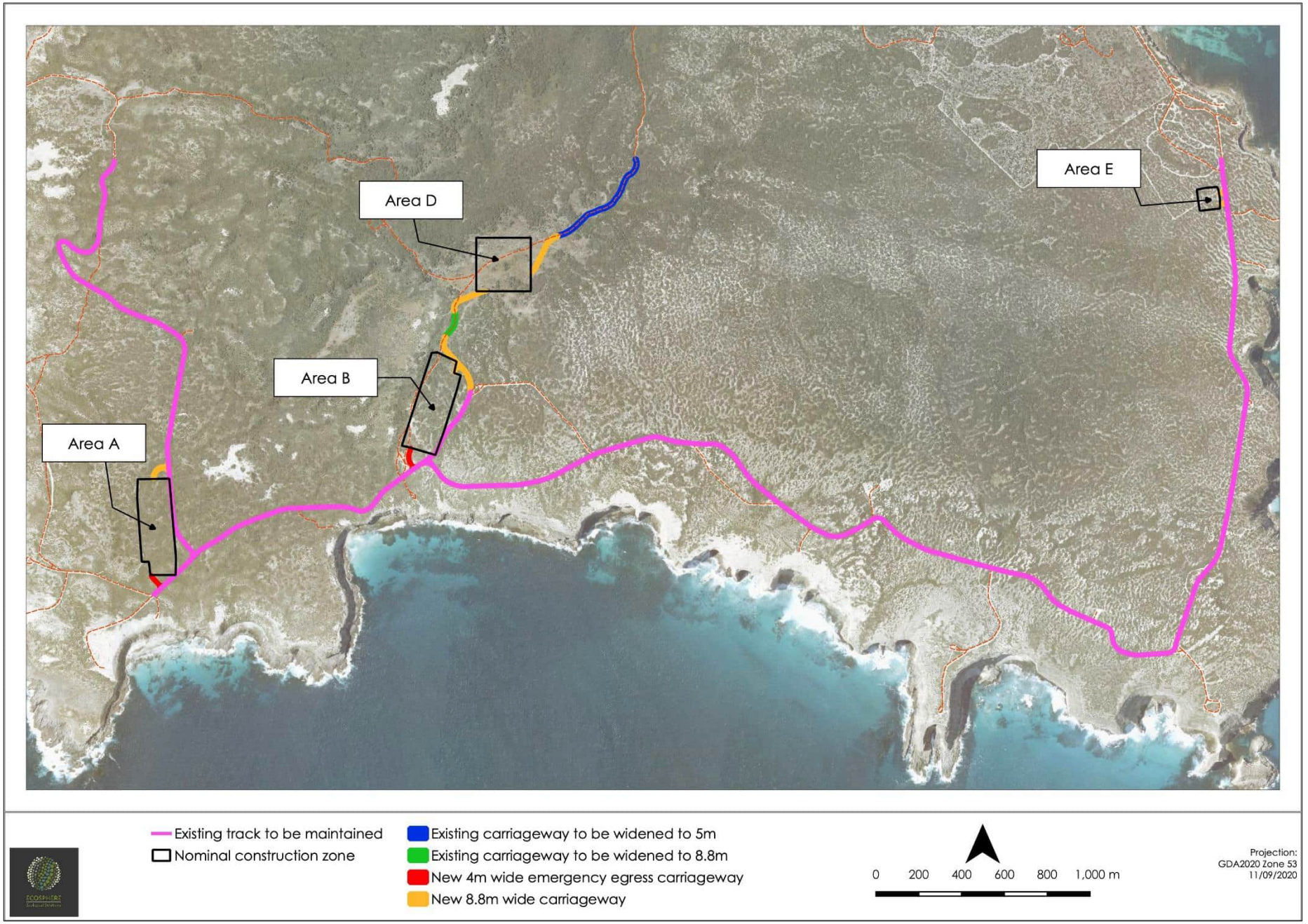

Figure 1. Location of the Project site with previous vegetation mapping extent.

2 Background

2.1 Southern Emu Wren.

The Southern Emu Wren (Eyre Peninsula) (*Stipiturus malachurus parimeda*) is listed as nationally Vulnerable under the *Environment Protection and Biodiversity Conservation Act (1999)* and Endangered under the *National Parks and Wildlife Act (1972).* Known records for this species exist within and surrounding the Project site (Figure 2), however, the presence, size and extent of populations present within the area has not been recently thoroughly assessed and required an additional on-ground survey to provide an accurate and up-to-date assessment of the current presence and distribution.

According to the species conservation advice (DotE 2013 and references therein), the common *Stipiturus malachurus* (the Southern Emu-wren), family Maluridae, is a tiny bird with a long (10 cm) filamentous tail made up of six feathers, which is usually held upright. Male birds are grey-brown streaked black above, warm tawny brown below, with a distinctive blue chin and throat and some blue around the eyes; females are similar but lack the blue coloration. This species is shy and has a weak flight, preferring to spend most of its time low in dense cover.

The Endangered subspecies *Stipiturus malachurus parimeda* (Southern Emu-wren – Eyre Peninsula) is of moderate size but has very much paler upper parts and lower parts, compared to the other subspecies and nominate species (*S. malachurus*). The adult male has a pale crown and forehead, with brownish grey nape and sides of the neck. The chin and throat are light grey-blue. The adult female is also very pale, with brownish grey forehead, crown, nape and hindneck. The Southern Emu-wren – Eyre Peninsula is found only on the southern tip of the Eyre Peninsula, South Australia. The subspecies is currently known from eleven locations on the peninsula, all of which are likely to be fragmented and isolated (DotE 2013 and references therein).

All previous records within the Whalers Way Project site were recorded between 2002 to 2008, with a gap in assessment for the species in recent years. The Southern Emu-wren (Eyre Peninsula) assessments during this period had estimated the population to be around 1,000 individuals (DAWE and references therein).

The five important EPSEW sub-populations are recognized (Pickett 2006):

- MacLaren Point–Point Haselgrove
- Marble Range

- Merintha Ck–Kellidie Bay
- West Point
- Whalers Way (and environs)

2.2 Western Whipbird (eastern)

The Western Whipbird (eastern) (Psophodes leucogaster leucogaster) is listed as nationally Vulnerable under the Environment Protection and Biodiversity Conservation Act 1999 and Endangered under the National Parks and Wildlife Act 1972. Five previous official records were obtained in the Whalers Way area around 2004, and these were recorded by call only, i.e. individuals were not observed visually (Figure 2). Whalers Way required an on-ground survey to provide an up-to-date assessment of the current presence and distribution of the species.

The Western Whipbird (eastern) is approximately 20 to 25 cm long. It is a distinctive bird that is characterised by its short triangular crest, a short and stout bill, long and powerful legs, short wings and a graduated tail. It is typically mostly a grey to olive colour above, with a prominent white stripe on each cheek accompanied by a black throat and chin, and a broad white stripe down the centre of its breast and belly. The Western Whipbird (eastern) usually occurs singly or in pairs, though has been observed to sometimes occur in small groups of three or four birds. The Western Whipbird (eastern) typically moves short distances within the mid-upper canopy of Mallee habitat and spends some of its time partially at ground level. It has been noted that it lacks an ability to fly long ranges, and in fact the longest continuous flight of a Western Whipbird (eastern) was only 30 m (DAWE and references therein).

The Western Whipbird (eastern) occurs in three isolated regional populations in southern South Australia: the first on the southern Eyre Peninsula; the second on the south-western Yorke Peninsula; and the third in the Murray-Mallee region of south-eastern South Australia. The population on the Eyre Peninsula is restricted to sites around Coffin Bay National Park and Lincoln National Park (DAWE 2020 and references therein). Based on known records, the Eyre and Yorke Peninsula populations are estimated to consist of 250 or more birds each.

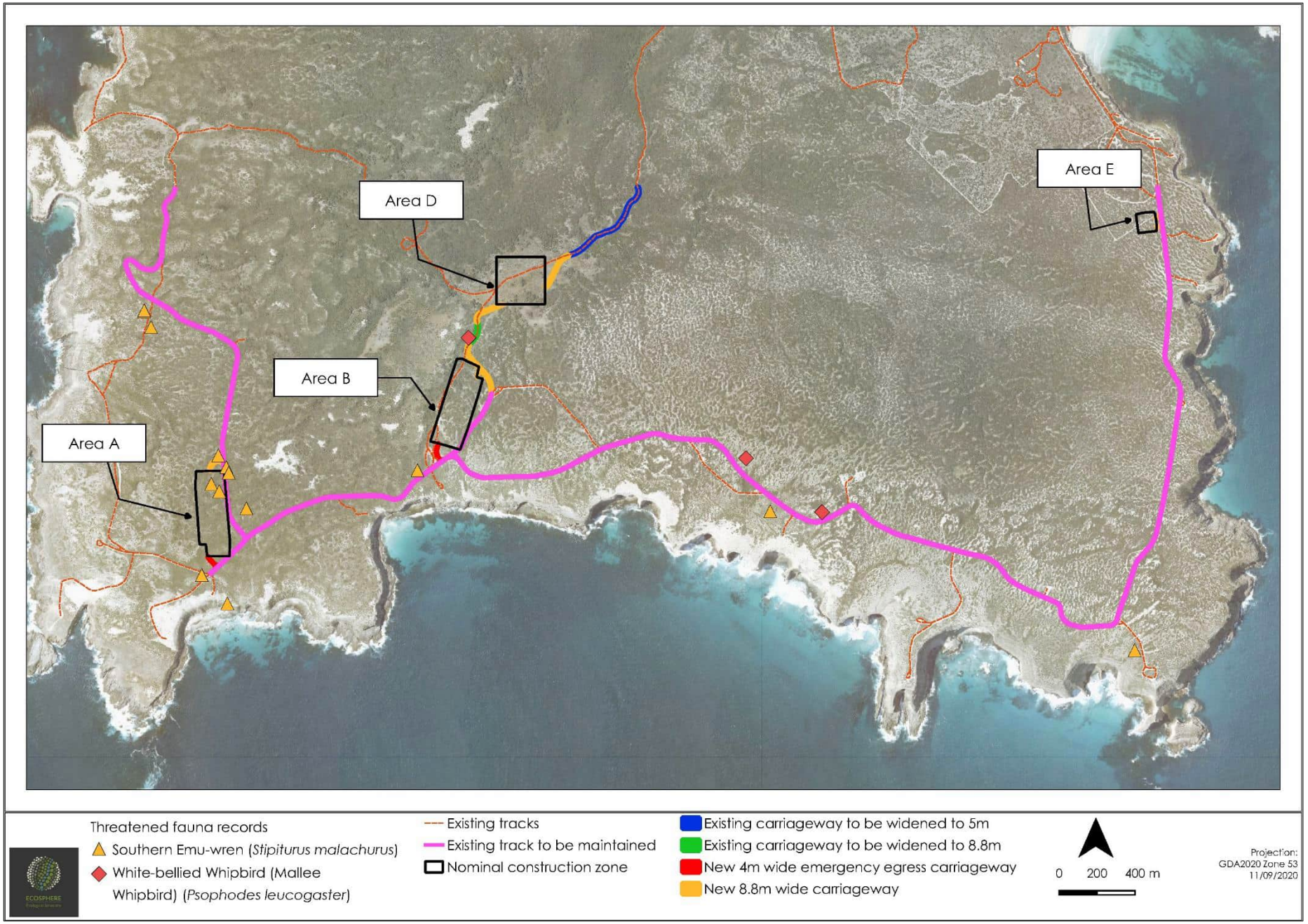

Figure 2. Locations of pre-existing records for Southern Emu-wren and Western Whipbird (eastern).

3 Methods

Nationally threatened avian survey methods were driven by the Guidelines for Detecting Birds Listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010). The field survey was undertaken by Andrew Sinel and Rob Kelman from Ecosphere on 22-24 June 2020. The targeted species are resident and therefore expected to be present if occupying the habitat. Spring would be the ideal time to survey given males are expected to be actively guarding territories through this period however birds were still expected to be active and identifiable if present. The weather during the survey period was relatively good for avian surveys with moderate wind speeds and mild daytime temperatures for the time of year. The Port Lincoln weather station recorded the following daily observations for the survey period shown in Table 1 (BOM 2020).

Table 1. Port Lincoln weather station (5055) daily weather observations (survey period shaded).

Date	Day	Temps		Rain	9:00 AM		3:00 PM	
		Min	Max		Dir	Spd	Dir	Spd
21	Su	9.2	15.9	7	WSW	17	WSW	28
22	Mo	10.5	15.4	0.4	WSW	17	SSW	28
23	Tu	7.5		0.6	NW	17	WNW	17
24	We	6.1	17	0	NW	2	NNW	22
25	Th	9.1	18.2	0	WNW	17	W	20

This survey was performed under Permit to Undertake Scientific Research, Ongoing Projects Permit Number: E26879-1.

3.1 Southern Emu-wren survey

The Southern Emu-wren assessment was undertaken using broadscale assessment methodology, covering an area of approximately 350 hectares over 3 days. Linear transects within critical habitat were utilised where surveyors walked slowly through the habitat approximately 40m apart. The direction of travel was dependent on the time of day with the sun kept behind the surveyors. The overall assessment methodology was to actively target locations with pre-existing records in the first instance. Once these areas were confirmed as present/absent, other areas without records were targeted to 'fill gaps' where possible.

The Southern Emu-wren was targeted by listening for calls or by observing physical signs of the species. If a call or sighting was observed, judicious use of call playback applications was used to confirm the sighting where necessary, as advocated by the EPBC Survey Guidelines for the Southern Emu-wren (Eyre Peninsula) (DEWHA 2010). A hand held GPS unit was used to

record the location within 10 m, and where possible the number and sex of each individual was recorded.

3.2 Western Whipbird (eastern) survey

The assessment for the Western Whipbird (eastern) (*Psophodes leucogaster leucogaster)* was guided by the DEWHA broadscale assessment methodology. The preferred habitat for this species is difficult to walk through having a dense canopy cover of around 1.5-2m. Western Whipbirds (eastern)are typically difficult to observe by sight, however have a highly unique and unmistakeable call, with calls often being able to be heard at distances of up to 800 m (DAWE and references therein). Western Whipbirds (eastern) are described as timid, elusive and cryptic, occupying dense habitat being heard rather than seen, their distinctive song usually the only indication of their presence. Detection by this method is determined as the best method for this species (DAWE and references therein). As a result, areas within the proposed Southern Launch infrastructure locations that were identified as having suitable habitat were targeted with records confirmed via call/song.

A hand held GPS unit was used to record the location, however, due to the difficulty in the observer getting in immediate proximity to the individual bird making the observed call, the mapping of the species has an accuracy of up to 100 m due to the inability in many cases to get within close range or calls ceasing as the surveyor approaches.

3.3 Limitations

Historical Western Whipbird and Southern Emu-wren species records were sourced from the BDBSA Supertable. The BDBSA only includes verified flora and fauna records submitted to DEW or partner organisations. It is recognised that drawing conclusions can be unreliable within areas that have been under represented in terms of biological studies. It is possible therefore, that records may occur within the Project site that are not reflected by database records. Although much of the BDBSA data has been through a variety of validation processes, the lists may contain errors and should be used with caution. DEW give no warranty that the data is accurate or fit for any particular purpose of the user or any person to whom the user discloses the information. The findings and conclusions made by Ecosphere are based upon information in existence at the time of the survey.

The likelihood of detection of individuals is reduced outside of the peak periods of dawn and dusk. While these periods were utilised, surveys were conducted across the entire day. The ability to assess occurrences outside of peak periods may be reduced. Therefore, it is concluded that areas without direct observations are not necessarily absent.

The use of audio playback was used during this survey. Audio playback has been proven to have an impact on bird behaviour. Scientific literature suggests that responding to call-playback may incur energy costs, disrupt social systems, lead to pair separation or nest abandonment and cause stress. This disruption was kept front of mind and the audio playback method was used very judiciously by one surveyor only and only to confirm a brief sighting.

4 Results

4.1 Southern Emu-wren

The results of the Southern Emu-wren (*Stipiturus malachurus parimeda)* survey confirmed a total of 18 individuals in the Project site. Four pairs, one group of three and several individual observations were recorded (Table 2). The species was confirmed to occur in proximity to previous known locations (Figure 3). At least four locations were recorded as potentially new breeding pairs/groups, between Point du Bastion west to Blue Whale Bay (Figure 3). Another male was recorded west of Cape Carnot. A male Southern Emu-wren was captured by photograph near Groper Bay (Figure 4) where three individuals were recorded.

Table 2. Southern Emu-wren new observations recorded June 2020.

Name	Comment	Ind. Observed	UTM Zone 53H	
			Easting	Northing
WWSEW1	Near pre-existing Cape Carnot records	1M, 1F	557328	6133639
WWSEW2	Near pre-existing Cape Carnot records	1M	557334	6133535
WWSEW3	Near pre-existing Cape Carnot records	1F	557406	6133466
WWSEW4	Near pre-existing Cape Carnot records	1M, 1F	557477	6133947
WWSEW5	Near pre-existing Cape Carnot records	1M	557638	6134098
WWSEW6	Near pre-existing Point du Bastion record	1M	562434	6133039
WWSEW7	New record	1M	561617	6133309
WWSEW8	New record	1M,1F	561326	6133327
WWSEW9	New record	1M	560789	6133447
WWSEW10	New record in proximity to pre-existing record	1M, 1F	560561	6133729
WWSEW11	New record west of Cape Carnot	1M	556878	6133739
WWSEW12	Near pre-existing Groper Bay record	2M, 1F	558655	6134055

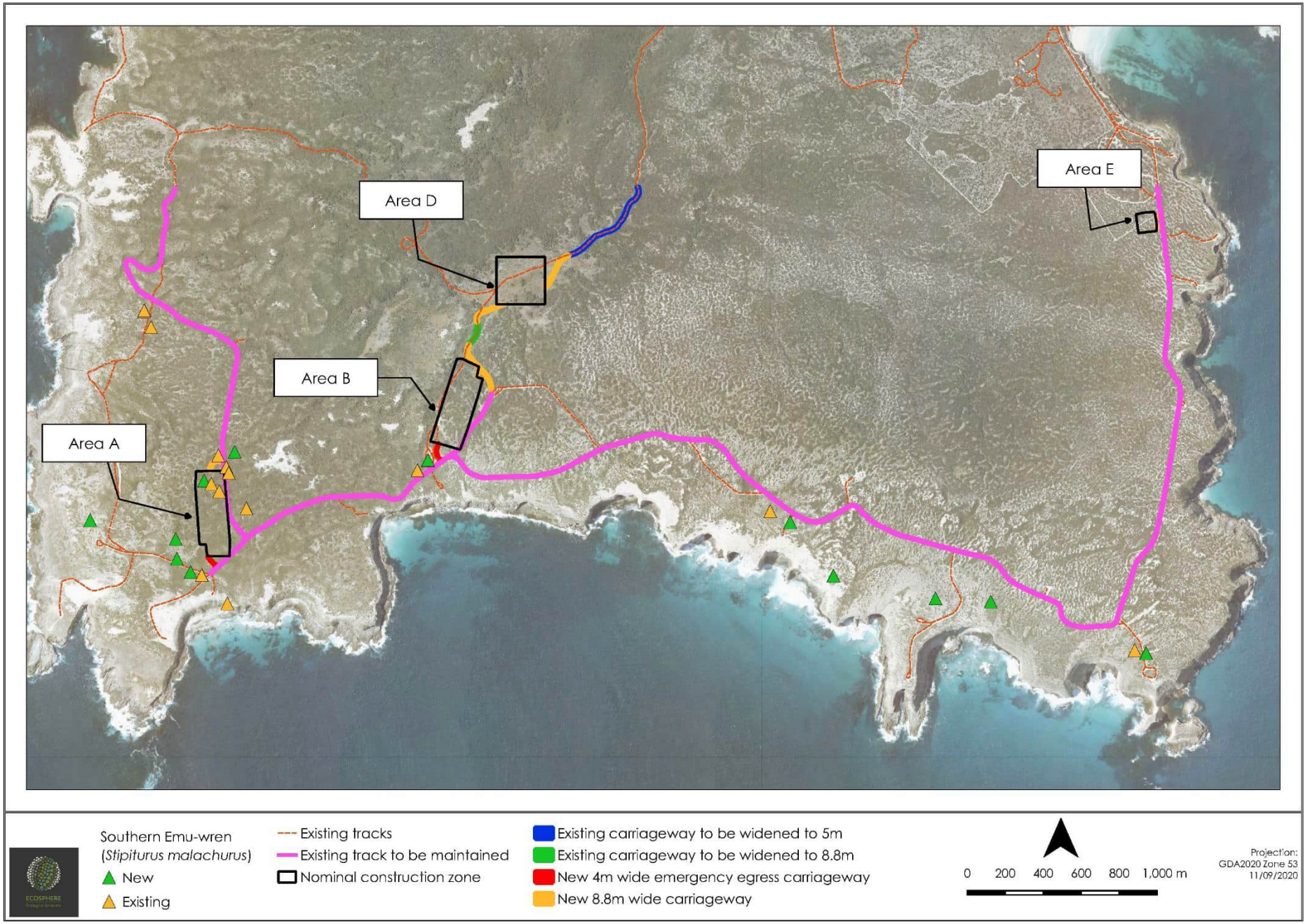

Figure 3. Locations of pre-existing records (amber) and new June 2020 records (green) for Southern Emu-wren.

Figure 4. Male Southern Emu-wren photographed near Groper Bay in coastal heath.
Photo: Rob Kelman.

4.1.1 Critical habitats

The critical habitat where pre-existing and updated/new observations occurred was Low Coastal Shrubland dominated by *Acrotriche patula* (Prickly Ground berry), *Beyeria lechenaultii* (Coastal Turpentine bush) (Vegetation association 1 in AECOM 2020) and *Callitris* sp. 'Limestone' (Native Pine) (Vegetation association 6 in AECOM 2020) with an average height of 500 mm. This often occurred with a tapestry of sparse (10-15%) cover of very low *Eucalyptus diversifolia* (Coastal White Mallee). This habitat was further enhanced if the shrubs present were 'wind hedged' into a very tight canopy cover enabling the individuals to move through the area without being sighted as in Figure 5 below where a dense canopy cover existed. No records were observed where the vegetation exceeded an average height of 1.5 m.

Figure 5. Southern Emu-wren critical habitat where pre-existing record confirmed at Point du Bastion.

4.1.2 Distribution

Based on the availability of habitat it was expected that groups/individuals inhabit the entire coastal strip from Point du Bastion, west to Redbanks and beyond (Figure 5), linking with the Cathedral Rocks Wind Farm records which conforms with Pickett (2006). Almost all records

occurred within 200-800 m distance from the cliff edge although some records were as little as 115 m from the cliff edge and the average occurrence around 300 m from the cliff edge.

The large majority of the pre-existing records were in the Cape Carnot area and this was consistent with the current survey (Figure 3). This area has a lower elevation than the eastern section and is more exposed to prevailing south-westerly winds in winter and southerly winds in summer. As a result, the south-western corner of Whalers Way associated with Cape Carnot has the highest frequency and broadest geographical section of critical habitat.

4.1.3 Current Status

Based on the broadscale assessment where records were spaced at an average of 300-400 m intervals on average, each containing on average 2 individuals, over the approximately 7.5 km length of the coastal strip and allowing for missed records and areas of higher density, it would be difficult to acknowledge that many more than 100 mature individuals inhabit the Whalers Way area in total.

It is unknown how effectively males are able to disperse within Whalers Way however one male Southern Emu-wren near Point du Bastion was observed traversing the access road of 8 m width, and demonstrated the ability to fly approximately 10-12 m on that occasion.

4.2 Western Whipbird (eastern)

The occurrence of Western Whipbird (eastern) (*Psophodes leucogaster leucogaster)* within the Project site was relatively widespread (Figure 6). Seven individual records were recorded by GPS (Table 3) however the number of birds observed by call outweighed these records significantly. It was difficult to confirm unique records as the calls were frequent and carry a significant distance. Records were therefore spaced sufficiently to avoid multiple records of the same individual unless two birds could be clearly identified as individuals calling simultaneously. Attempts to obtain a photograph of the Western Whipbird were unrewarded with a single brief sighting of a bird crossing the road.

Table 3. Western Whipbird new observations recorded June 2020.

Name	Comment	Ind. Observed	UTM Zone 53H	
			Easting	Northing
WWWWB1	Two birds responding to each other's call	2 (song)	557618	6134086
WWWWB2	Single bird calling	1 (song)	557177	6134694
WWWWB3	Single bird calling near project site footprint	1 (song)	560317	6133916
WWWWB4	Single bird calling near project site footprint	1 (song)	560422	6134448
WWWWB5	Single bird calling recorded during SEW survey	1 (song)	560896	6133755
WWWWB6	Single bird calling near project site footprint	1 (song)	562470	6135285
WWWWB7	Single at road edge brief sighting	1 (sighting)	557241	6134935

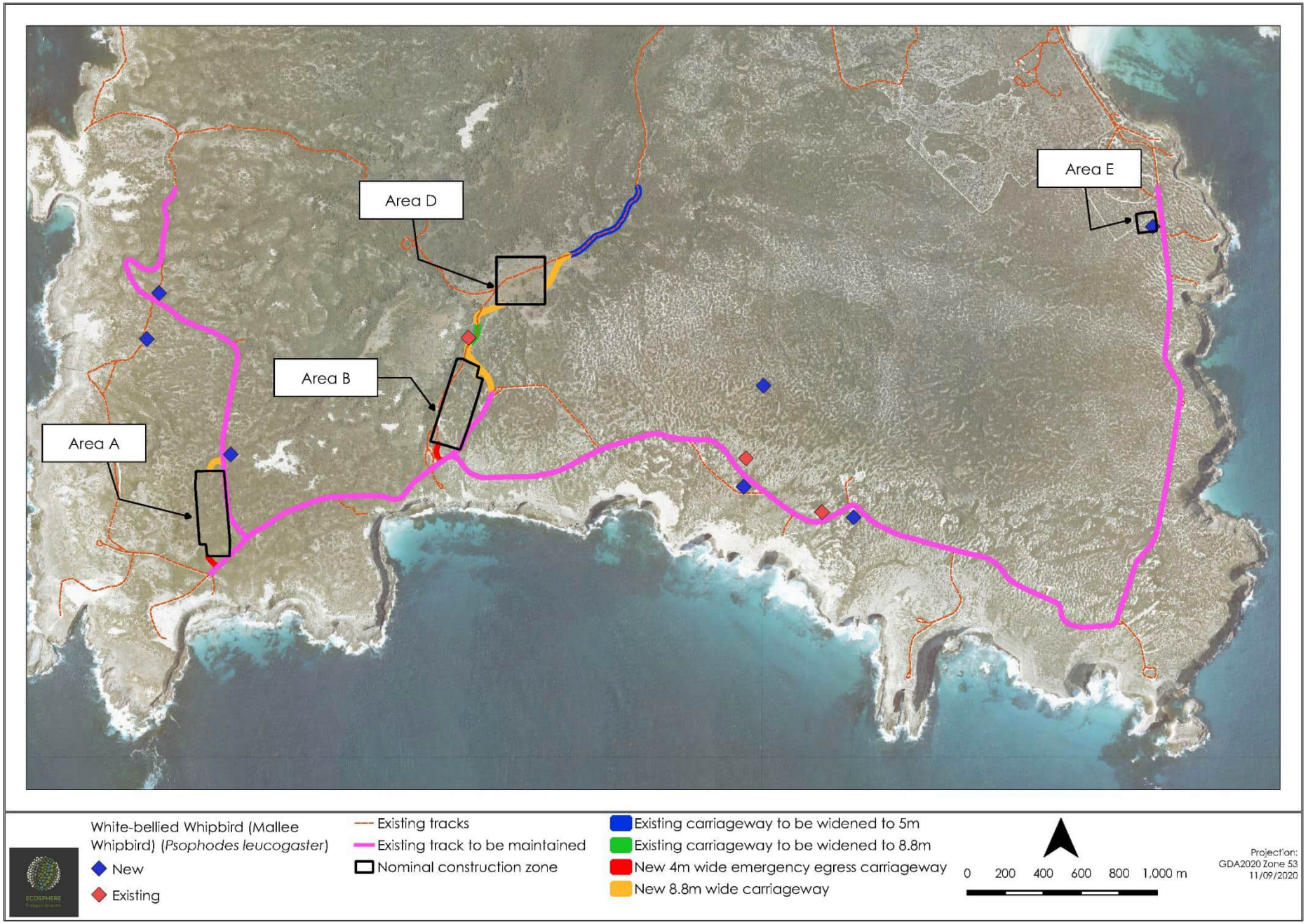

Figure 6. Locations of pre-existing records (red) and new June 2020 records (blue) for Western Whipbird.

4.2.1 Critical habitats

The critical habitat of the Western Whipbird (eastern) within Whalers Way was confirmed as low Mallee, generally either mixed *Eucalyptus diversifolia* (Coastal White Mallee) or *Eucalyptus angulosa* (Ridge-fruited Mallee)(Vegetation associations 3 and 4 in AECOM 2020) with an average height of 1.5-2 m with an open understorey of low shrubs or patches broken by areas of low shrubland (Figure 7). Where records were observed, it was often difficult to traverse through the vegetation due to the density of the canopy.

Figure 7. Typical Low Mallee habitat where Western Whipbird was recorded at Whalers Way.

4.2.2 Distribution

The Western Whipbird (eastern) was widely distributed across the Project site (Figure 6) and were recorded at all targeted infrastructure sites. Based on AECOM 2020, a generous proportion of the Project site footprint includes these vegetation associations. The Native Vegetation Floristic Areas -

NVIS - Statewide mapping data indicates that approximately 50% of the Project site is occupied by *Eucalyptus* mid Mallee woodland \ *Melaleuca* shrub \ *Correa* shrub (DEW 2011).

4.2.3 Status

As it is unknown whether calls are made by numerous individuals or dominant birds moving over wide areas, it is difficult to estimate the populations of individual birds present. Based on the call frequency, it appeared that there were numerous birds, spread over a wide area.

5 Conclusion

The results of the survey confirmed the presence of both Southern Emu-wren and Western Whipbird within the Project site. It also confirmed that the pre-existing records remain current and consistent with the 2020 findings in terms of distribution and frequency.

The Southern Emu-wren is likely to inhabit all areas where critical habitat exists, accounting for the coastal strip from the cliff edge to an average of 300 +/- 150 m inland. The exception to this was the Cape Carnot area where records exist within a 1500 m radius of the Cape. The Cape Carnot area had the highest number and density of birds based on pre-existing and new records confirmed. Despite this, the critical habitat is poorly represented within Whalers Way as a percentage of the overall area.

Western Whipbird (eastern) was inconspicuous by physical presence but gave itself away by the distinctive call and vocal nature of the species. Western Whipbird was observed frequently during targeted surveys however it was not known whether this was single individuals calling across wide areas or numerous individual birds within smaller territories. This species was however recorded within the most dominant vegetation associations as mapped in AECOM (2020) and as described in the Native Vegetation Floristic Areas - NVIS – Statewide across the Project site.

To further document and more accurately assess for the population extent and distribution of both species would require many weeks of field survey work which may result in significant disturbance and disruption to normal behaviour. What is inconclusive is the potential impacts of further fragmentation and disturbance that is associated with the construction, infrastructure upgrades and operation of the project. In the first instance, it is recommended that avoidance of all critical habitat for Southern Emu-wren is prioritised due to the low distribution and narrow band of habitat available. No recommendations are made with regard to the Western Whipbird due to the extensive nature of preferred habitat within Whalers Way based on Project site footprint mapping, NVIS mapping and personal observation.

6 References

AECOM Australia (2020) Whalers Way Orbital Launch Complex Flora and Fauna Assessment and Preliminary Impact Assessment. Report to Southern Launch.

Bureau of Meteorology (2020) Port Lincoln, South Australia June 2020 Daily Weather observations. <http://www.bom.gov.au/climate/dwo/202006/html/IDCJDW5055.202006.shtml>

Department of Agriculture, Water and the Environment (DAWE) (2020) Species Profile and Threats Database *Psophodes leucogaster leucogaster* — Mallee Whipbird. SPRAT Profile Online resource viewed 1 July 2020. <http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81025>

Department of Agriculture, Water and the Environment (2020) Species Profile and Threats Database *Stipiturus malachurus parimeda* – Southern Emu-wren - Eyre Peninsula. SPRAT Profile Online resource viewed 1 July 2020. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26006

Department for Environment and Water (2011) Native Vegetation Floristic Areas - NVIS - Statewide (Incomplete Version).

Department of Environment Water Heritage and Agriculture (2010) Survey guidelines for Australia's threatened birds Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999

Department of the Environment (DotE) (2013). Approved Conservation Advice for *Stipiturus malachurus parimeda* (Southern Emu-wren - Eyre Peninsula). Canberra: Department of the Environment.

Pickett, M. (2006) Habitat Management Guidelines for the Eyre Peninsula Southern Emu-wren. Department for Environment and Heritage, PO Box 22 Port Lincoln SA 5606. October 2006.

Appendix B

Targeted Survey for Southern Emu-wren (Eyre Peninsula) and Mallee Whipbird – Relocation of Launch Site A 2021

Revision 9 – 03-Aug-2022
Prepared for – Southern Launch – ABN: 33 621 420 504

ECOSPHERE
Ecological Solutions

Whalers Way Orbital Launch Complex

Targeted Avian Assessment December 2021- Launch Pad A Options

February 2022

Document information and distribution

Document information	
Item	Detail
Project number	-
Document title	Whalers Way Orbital Launch Complex Targeted Avian Assessment Launch Pad Options
Client	Southern Launch
Prepared by	Marina Louter, Andrew Sinel
Reviewed by	Matt McDonnell
Review date	20/01/2022
Document status	Draft
Version number	3

Document distribution				
Authors	Document status	Version no	Date of issue	Issued to
M Louter	Draft V1	1	18/01/2022	Matt McDonnell, AECOM
M Louter	Draft V2	2	21/01/2022	Matt McDonnell, AECOM
M Louter	Final	3	03/02/2022	Matt McDonnell, AECOM
M Louter	Final (updated)	4	04/02/2022	Matt McDonnell, AECOM

Acronyms and definitions

Abbreviation	Description
AECOM	AECOM Australia Pty Ltd
ARU's	Autonomous Recording Unit
BOM	Bureau of Meteorology
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPSEW	Eyre Peninsula Southern Emu-wren
GPS	Global Positioning System
km	Kilometre(s)
NPW Act	*National Parks and Wildlife Act 1972*
Project	The proposed WWOLC
Project Area	The key infrastructure component of WWOLC, as described in Section 1.2
SA	South Australia(n)
Southern Launch	Southern Launch Space Pty Ltd
sp.	Species
spp.	Species (plural)
ssp.	Sub-species
unk	Unknown
WBWB	White-bellied Whipbird
WWOLC	Whalers Way Orbital Launch Complex

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1 Introduction

1.1 Background

Southern Launch Space Pty Ltd (Southern Launch) is proposing to construct the Whalers Way Orbital Launch Complex (WWOLC – the Project). The WWOLC is proposed to be situated at the tip of the Eyre Peninsula in South Australia, at Whalers Way, and is to be built as an orbital rocket launch facility. Southern Launch intend to establish infrastructure that will support the launch of domestic and international launch vehicles.

The current development proposal for the WWOLC is anticipated to be undertaken in four phases between 2022 and 2025. Two launch sites (Launch Site A and Launch Site B) are proposed containing a range of elements and structures and will provide integrated, and largely self-contained facilities for the assembly, preparation, staging and launch of the various vehicles to be launched from the WWOLC. An Infrastructure Site (Site D) will contain Infrastructure facilities including a dam, magazine, and ancillary storage facilities. A permanent range control facility (Site E) which will provide facilities for launch control, range control, security, office, administration, and visitor facilities.

The primary avian species of concern within the Whalers Way area are the Nationally threatened Eyre Peninsula Southern Emu-wren (EPSEW) *Stipiturus malachurus parimeda* and the White-bellied Whipbird (naming as per suggestions by Burbidge *et. al* 2017) (WBWB) also known as Mallee Whipbird *Psophodes leucogaster leucogaster*. Both these species have historical and recent observations and suitable habitat within and surrounding the Project Area.

1.2 The Project Area

Proposed Launch Site B and Infrastructure Site D (workshop area) are positioned in an area that was previously used for recreation and tourism purposes. This site is designed as a rocket launch facility sited and designed to support small lift launch vehicles with sizes from micro to small conventional (less than 10 tonnes up to approximately 60 tonnes). It is located in an area with existing tracks and relatively open areas of vegetation(see Ecosphere 2022 for details). Vegetation in this area has been mapped by Ecosphere and the condition of vegetation has been assessed as relatively poor with weed species present (see Ecosphere 2022 for details). Given the type and condition of the vegetation it is deemed there is a low likelihood that EPSEW and WBWB are present within these two areas.

As part of the project design, multiple location options for Launch Site A have been proposed. The infrastructure and 5 location options for the proposed Launch Site A (hereafter referred to as the Project Area) are presented in Figure 1 below.

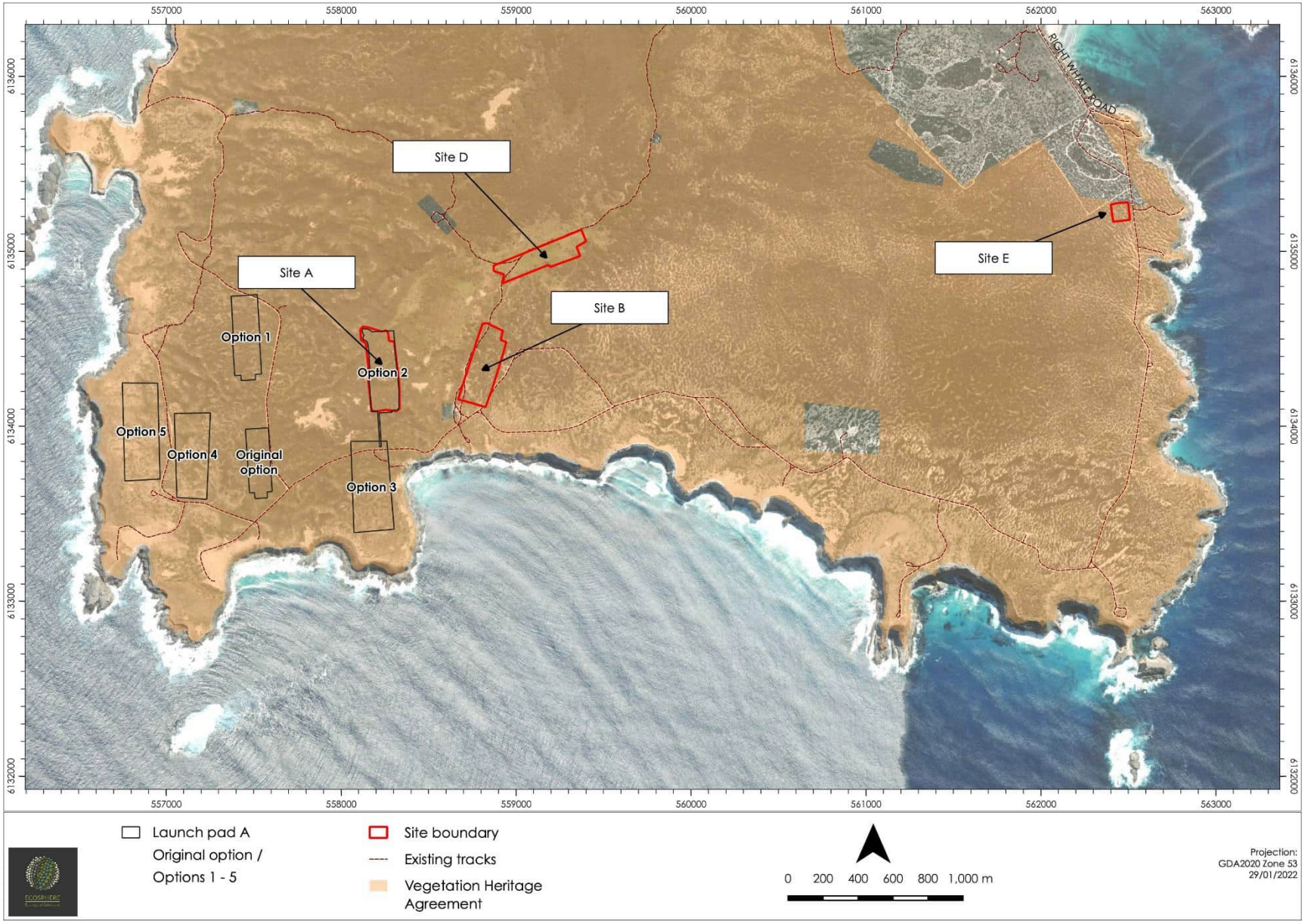

Figure 1. Location of multiple options for Launch Site A at Whalers Way, including the original option.

1.3 Previous works

An EPBC Self-assessment and EPBC Referral (EPBC Ref: 2021/9013) were prepared for the Project by AECOM (2021a, b) and the Environmental Impact Statement (EIS) that was prepared for the Project details the site (Southern Launch 2020). Native vegetation has been assessed and targeted bird surveys have been undertaken for the proposed Project.

Both EPSEW and WBWB have been observed at the Whalers Way site of the Project in 2020 during a baseline vegetation survey and a subsequent targeted bird survey (Ecosphere Ecological Solutions 2020a,b). A site selection survey was undertaken in June 2021(Ecosphere Ecological Solutions 2021) to set up EPSEW and WBWB impact (Whalers Way) and control (Lincoln National Park) monitoring sites to be used for avian monitoring. Following the site selection survey, targeted avian surveys for EPSEW and WBWB were undertaken before and after Test Launch 1(Ecosphere Ecological Solutions– *in draft*).

The previous surveys undertaken by Ecosphere at Whalers Way identified 20 individual EPSEW sites (14 monitoring sites and 6 opportunistic sites) and 19 individual WBWB sites (13 Monitoring sites and 6 opportunistic sites), as detailed in Figure 2 and Figure 3 on the next page. In addition to the 2020-2021 data, historical EPSEW (13 records) and WBWB (9 records) observations within Whalers Way are presented in Figure 2 and Figure 3.

Refer to the following ecological reports for more details:

- AECOM Australia (2020). Whalers Way Orbital Launch Complex Flora and Fauna Assessment and Preliminary impact Assessment. Report to Southern Launch.
- AECOM Australia (2021a). EPBC Self-assessment. Report to Southern Launch.
- AECOM Australia (2021b). EPBC Referral. Report to Southern Launch.
- AECOM Australia (2021c). Whalers Way Test Launch September 2021 - Acoustic review. Report to Southern Launch.
- Ecosphere Ecological Solutions Pty Ltd (2020). *Broadscale Distribution and Status of the Eyre Peninsula Southern Emu-wren (Stipiturus malachurus parimeda) and Western Whipbird (eastern) (Psophodes leucogaster leucogaster) at Whalers Way, June 2020*. Report to Southern Launch.
- Ecosphere Ecological Solutions Pty Ltd (2021). *Whalers Way Orbital Launch Complex. Test Launch Campaign - Site Selection survey*. Report to Southern Launch.
- Ecosphere Ecological Solutions Pty Ltd (2022a – *in draft*). *Whalers Way Orbital Launch Complex. Test Launch Campaign – Avian Survey Report Test Launch 1*. Report to Southern Launch.

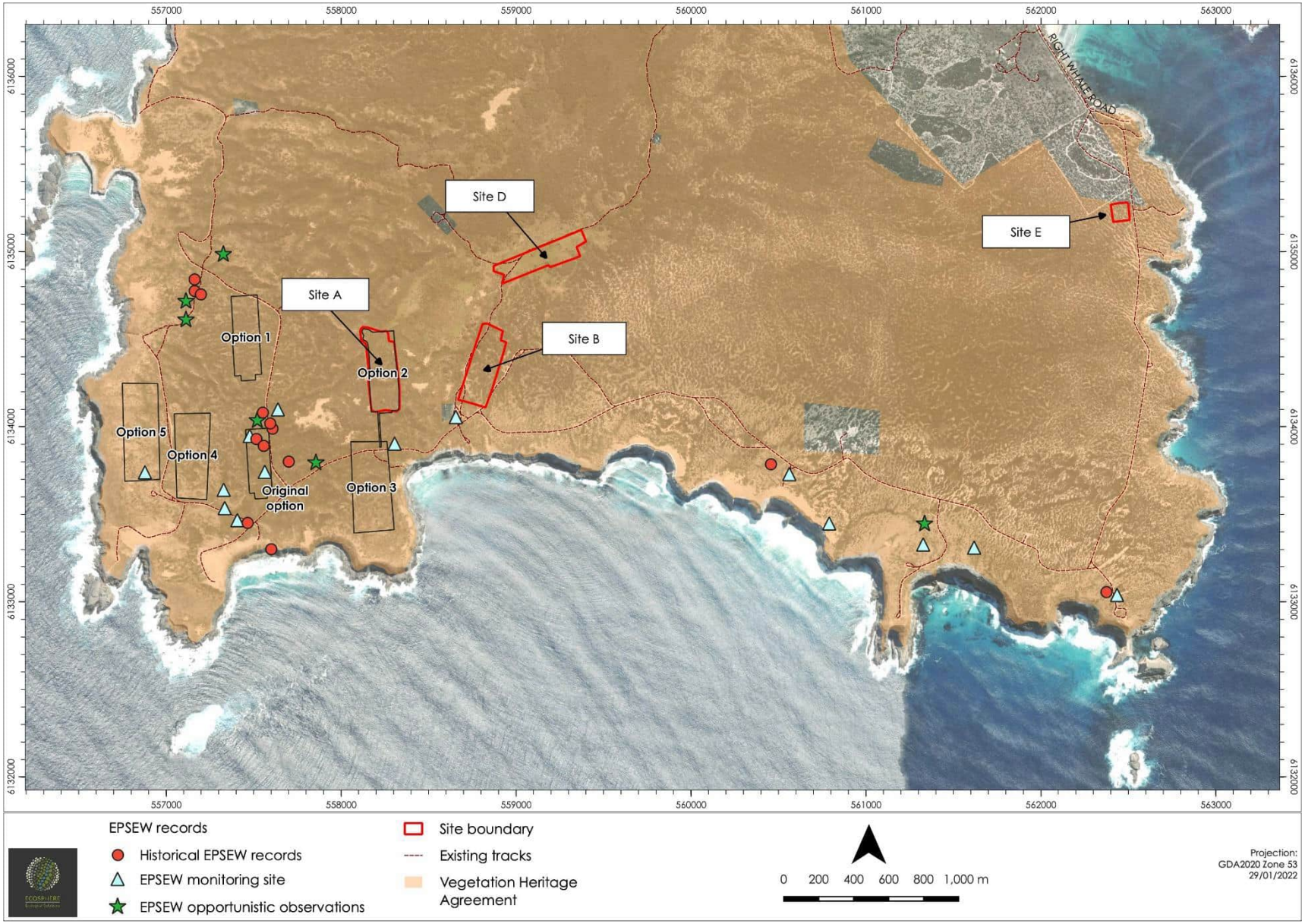

Figure 2. Location of EPSEW monitoring sites, opportunistic observations, and historical records within Whalers Way.

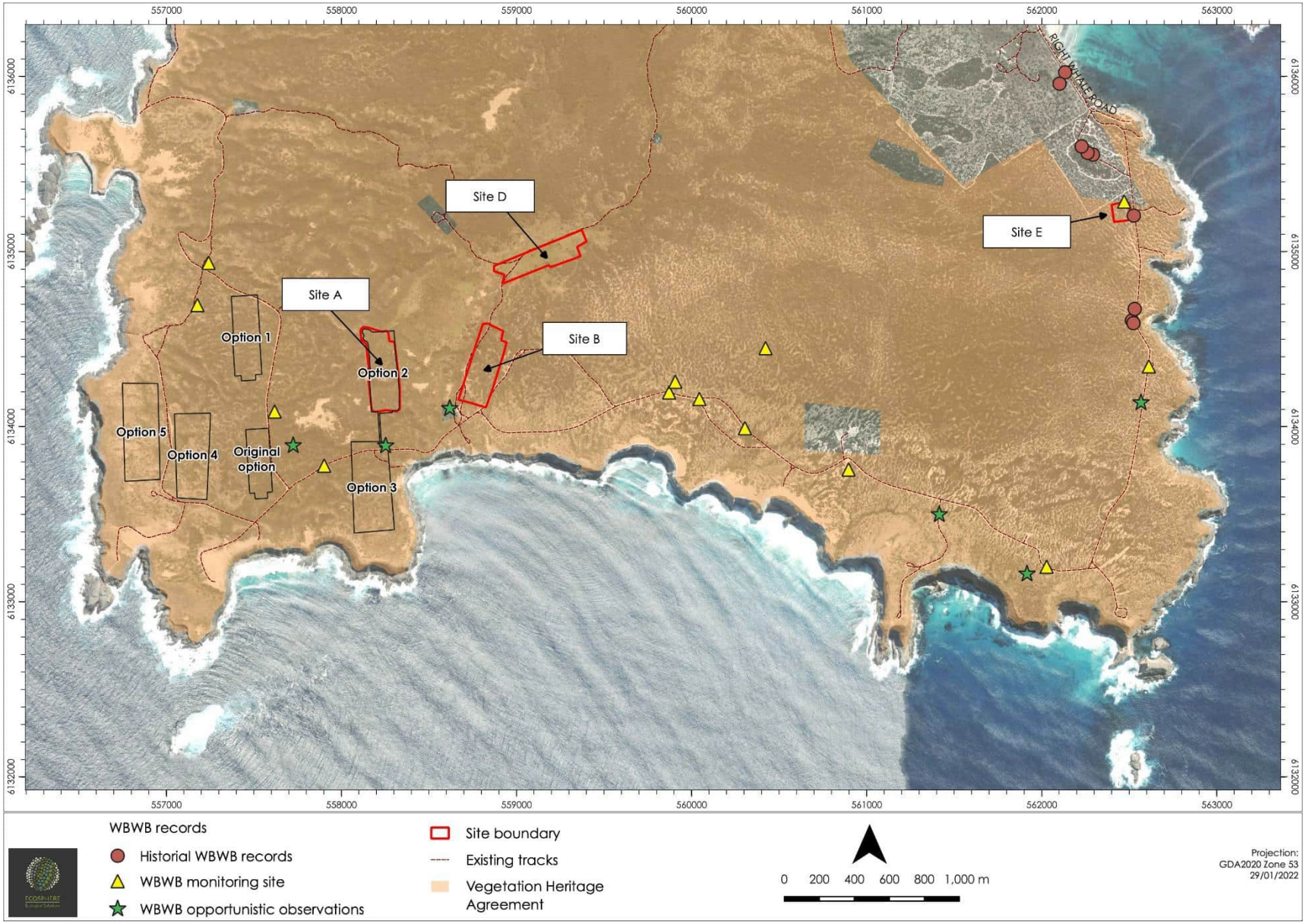

Figure 3. Location of WBWB monitoring sites, opportunistic observations, and historical records within Whalers Way.

The results from the Site Selection Survey and Test Launch 1 of the Test Launch Campaign indicated that the original location option for Launch Site A (as per Figure 1) contained a high number of EPSEW and it was inferred that the habitat within the original location for Launch Site A is critical habitat for this species (Ecosphere 2020).

Based on this information, and EIS submissions from both the public and State Government agencies, Southern Launch determined to undertake a further targeted bird survey for both the EPSEW and WBWB at multiple site options for Launch Site A with the aim to locate a site to minimise impacts to both EPSEW and WBWB as much as possible, with consideration of other constraints such as heritage, launch trajectories etc.

1.4 Objectives

This report details the results of the targeted avian assessment undertaken in December 2021. The overall aim of the targeted survey was to verify the presence of EPSEW and WBWB within multiple location options for Launch Site A.

The specific objectives were to:

- Undertake on ground avian surveys at Launch Site A options (using previously utilized survey methods) to verify the presence and abundance of EPSEW and WBWB within each site;
- Map EPSEW and WBWB sites in relation to the location options for Launch Site A; and
- Report the findings in a short summary report.

The information presented in this report can be used to provide direction on the preferred location for Launch Site A from an ecology perspective (as per Figure 1).

2 Methods

The targeted survey undertaken in December 2021 was conducted utilising methods consistent with Birdlife Australia Systematic Bird surveys (2-ha, 20 minute search) (Birdlife 2021a), recommended survey method (as per the Guidelines for Detecting Birds Listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010 – see Appendix 1) and Department of Environment and Water (DEW) biological survey methods (Heard and Channon 1997; Owens 2000).

Field surveys were conducted under the following research and ethics permits/licenses:

- Scientific Research Permit No. E27057-1 (Department for Environment and Water);
- Wildlife Ethics Committee (WEC) Approval No. 6/2021, (Wildlife Ethics Committee); and
- Scientific Licence No. 370 (Animal Welfare, National Parks and Wildlife SA).

2.1 Timing of events

The targeted avian survey was undertaken by two ecologists over 2 days, on 16 and 17 December 2021.

2.2 Climate and weather conditions

Port Lincoln is the nearest weather station with historical climate data for comparative purposes (station 018192, open since 1992). Weather conditions during the targeted avian survey period were considered suboptimal for avian surveys (Table 1). Maximum temperatures reached 37.7 C on 17 December 2021 and the coolest minimum reached 10.5 C on 16 December 2021. Strong winds and gusts of up to 67 km/hour were recorded during the survey period. The morning and late afternoon of 16 December were suitable to survey for the presence of EPSEW and WBWB, but survey conditions were more challenging in the afternoon of 17 December, with high temperatures and strong winds.

Table 1. Weather variables during the Pre-launch avian survey, as recorded at Port Lincoln weather station (BOM 2021).

Date	Min air temp (degrees °C)	Max air temp (degrees °C)	Rainfall (mm)	Max wind gust			9 am			3 pm		
				Direction	Speed (km/h)	Time (local)	Temp (degrees °C)	Direction	Speed	Temp (degrees °C)	Direction	Speed
16 Dec 2021	10.5	25.3	0.0	E	26	08:51	19.6	E	15	23.9	ENE	17
17 Dec 2021	13.6	37.7	0.0	W	67	13:03	23.6	NE	19	28.8	W	37

2.3 Avian surveys

Survey methods consisted of (1) active searches surveys (20min/2ha) and (2) playback experiments. Both these methods have been previously described in detail in Ecosphere (2022a).

2.4 Site photos

Up to 6 site photos were taken at each of the assessed Launch Site A options to capture vegetation throughout each site. For each photo a GPS point and the direction of the photo was recorded.

2.5 Limitations

Avian survey data collected for was limited to a 2-day period, and thus only represent a snapshot of current conditions at the time of the survey. Seasonality and variation in local weather conditions may impact on avian survey results as birds are generally less active in the nonbreeding season and when climatic conditions are challenging (i.e. low/high temperatures, strong winds/rain).

The result detailed in this report consist of descriptive statistics (i.e. not inferential statistics) that display and summarize the avian observations and data collected at specific sites at a given point in time. This data sample is limited to those specific sites and cannot be used to infer the presence of the focal species within the broader area of Whalers Way.

Vegetation on site was photographed, but not assessed in detail. As such, variation in vegetation communities and flora species diversity within and between Launch Site A options was not recorded as part of the scope of this report.

3 Results

A total of eight 20min/ha surveys (2 per Launch Site option) and thirty (30) Playback experiments were undertaken during the December 2021 targeted survey, consisting of 17 EPSEW and 13 WBWB playback experiments.

3.1 Bird diversity within the Launch Site A options

Bird diversity (the number of avian species observed at a site, as recorded during 20min/ha surveys) varied between mornings and afternoons and was generally higher in the morning, when birds are generally more active. Bird diversity varied per site, with the highest number of avian species observed at Launch Site A location options 2 and 3, and the lowest at Launch Site A locations 4 and 5 (Table 2).

Table 2. Overview of the 20min/ha surveys results of the survey at Whalers Way in December 2021.

Launch Site A	Date	Morning/afternoon	Bird Diversity (number of avian species) (20 min/ha)
Option 2	16/12/2021	Morning	10 species
	17/12/2021	Morning	12 species
Option 3	16/12/2021	Afternoon	5 species
	17/12/2021	Morning	11 species
Option 4	16/12/2021	Afternoon	4 species
	17/12/2021	Morning	4 species
Option 5	16/12/2021	Afternoon	4 species
	17/12/2021	Morning	6 species

3.2 EPSEW and WBWB presence within the Launch Site A options

Of the 17 EPSEW playback experiments, EPSEW were present at 6 sites. Of the 13 WBWB playback experiments, WBWB were present at 5 sites (Table 3 and Figure 4).

A minimum of 10 EPSEW was observed at the location options for Launch Site A at Whalers and minimum of 5 WBWB was observed/heard at the location options for Launch Site A at Whalers Way Location details and observations details of each playback experiment are presented in Table 4.

Survey results per Launch Site A options are described in Section 3.3.

Table 3. Overview of the 30 playback experiment results at Whalers Way in December 2021.

Launch Site A	Date	Number of playback experiments	EPSEW not detected	EPSEW detected	WBWB not detected	WBWB detected
Option 2	16/12/2021	4		2		2
	17/12/2021	4	2		2	
Option 3	16/12/2021	4	2		2	
	17/12/2021	6	1	2		3
Option 4	16/12/2021	4		2	2	
	17/12/2021	4	3		1	
Option 5	16/12/2021	2	2			
	17/12/2021	2	1		1	
TOTALS		**30 playbacks**	**11 playbacks**	**6 playbacks**	**8 playbacks**	**5 playbacks**

Table 4. Observations of EPSEW and WBWB at launch site A options at Whalers Way in December 2021.

	Date	Time	Location	Description	GPS Location	Observations	Comments
1	17-Dec-21	11:31	Option 2	Option 2 - North	53 H 0558216 6134370	no focal birds observed/heard	
2	17-Dec-21	11:37	Option 2	Option 2 - North	53 H 0558216 6134370	no focal birds observed/heard	
3	16-Dec-21	10:43	Option 2	Option 2 - Middle	53H 0558216 6134253	1 EPSEW	Strong response, male only seen, heard first.
4	16-Dec-21	10:54	Option 2	Option 2 - Middle	53H 0558216 6134253	at least 1 WBWB present	No response to playback, but whipbird present (heard).
5	17-Dec-21	12:00	Option 2	Option 2 - North	53 H 0558137 6134557	no focal birds observed/heard	Fairy wren came into PB, but no response of focal bird, no birds seen or heard before playback.
6	17-Dec-21	12:05	Option 2	Option 2 - North	53 H 0558137 6134557	no focal birds observed/heard	
7	16-Dec-21	11:25	Option 2	Option 2 - South	53 H 0558244 6134065	2 EPSEW	Strong response, pair seen
8	16-Dec-21	11:34	Option 2	Option 2 - South	53 H 0558244 6134065	at least 1 WBWB present	No response to playback, but whipbird present (heard).
9	16-Dec-21	13:50	Option 3	Option 3 - Middle	53 H 0558164 6133663	no focal birds observed/heard	
10	16-Dec-21	13:59	Option 3	Option 3 - Middle	53 H 0558204 6133557	2 EPSEW	Pair agitated and strong vocal response, but birds did not cross an open area.
11	17-Dec-21	7:33	Option 3	Option 3 - Middle	53 H 0558164 6133663	no focal birds observed/heard	
12	17-Dec-21	7:07	Option 3	Option 3 - North	53 H 0558249 6133774	no focal birds observed/heard	
13	17-Dec-21	7:15	Option 3	Option 3 - North	53 H 0558125 6133678	1 EPSEW	1 bird only responded.
14	17-Dec-21	8:20	Option 3	Option 3 - North	53 H 0558249 6133774	at least 1 WBWB present	No response to playback, but whipbird present (heard).
15	17-Dec-21	8:27	Option 3	Option 3 - North	53 H 0558125 6133678	at least 1 WBWB present	No response, but whipbird heard and present in general area (heard).
16	16-Dec-21	13:30	Option 3	Option 3 - South	53 H 0558197 6133518	no focal birds observed/heard	
17	16-Dec-21	13:35	Option 3	Option 3 - South	53 H 0558197 6133518	no focal birds observed/heard	
18	17-Dec-21	7:55	Option 3	Option 3 - South	53 H 0558162 6133424	at least 1 WBWB present	2 songs heard, but did not come to playback at all.
19	17-Dec-21	9:40	Option 4	Option 4 - East	53 H 0557126 6133837	no focal birds observed/heard	
20	16-Dec-21	15:35	Option 4	Option 4 - Middle	53 H 0557214 6133904	2 EPSEW	Strong response, female called first, pair seen, no song.
21	16-Dec-21	15:40	Option 4	Option 4 - Middle	53 H 0557105 6133745	no focal birds observed/heard	
22	17-Dec-21	9:29	Option 4	Option 4 - Middle	53 H 0557214 6133904	no focal birds observed/heard	
23	17-Dec-21	9:32	Option 4	Option 4 - Middle	53 H 0557105 6133745	no focal birds observed/heard	
24	16-Dec-21	15:39	Option 4	Option 4 - North	53 H 0557093 6133992	2 EPSEW	Response, but birds never came into the speaker. Likely 2 birds, but only one clearly seen.
25	16-Dec-21	16:06	Option 4	Option 4 - North	53 H 0557078 6134004	no focal birds observed/heard	
26	17-Dec-21	9:54	Option 4	Option 4 - North	53 H 0557093 6133992	no focal birds observed/heard	
27	16-Dec-21	14:49	Option 5	Option 5 - Middle	53 H 0556837 6133861	no focal birds observed/heard	
28	17-Dec-21	13:13	Option 5	Option 5 - North	53 H 0556894 6134119	no focal birds observed/heard	
29	17-Dec-21	13:18	Option 5	Option 5 - North	53 H 0556894 6134119	no focal birds observed/heard	
30	16-Dec-21	15:02	Option 5	Option 5 - South	53 H 0556899 6133726	no focal birds observed/heard	

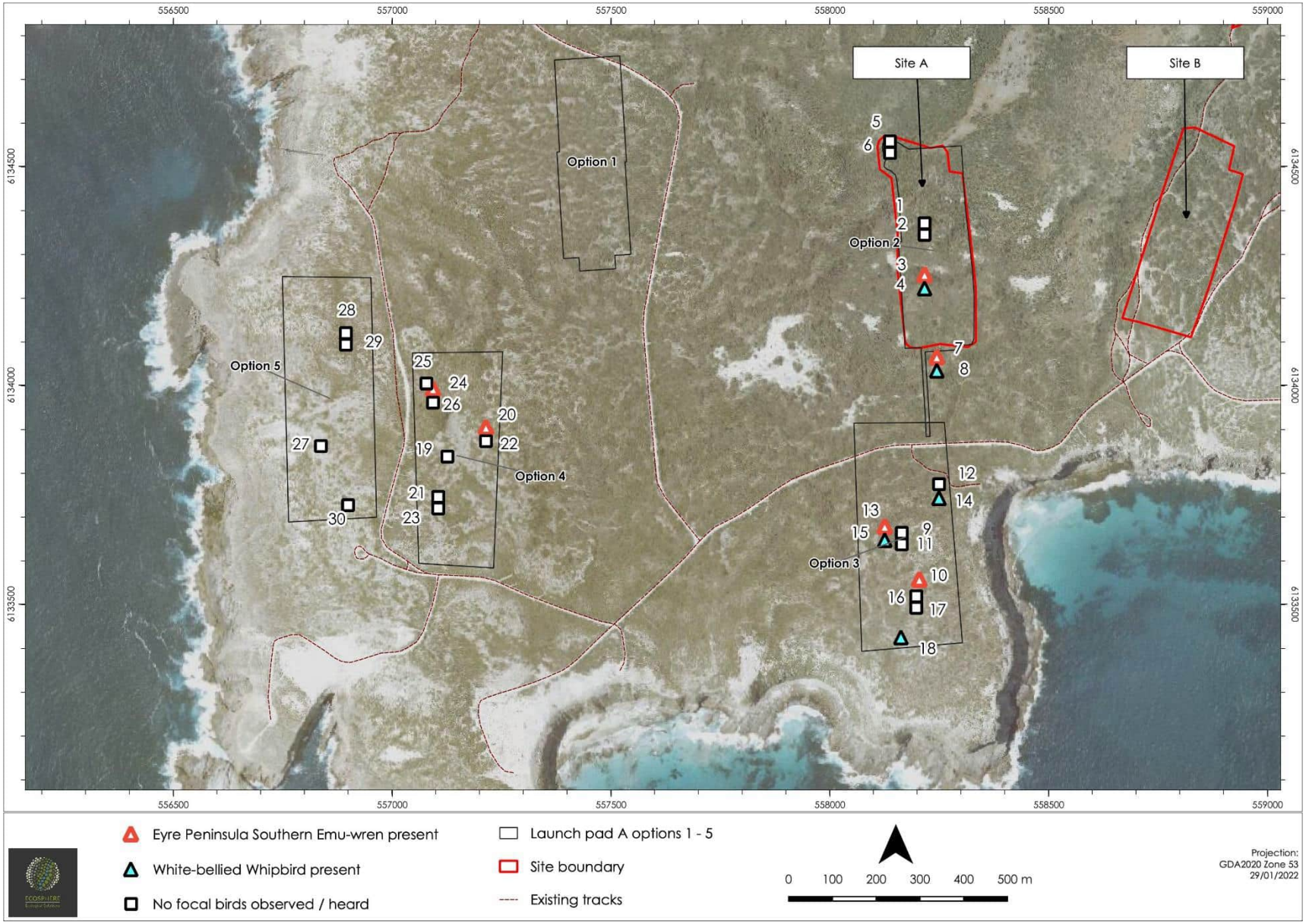

Figure 4. Location of the 30 playback experiments undertaken at Whalers Way in December 2021.

3.3 Launch site A - location options

3.3.1 Launch Site A - option 1

Launch Site A option 1 is located in the North-Eastern Section of the Project Area (Figure 1). Option 1 was not surveyed for the presence of EPSEW and WBWB as this site has known heritage constraints. As such Launch Site A option 1 is not further discussed in this report.

3.3.2 Launch Site A - option 2

Launch site A option 2 is located directly west of Launch Site B (Figure 1). A total of 8 playback experiments were undertaken at 4 locations within this location, consisting of 4 EPSEW and 4 WBWB playbacks. At 2 locations (in the centre and southern end of the site), both EPSEW and WBWW were recorded. The two focal species were not recorded in the northern section of the site (Figure 4).

3.3.3 Launch Site A - option 3

Launch Site A option 3 is located directly south of Launch Site A option 2 (Figure 1). A total of 10 playback experiments were undertaken within Launch Site A option 3, consisting of 6 EPSEW and 4 WBWB playbacks. EPSEW and WBWW were recorded at 5 locations throughout the site (Figure 4).

3.3.4 Launch site A - option 4

Launch Site A option 4 is located in the Western Section of Whalers Way (Figure 1). A total of 8 playback experiments were undertaken within Launch Site A option 4, consisting of 5 EPSEW and 3 WBWB playbacks. EPSEW were recorded at 2 locations within the site. No WBWB were recorded at this location (Figure 4).

3.3.5 Launch site A - option 5

Launch Site A option 5 is located in the most Western Section of the Whalers Way, close to the coast (Figure 1). A total of 4 playback experiments were undertaken within this location, consisting of 2 EPSEW and 2 WBWB playbacks. No EPSEW and WBWW were recorded at this site during the December 2021 survey (Figure 4). However, EPSEW have been detected in the most southern end of the site during previous surveys (see Figure 2).

3.4 Site photos

Site photos of launch site A options 2 - 5 are presented below.

Site photos Launch Site A - option 2

Direction: West
GPS: 53H 0558209 6134067

Direction: North
GPS: 53H 0558214 6134106

Direction: South
GPS: 53H 0558216 6134253

Direction: East
GPS: 53H 0558216 6134253

Direction: South
GPS: 53H 0558235 6134502

Direction: South
GPS: 53 H 0556250 6134254

Site photos Launch Site A - option 3

Direction: South
GPS: 53H 0558259 6133851

Direction: North
GPS: 53H 0558161 6133618

Direction: South
GPS: 53H 0558168 6133395

Direction: North-East
GPS: 53H 0558249 6133774

Direction: North-East
GPS: 53H 0558204 6133557

Direction: North-East
GPS: 53H 0558201 6133403

Site photos Launch Site A - option 4

Direction: East
GPS: 53H 0557214 6133904

Direction: South
GPS: 53H 0557140 6133959

Direction: NN-East
GPS: 53H 0557105 6133745

Direction: East
GPS: 53H 0557077 6133362

Direction: North
GPS: 53H 0557150 6133776

Direction: East
GPS: 53H 0557126 6133837

Site photos Launch Site A - option 5

Direction: South
GPS: 53H 0556827 6134215

Direction: South-East
GPS: 53H 0556845 6134004

Direction: North
GPS: 53H 0556905 6133709

Direction: South-West
GPS: 53H 0556905 6134183

Direction: East
GPS: 53H 0556894 6134119

4 Discussion

Bird diversity was considered to be variable between sites, with a low number of bird species observed at option 4 and option 5 and higher number of species recorded at option 2 and 3. The survey period was very brief (2 days) and the results are considered only a snapshot and time. Furthermore weather conditions were not optimal for avian surveys, and seasonality (i.e. the survey was undertaken in summer) likely impacted on the activity of bird species. Given these factors the December 2021 survey may not have captured the actual diversity at sites.

During the December 2021 targeted survey EPSEW were observed at 6 out of the 17 playback locations. A minimum of 10 individuals was observed at the location options for Launch Site A at Whalers Way. EPSEW group size observed during the surveys varied from 1 to 2 individuals. WBWB were observed at 5 out of the 13 visited sites. A minimum of 6 WBWB was observed/heard at the location options for Launch Site A at Whalers Way. It should be noted that there was no time to determine the exact number of individuals in a group by way of additional multiple follow-up observations and it is therefore possible that others may have been present at sites where a single individual or a pair of EPSEW/WBWB was recorded.

The presence and abundance of EPSEW and WBWB within each of the assessed Launch Site A options is considered to be an underestimate, as group size of cryptic and secretive birds such as emu wrens and whipbirds can be difficult to estimate without detailed behavioural observations repeated over an extended period of time and without marking individuals. Furthermore, the survey period was brief, weather conditions were not optimal for avian surveys, and seasonality (i.e. the survey was undertaken in summer) likely impacted on the activity and thus detectability of the two focal species. In particular WBWB were not as vocal in December 2021 (summer), compared to surveys undertaken earlier in the year during spring, when WBWB could be heard singing throughout the day, with peaks in song activity at dusk and at dawn.

4.1 Summary

EPSEW

During the targeted avian survey in December 2021, EPSEW were detected at Launch Site options 2, 3, and 4 (Table 5). No EPSEW were detected at site 5. However previous surveys undertaken in 2020 detected EPSEW in the southern end of this location (see Ecosphere 2020 for details).

WBWB

During the targeted avian survey in December 2021,WBWB were detected at Launch Site options 2 and 3, and not at Launch Site options 4 and 5 (Table 5). Launch Site options 4 and 5 have dense and low coastal vegetation that could be considered less suitable (e.g. too low/sparse) for WBWB to occupy/utilize frequently.

Table 5. Summary of avian survey results at Whalers Way in December 2021.

Launch Site A	Mean Bird Diversity (20 min/ha)	Total # of EPSEW detected at site	Total # of WBW detected at site
Option 1	Not assessed	Not assessed	Not assessed
Option 2	11.0	3 (pair and single male)	2
Option 3	8.0	3 (pair and single bird (unknown sex))	3
Option 4	4.0	4 (2 pairs)	0
Option 5	5.0	0	0
		10	**5**

Given the above described factors, it is deemed likely that EPSEW and WBWB utilize 4 of the 5 assessed location options for launch site A.

5 References and bibliography

AECOM Australia (2020). Whalers Way Orbital Launch Complex Flora and Fauna Assessment and Preliminary impact Assessment. Report to Southern Launch.

AECOM Australia (2021a). EPBC Self-assessment. Report to Southern Launch.

AECOM Australia (2021b – in prep). EPBC Referral. Report to Southern Launch.

AECOM Australia (2021c). Whalers Way Test Launch September 2021 - Acoustic review. Report to Southern Launch.

Birdlife (2021a). survey Techniques - 2-ha, 20 min Search. Accessed in June 2021: https://birdata.birdlife.org.au/survey-techniques

Birdlife (2021b). Southern Emu-wren *Stipiturus malachurus* Maluridae. Accessed in June 2021: https://www.birdlife.org.au/bird-profile/southern-emu-wren.

Birdlife International (2021c). Western Whipbird *Psophodes nigrogularis*. Accessed in June 2021: http://datazone.birdlife.org/species/factsheet/22705330.

Burbidge A.H., Joseph L., Toon A., White, L.C., McGuire, A., and Jeremy J. Austin (2017). A case for realigning species limits in the southern Australian whipbirds long recognised as the Western Whipbird (*Psophodes nigrogularis*), *Emu - Austral Ornithology*,117(3): 254-263, DOI: 10.1080/01584197.2017.1313685.

Bureau of Meteorology (2020). Port Lincoln, South Australia June 2020 Daily Weather observations.

Department of Agriculture, Water and the Environment (DAWE) (2020) Species Profile and Threats Database *Psophodes leucogaster* — Mallee Whipbird. SPRAT Profile Online resource [viewed 1 July 2020].

Department of Agriculture, Water and the Environment (DAWE) (2020) Species Profile and Threats Database *Stipiturus malachurus parimeda* – Southern Emu-wren - Eyre Peninsula. SPRAT Profile Online resource [viewed 1 July 2020].

Department of Environment Water Heritage and Agriculture (DEWHA) (2010). survey guidelines for Australia's threatened birds Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*.

Department of the Environment (DotE) (2013). Approved Conservation Advice for *Stipiturus malachurus parimeda* (Southern Emu-wren - Eyre Peninsula). Canberra: Department of the Environment.

Ecosphere Ecological Solutions Pty Ltd (2020). *Broadscale Distribution and Status of the Eyre Peninsula Southern Emu-wren (Stipiturus malachurus parimeda) and Western Whipbird (eastern) (Psophodes leucogaster leucogaster) at Whalers Way, June 2020*. Report to Southern Launch.

Ecosphere Ecological Solutions Pty Ltd (2021). *Whalers Way Orbital Launch Complex. Test Launch Campaign - Site Selection survey*. Report to Southern Launch.

Garnett, S.T., Szabo J.K., and Dutson G. (2011). The action plan for Australian birds 2010. CSIRO Publishing, Melbourne.

Heard, L. and Channon, B. (1997). Guide to a Native Vegetation survey Using the Biological survey of South Australia. Geographic Analysis and Research Unit, Department for Housing, Urban Development.

Higgins, P.J., Peter, J.M., Steele, W.K. (Eds.), (2001). Handbook of Australian, New Zealand and Antarctic Birds, vol. 5. *Oxford University Press*, Melbourne.

Maguire, G.S. (2006a). Behavioural Ecology of the Southern Emu-wren (*Stipiturus malachurus*). PhD thesis. The University of Melbourne, Melbourne.

Maguire, G.S. (2006b). Territory quality, survival and reproductive success in southern emu-wrens *Stipiturus malachurus. Journal Of Avian Biology 37: 579-593.*

Maguire, G. S. (2006c). Fine-scale habitat use by the southern emu-wren, *Stipiturus malachurus*. *Wildlife Research* 33: 137-148.

Maguire, G.S., and Mulder, R.A. (2004). Breeding biology and demography of the southern emu-wren (*Stipiturus malachurus*). *Australian Journal of Zoology* 52: 583–604. doi:doi:10.1071/ZO04043.

McGuire, A.L. (2012). Song divergence in the duetting western whipbird *Psophodes nigrogularis*: function, sex differences and the influence of habitat. PhD thesis. Flinders University, Adelaide.

McGuire, A.L., Johnston G., Robertson J., and Kleindorfer, S. (2011). Comparison of survey methods for detection of the elusive Western Whipbird *Psophodes nigrogularis* with notes on its distribution. *South Australian Ornithologist* 37(2): 49-59.

Osenberg, C.W., Schmitt, R.J., Holbrook, S.J., Abu-Saba, K.E. & Flegal, A.R. (1994). Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecological Applications* 4:16– 30.

Owens H. (Ed.) (2000). Guidelines for Vertebrate surveys in South Australia Using the Biological survey of South Australia. Biological survey and Research Section, National Parks and Wildlife SA, Department for Environment and Heritage.

Pickett, M.l. (2000). The Mount Lofty Ranges southern emu-wren *Stipiturus malachurus intermedius*: results of banding and monitoring, 1994-1998. Conservation Council South Australia, Adelaide

Pickett, M. (2006). Habitat Management Guidelines for the Eyre Peninsula Southern Emu-wren. Department for Environment and Heritage, PO Box 22 Port Lincoln SA 5606. October 2006.

Southern Launch (2020). Environmental Impact Statement (EIS).

Thiault, L., Kernaleguen L., Osenberg C.W., Claudet J. (2017). Progressive-Change BACIPS: a flexible approach for environmental impact assessment. *Methods in Ecology and Evolution* 8:288–296.

Webster, H.O. (1966). The western whipbird at Two Peoples Bay. *Western Australian Naturalist*, 10:25-28.

Underwood, A.J. (1992). Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. *Journal of Experimental Marine Biology and Ecology* 161:145–178.

Appendix C

Targeted Threatened Flora Species Assessment

ECOSPHERE
Ecological Solutions

Southern Launch Whalers Way Project: targeted threatened flora species assessment, October 2020

4 December 2020

Document Information	
Project number	JX0213b
Document title	Southern Launch Whalers Way Project: targeted threatened flora species assessment, October 2020
Client	AECOM
Prepared by	Andrew Sinel
Reviewed by	-
Review date	-
Document status	Final
Version number	2

Document distribution				
Authors	Document status	Version number	Date of issue	Issued to
Andrew Sinel	Draft	1	4/12/2020	Matt McDonnell, Senior Environmental Planner AECOM
Andrew Sinel	Final	2	9/12/2020	Matt McDonnell, Senior Environmental Planner AECOM

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1 Introduction

Southern Launch are proposing to construct an orbital launch facility at Whalers Way on the southern tip of the Eyre Peninsula in South Australia. Whalers Way has been identified as a suitable location for the project which consists of the design and delivery of two separate types of facilities, and includes supporting infrastructure such as road upgrades, installation of transmission lines and various tourist facilities. The current proposal has planned for the design and construction of various infrastructure (The Project site, Figure 1).

Whalers Way is a parcel of land which is largely intact native remnant coastal Mallee vegetation that has been managed by the Theakstone family since 1887. In 1969 Robert Theakstone commenced work to secure the 1,052 hectares of privately owned land as a Historic Reserve and Wilderness Sanctuary, to which it remains to this day under Heritage Agreement (HA 148). Whalers Way primary existing land use is as a tourist destination.

In April 2020, AECOM Australia undertook a desktop and onsite broad ecological assessment on behalf of Southern Launch (AECOM 2020). This survey was undertaken outside of the peak period to determine the extent of the flora species richness resulting in the requirement for a spring survey assessment that would aid in better determining the full extent of available floristic diversity within the project site.

1.1 Objectives

The findings of the desktop assessment determined that species of either limited presence during the year such as ephemeral or seasonal herbaceous species such as orchids or alternatively species of an inconspicuous nature that are difficult to pinpoint when not in flower such due to morphological similarities with surrounding vegetation such as *Prostanthera calycina* (EP Mintbush).

The specific objectives of the targeted flora survey were to:

- Review existing information related to the previous records and presence of critical habitat within the Project site.
- undertake targeted surveys within all project footprints to determine the presence and extent of any threatened flora species.
- Undertake targeted threatened flora surveys within habitat areas outside the Project footprints which are most likely to support threatened flora species.
- Ground truth existing threatened flora records within Whalers Way generally to determine the presence of species, particularly those of more recent observations.

- Report on the findings of any threatened species records within Whalers Way with a specific focus on project infrastructure footprints.

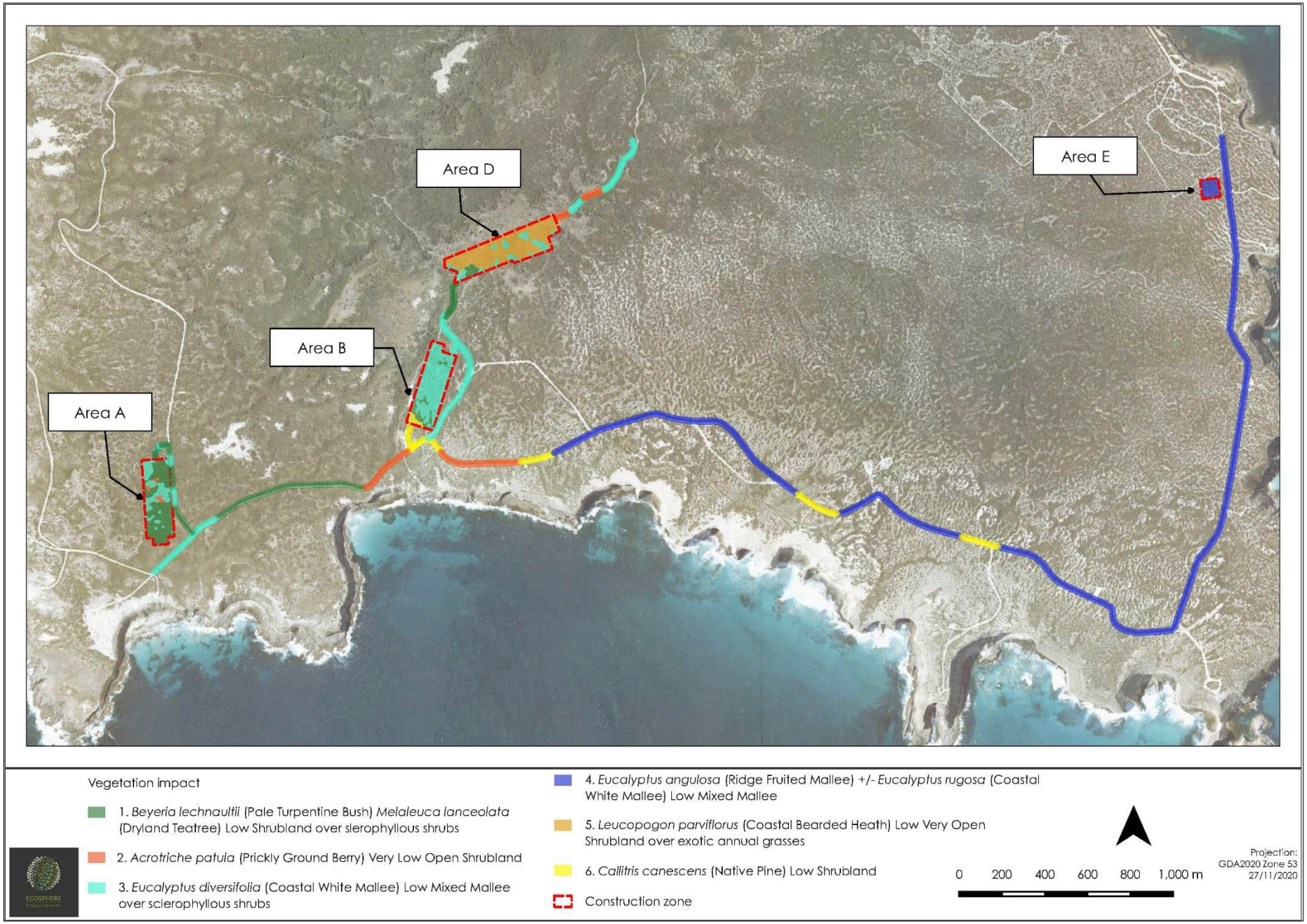

Figure 1. Location of the Whalers Way Project area with vegetation mapping.

2 Background

The baseline assessment found that the vegetation was relatively homogenous in compositions with two dominant mallee communities fringing coastal heath communities occupying the coast from adjacent to cliffs. Within the project footprint, most vegetation was limited to 3m or less in height with an overall average height of 1.5-2m. the canopy height was relatively consistent with proximity to the cliff edges and exposure to wind based on topography. Soils were largely sands over limestone of variable depth which dictated the mallee type present with eucalyptus diversifolia occurring in the western extent of the Project areas and Eucalyptus angulosa dominant communities in the east.

As a result of the exposure to wind and salt spray communities were largely dominated by a high cover of few species with the exposure leading to few species able to fill the niche available within 1km of the coast. Faunal communities were consistent with that with specialise d species observed in high abundance however species richness was relatively low, with again specialist niche availability suiting a small number of species. Areas north of the Project area are likely to have a higher species richness as a larger range of soil types and topographies present themselves.

3 Methods

The field survey was undertaken by Andrew Sinel and Matt Launer on 13-15th October 2020. Both Ecologists are highly experienced in threatened flora assessments and have both conducted numerous roadside threatened species assessments.

Infrastructure areas were assessed as a grid search with an approximately 10 metre intervals giving a 5m each side of the transect search. The desktop assessment guided the targeted survey with species that were considered likely to occur given highest order of priority with other additional herbaceous annual species not previously recorded added to flora species lists for the bushland assessments.

Access tracks were assessed with one surveyor covering each side as an up and back method with approximately 10m covered off on each side. The Whalers Way Road was assessed from a vehicle driven at walking pace along each side of the road.

Additional sites were assessed whereby areas of highest habitat preference were examined to determine if any threatened species were present within Whalers Way but potentially not within the Project area footprints. This was largely undertaken as cliff top surveys, swales with richer soil types, or areas of poorly represented vegetation communities such as *Melaleuca* ephemeral swales immediately north of the Project areas.

3.1 Desktop assessment

A desktop assessment was undertaken for the individual infrastructure locations with a 20 km buffer applied. The Baseline assessment undertook a standard 10 km buffer which is typically suitable to garner a cross section of species within the local area. The location and shape of the Whalers Way area means that buffers of 10 km have 75% of the area within a marine environment and not covering a wide range of terrestrial habitat types. An updated desktop assessment using a 20 km buffer enables a more thorough baseline in determining the extent of possible species utilising this habitat which can then further guide a targeted assessment.

4 Results

4.1 Desktop assessment

The additional desktop assessment returned 33 species of federal and state conservation significance with records within 20 km of the infrastructure sites. Five of these species were nationally threatened (Table 1). The EPBC protected matters search results added a further three species, (*Acacia pinguifolia*, *Caladenia tensa* and *Pleuropappus phyllocalymmeus*) which did not have historical records within 20 km.

Following the baseline surveys, and based on existing records and presence of habitat within the Project areas, four species were considered as likely occurring within the Project area, these were:

- *Acacia alcockii*
- *Caladenia bicalliata*
- *Hibbertia cinerea*
- *Prostanthera calycina*

An additional seven species were considered as possibly occurring within the Project area. These were:

- *Phyllanthus calycinus*
- *Poa fax*
- *Prasophyllum calcicola*
- *Prasophyllum occultans*
- *Sphaerolobium minus*
- *Stackhousia annua*
- *Thysanotus wangariensis*

Table 1. historical threatened flora records within 20km of infrastructure sites.

Species	AUS	SA	Data source	Most recent sighting	Species known habitat preferences	Likelihood of use for habitat – Comments
Acacia alcockii (Alcock's Wattle)		R	1	2009	Normally grows in sand over limestone in Mallee communities, sometimes with Melaleuca spp. Numerous records close to coastal fringe within Port Lincoln NP and Cathedral Rocks however not recorded during targeted flora survey in BDBSA location.	Likely – Record within Whalers Way however not recorded during baseline survey
Acacia dodonaeifolia (Hop-bush Wattle)		R	1	2017	Occurs with mallee habitat and also within open paddocks on hillsides and disturbed areas. Responds to fire and will grow densely following burns. Local records all around Tulka with exception of one record north of dunes at Wanna in similar habitat.	Unlikely –previous recent records within 10km however no suitable habitat occurs within Project area
Acacia pinguifolia (Fat leaved Wattle)	EN	E	5		Endemic to South Australia and has a widely separated distribution with disjunct populations located on Eyre Peninsula and Fleurieu Peninsula. Specimens from the southern Eyre Peninsula were collected from an undulating terrain with a westerly aspect, either on cream loam with clay subsoil, on red loam (calcareous), brown clay-loam on schist, brown clay loam on broken limestone, and pale grey sand over ironstone gravel. No records within 20km.	Unlikely – No previous records and no suitable habitat occurs within Project area
Anthocercis anisantha ssp. anisantha (Port Lincoln Ray-flower)		R	1	1995	Spinescent shrub to 3 m, leafy to almost leafless, pubescent with predominantly glandular or non-glandular hairs, rarely glabrous Occurs in south-western W.A. and on the mainland and offshore islands in the Port Lincoln area, S.A. Usually grows in woodland or shrubland on undulating plains, associated with granite.	Unlikely – one record within 20km within PL NP and no suitable habitat present
Asplenium trichomanes (Common Spleenwort)		R	1	2002	Maidenhair spleenwort is a small fern in the spleenwort genus *Asplenium*. It is a widespread and common species, occurring almost worldwide in a variety of rocky habitats.	Unlikely – no suitable habitat occurs within Project area.
Caladenia bicalliata ssp. bicalliata (Western Daddy-long-legs)		R	1	1995	Occurs singly or in small clumps in calcareous sands or in leaf litter on limestone and chiefly coastal. Recorded from Fishery Bay to Cape Jervis on light brown sand growing near *Leucopogon parviflorus*, *Caladenia latifolia* and *Asparagus asparagoides*. Flowers from August to September	Likely – preferred habitat present and nearby records.
Caladenia tensa	EN		5	-	Bates (2009) considers this species to be widespread in SA from the west coast, throughout Eyre Peninsula and adjacent pastoral zone, the Flinders Ranges, rare in the Mt Lofty Ranges and more common in the Murray and upper south-east. The Greencomb Spider-orchid grows on red-brown sandy loams on rises in open woodland dominated by Yellow Gum (*Eucalyptus leucoxylon* and Rottnest Island Pine (*Callitris preissii*).	Unlikely – no records within 20km and no suitable habitat occurs within Project area

Species	AUS	SA	Data source	Most recent sighting	Species known habitat preferences	Likelihood of use for habitat – Comments
Drosera stricticaulis (Erect Sundew)		V	1	1982	Erect, robust tuberous, perennial, herb, to 0.25 m high. Fl. pink, Jul to Oct. Sandy clay, loam. Along watercourses, granite outcrops. Sites where D. stricticaulis is known to occur are mainly erosional or plains landforms with sodosolic brown or red duplex or red loam soils over Precambrian rocks	Unlikely – No suitable habitat present
Eucalyptus conglobata ssp. conglobata (Port Lincoln Mallee)		R	1	2018	Occurs in dense Mallee scrub on fertile loam soils over limestone. Nearest record just within 20km and located on lower less exposed sites with orange and red loams.	Unlikely- no suitable habitat occurs within Project area
Eucalyptus gillenii (Mount Lindsay Mallee)		R	1	1958	Was known from only Mount Wooltarlinna and Birksgate Range in far north -west of the state. Unknown whether local records are planted specimens. Last record being 1958 suggests something may be awry with this record.	Unlikely, no recent records and no suitable habitat occurs within Project area
Hibbertia cinerea (Port Lincoln Guinea-flower)		R	1	2004	Decumbent habit with cane-like branches that scramble into other vegetation. Can be up to 2m high. Grows usually on sandy soil often with limestone outcrops in more or less coastal scrub to low mallee vegetation on the southern point of Eyre Peninsula, South Australia. Conservation status: Although restricted in its distribution H. cinerea is locally common and conserved in Lincoln National Park. Record within Whalers Way associated with few other records which appear to wrong coordinate.	Likely – Suitable habitat and records within Port Lincoln NP and north of Whalers Way
Leucopogon clelandii (Cleland's Beard-heath)		R	1	1985	Diffuse shrub, 13-30 cm high; stems and branchlets glabrous; leaves spreading to reflexed, broadly ovate, sometimes triangular or orbicular	Unlikely – No records in past 35 years.
Lobelia heterophylla (NC)		R	1	1995	Annual herbs with a distinct tap root and often with only one erect stem to 30 cm high, glabrous;	Unlikely - only the single unconfirmed record
Myoporum parvifolium (Creeping Boobialla)		R	1	1995	Prostrate mat-forming shrub usually less than 0.1 m tall. Known from coastal mallee habitat around Port Lincoln.	Unlikely - no suitable habitat present.
Olax obcordata		R	1	1967	The flowering period is September to October (Jessop ed 1986) and fruit develop and mature in December to January. South Australia Seed Conservation Centre (SCC) located populations of plants on Kangaroo Island. No plants have been located from the searches undertaken on Eyre Peninsula.	Unlikely – No records in past 40 years.
Phyllanthus calycinus (Snowdrop Spurge)		R	1	2015	Erect shrub, 0.2-1.2 m high. Fl. white-cream/pink, Jun to Dec or Jan. Often on sandy soils. Appears to be associated with *Acacia paradoxa* based on local records.	Possible – recent records but lack of associated *Acacia paradoxa*

Species	AUS	SA	Data source	Most recent sighting	Species known habitat preferences	Likelihood of use for habitat – Comments
Pleuropappus phyllocalymmeus (Silver Candles)	VU	V	5	-	On Eyre Peninsula, the species occurs in nine subpopulations with an extent of occurrence of 2900 km2. Occurs on sandy loams to clay loams or light clays Sites are sometimes gypseous. The species occurs on the margins of coastal saline lakes and depressions. On Eyre Peninsula the species predominantly occurs in shrubland and grassland.	Unlikely- no records within 20km and no suitable habitat present.
Poa fax (Scaly Poa)		R	1	1997	Known from dune mallee and gypsum plains and near-coastal sands (Vicflora 2020).	Possible – recent records within 5km and habitat present
Prasophyllum calcicola (Limestone Leek-orchid)		V	1	1995	Flowers September to early October. Flowering is not dependent on fire or disturbance. As the name calcicola' (growing in calcium rich soils) suggests, plants occur only in calcareous soils, either in leaf litter on travertine limestone, in calcareous sand or in red-brown loam over limestone, usually within a few kilometres of the sea, either in scrubby heath or under mallee, but uncommonly, usually as single plants or small groups widely spread.	Possible – Records within 20km and suitable habitat present.
Prasophyllum fecundum (Self-pollinating Leek-orchid)		R	1	2004	Mallee-Broombush or *Callitris* scrub in the more fertile terra-rossa soils, or in deep yellow sands, which have largely been cleared for farming so that only small, isolated populations of P. fecundum remain.	Unlikely – records within 20km but no suitable habitat present
Prasophyllum goldsackii (Goldsack's Leek-orchid)	EN	E	1	1982	Goldsack's leek orchid grows in hard terra rossa soil on the lower Eyre Peninsula and on the Yorke Peninsula. It is difficult to observe because the flowers rarely open and when they do open, appear withered.	Unlikely – No records in past 40 years.
Prasophyllum occultans (Hidden Leek-orchid)		R	1	1995	Plants occur singly or in small groups in well-grassed open forests. Habitats recorded include: mallee-broombush or in low scrub about rock, outcrops in the Lower North wheat-belt, on shallow soils over rock, including limestone, often with other Leek-orchids. near Native Pine woodland with mixed shrubs on sandy soil, along with *Prasophyllum occidentale* and *P. pallidum.*	Possible – record within Whalers HA, no suitable habitat within Project areas
Prostanthera calycina (West Coast Mintbush)	VU	V	1	1990	Occurs in association with *Eucalyptus diversifolia* Mallee. Records in nearby heritage agreements. Intensive targeted search for this species returned no individuals. Recorded *Prostanthera serpyllifolia* along coast fringe in similar preferred habitat. Definitely not recorded within project footprints.	Likely – Records within 20km and suitable habitat present.
Pteris tremula (Tender Brake)		R	1	2002	Fern species occurs in wet shaded gullies or gorges, sinkholes or in caves.	Unlikely - No suitable habitat present within Project area.

Species	AUS	SA	Data source	Most recent sighting	Species known habitat preferences	Likelihood of use for habitat – Comments
Ptilotus beckerianus (Ironstone Mulla Mulla)	VU	V	1, 5	1984	Occurs in the central and western regions of Kangaroo Island and in the southern part of Eyre Peninsula, from near Marble Range to a railway line near the Hyde Road and Lincoln Highway intersection, near Port Lincoln. The Ironstone Mulla Mulla occurs in association with several plant communities including Sugar Gum (*Eucalyptus cladocalyx)* open woodland, Drooping She-oak (*Allocasuarina verticillata*) woodland and Broombush (*Melaleuca uncinata*) shrubland on Eyre Peninsula. Previous personal knowledge of this species has seen it largely confined to gravelly soils around Wanilla on southern Eyre Peninsula. Very different habitat to that found within Project area.	Unlikely- no records within 20km and no suitable habitat present.
Sphaerolobium minus (Leafless Globe-pea)		R	1	1995	Rush-like shrub usually <50 cm high; stems terete, mostly leafless, sometimes with a few linear leaves. Sclerophyll forests, woodlands and heathlands	Possible- records within 20km, suitable habitat present.
Spyridium bifidum ssp. bifidum (Marble Range Spyridium)		V	1	2013	There is no literature available on the habitat preferences for this species however the author has recorded this species in high abundance south of Cummins in *Eucalyptus incrassata* Mallee associated with *Acacia pinguifolia* and *Daviesia pectinata*.	Unlikely, no suitable habitat present within Project area
Spyridium leucopogon (Silvery Spyridium)		R	1	1967	Small slender shrub; leaves narrow-linear, 3-6 mm long, 0.5-0.75 mm wide, more or less erect.	Unlikely – No records in past 40 years.
Spyridium spathulatum (Spoon-leaf Spyridium)		R	1	2018	Erect shrub, 1-2 m high; leaves spathulate, 5-15 mm long, more or less glabrous above, silky- or golden-pubescent below, margins recurved, apex mucronate	Unlikely – All records near Port Lincoln.
Stackhousia annua (Annual Candles)	VU	V	1	1995	Annual herb, may be confused with perennial Stackhousia aspericocca.	Possible, no records within 15km. Suitable habitat present
Tecticornia lepidosperma		R	1	1996	Decumbent to erect, robust shrub, 0.15-1.3 m high. Fl. Sep to Nov. Coastal & inland saline areas, tidal mud flats.	Unlikely - records within 20km however no suitable habitat present within Whalers Way
Thelymitra epipactoides (Metallic Sun-orchid)	EN	E	1, 5	2001	Occurs largely on fertile red loams ideally suited to cropping, hence the high levels of fragmentation, with most remnant populations occurring within road reserves and other easements such as rail, power and water corridors. It is likely the historical disturbance from grazing has all but destroyed any real chance of this species occurring within area.	Unlikely- No suitable habitat present within Project areas.

Species	AUS	SA	Data source	Most recent sighting	Species known habitat preferences	Likelihood of use for habitat – Comments
Thysanotus nudicaulis		E	1	1967	Perennial herb, rhizome small and more or less erect; roots swollen into tubers. Flowers purple, Nov to Dec. Sand, lateritic clay, sandy clay	Unlikely – No records in past 40 years.
Thysanotus wangariensis (Eyre Peninsula Fringe-lily)		R	1	1995	Perennial, with small (5-10 mm diam.) rhizome with stiff fibrous non-tuberous roots; plant leafless at maturity. Recorded within 10km, on limestone outcropping with *Eucalyptus angulosa*	Possible – records within previous 25 years, potentially suitable habitat.
Wurmbea decumbens (Trailing Nancy)		R	1	1991	Records at Lincoln national park where found growing on stony limestone ledges.	Unlikely – No records within 10km and no suitable habitat present within Project area.
Xanthorrhoea semiplana ssp. tateana (Tate's Grass-tree)		R	1	2018	Widespread throughout southern Eyre Peninsula, most often in association with Mallee / Banksia, Hysterobaeckea on inland consolidated white sand dunes and low rises. Species observed in road reserve not far from Fishery Beach. Record near Groper Bay associated with some other doubtful records and observation description does not match site location. No Yaccas present within coastal fringe of HA nor within Project areas. No Yaccas recorded within HA at all however may be present in northern sections as present on Fisheries Beach Road reserve.	Unlikely - not observed during the baseline assessment.

Source; 1- BDBSA, 2 - AoLA, 3 – NatureMaps 4 – Observed/recorded in the field, 5 - Protected matters search tool, 6 – others

Conservation status: Aus.: Australia (Environment Protection and Biodiversity Conservation Act 1999). SA: South Australia (National Parks and Wildlife Act 1972). Conservation codes: EN/E: Endangered. V: Vulnerable

4.2 Field assessment

Following detailed assessments of the project areas, road and access tracks and opportunistic searches, no threatened flora species were observed within the Project areas or within the general Whalers Way Project areas.

4.2.1 Likely species

Species considered likely to occur had a strong focus in targeted assessment. A summary of the findings of these is provided below.

Acacia alcockii

This species is a common component of mallee communities, particularly on the southern side of Port Lincoln where the shallow limestone outcrops associated with *Eucalyptus socialis* and *Eucalyptus conglobata* occur however there are numerous records on the south eastern corner of the Lincoln NP and further west of the Whalers Way area. The record located within Whalers Way near Groper Bay is thought to be incorrect coordinates with two other associated records; (*Eucalyptus gillenii* and *Xanthorrhoea semiplana* ssp. *tatei*) not being present and the record description does not match the location. This species is more likely north of the Project area and remains likely to occur within the Whalers Way HA but unlikely within the Project area

Caladenia bicalliata

Only a few records on lower EP with one within 20km. The habitat description and locations of other records suggests that this species may be present somewhere in the wider Whalers Way area however no *Caladenia* of any species were observed during the targeted surveys. This species would remain as a targeted species in any other surveys within the area due to habitat preferences. Possible/Likely within wider Whalers Way. Unlikely within Project area.

Hibbertia cinerea

This species was targeted heavily during the survey, primarily due to *Hibbertia* species being flowering prolifically during the survey period. Consistently looking for morphological characteristics of this species as well as regular flower checks and stamen counts, no individuals of this species were observed within any project footprints or road areas. Other records in the regional area are associated with *Gahnia* sedgelands and away from the exposed coast so potentially unlikely within Whalers Way and not present within Project area.

Prostanthera calycina

Another species heavily targeted due to flowering period aligning perfectly with survey making the species obvious if present. Following no observations within the Project areas, surveys along the cliff edge where they are commonly encountered in other areas on EP yielded *Prostanthera serpyllifolia* (Figure 2), a non-conservation significant member of the genus. Highly unlikely within Whalers Way.

Figure 2. *Prostanthera serpyllifolia* on cliff edge at Whalers Way.

4.2.2 Possible species

Phyllanthus calycinus

Most records are located on the eastern side of the peninsula and while having similar habitat preferences of coastal mallee, most records indicate an association with species such as *Acacia paradoxa* (Kangaroo Thorn) which was not present within the Project areas. May have a presence in the northern extent of Whalers Way. Unlikely

Poa fax

Other records on lower EP have affinity with sand dunes making it unlikely this species is present within Whalers Way. Two records at Fishery Bay highlighted the species however the dune

habitat preference is very sparsely present within Whalers Way. Definitely not present within Project areas, unlikely within Whalers other than possibly Redbanks area on western side.

Prasophyllum calcicola

Recorded within Lincoln NP growing with *Eucalyptus diversifolia* and *Acacia rupicola*. Suggests this species may be present in northern extent of Whalers area but following field survey is very unlikely to be present within the Project areas adjacent the coast.

Prasophyllum occultans

Another *Prasophyllum* species preferring *Eucalyptus diversifolia* mallee however no *Prasophyllum* were recorded within the Project areas or within Whalers Way area associated with the project in general. Almost all areas had abundant presence of *Microtis* sp. (Onion Orchid, Figure 3) and *Acianthus* sp. (Mayfly Orchids) during the survey but no other evidence of orchid species was observed.

Figure 3. Microtis spp. present within Project area undergrowth.

Sphaerolobium minus

Described as preferring *Eucalyptus diversifolia* mallee on sandy loams however records are more associated with distance from exposed coastline and along roper Bay Road. No

observations made during field surveys despite flowering aligning with survey period. Highly Unlikely.

Stackhousia annua

The perennial species of *Stackhousia* was recorded within both *Eucalyptus angulosa* and *E. diversifolia* communities on numerous occasions during the survey (Figure 4) however no presence of the annual threatened species were observed.

Figure 4. *Stackhousia aspericocca* at Range control site E.

Thysanotus wangariensis

Described as occurring with *Eucalyptus angulosa* mallee, all records are well north of Project area and associated also with *Xanthorrhoea* and *Melaleuca*, not present within Project areas. Unlikely.

5 Conclusion

The nature of the Project areas and their proximity to the coast result in the landscape being particularly harsh and requiring tolerance of high salt load and highly alkaline soils. This leaves a very narrow pH band for nutritional requirements meaning species present are incredibly highly specialised. While most species assessed under this survey are tolerant of these conditions, looking over historical records show that the large majority are located on the eastern side of the peninsula. These areas are likely to have a far lower salt spray load and potentially lower wind velocity. The cliffs of the Whalers area potentially increase the wind velocity at the tops of the cliffs meaning these areas are subject to far harsher conditions than other surrounding areas.

While the vegetation is largely intact and of good condition, the diversity of flora species generally is low comparatively with other areas of intact vegetation on the Eyre Peninsula. The numbers of threatened species for an area of largely intact vegetation is surprisingly low, which if compared to an area such as the Koppio Hills, 40km north of the Project area, would likely return three times the number.

There is a low likelihood of threatened flora species being located within the project footprints with three surveys across the Whalers general Project areas over three seasons, including walking the entire Whalers coastal band during Southern Emu Wren surveys, not throwing up any surprises. If there are any threatened species present, it is likely that they occur in isolated pockets or as solitary individuals across the general Whalers Project areas or alternatively north of the Project areas where there is a far higher likelihood of threatened species occurring.

Appendix D

Protected Matters Search Tool

Australian Government

Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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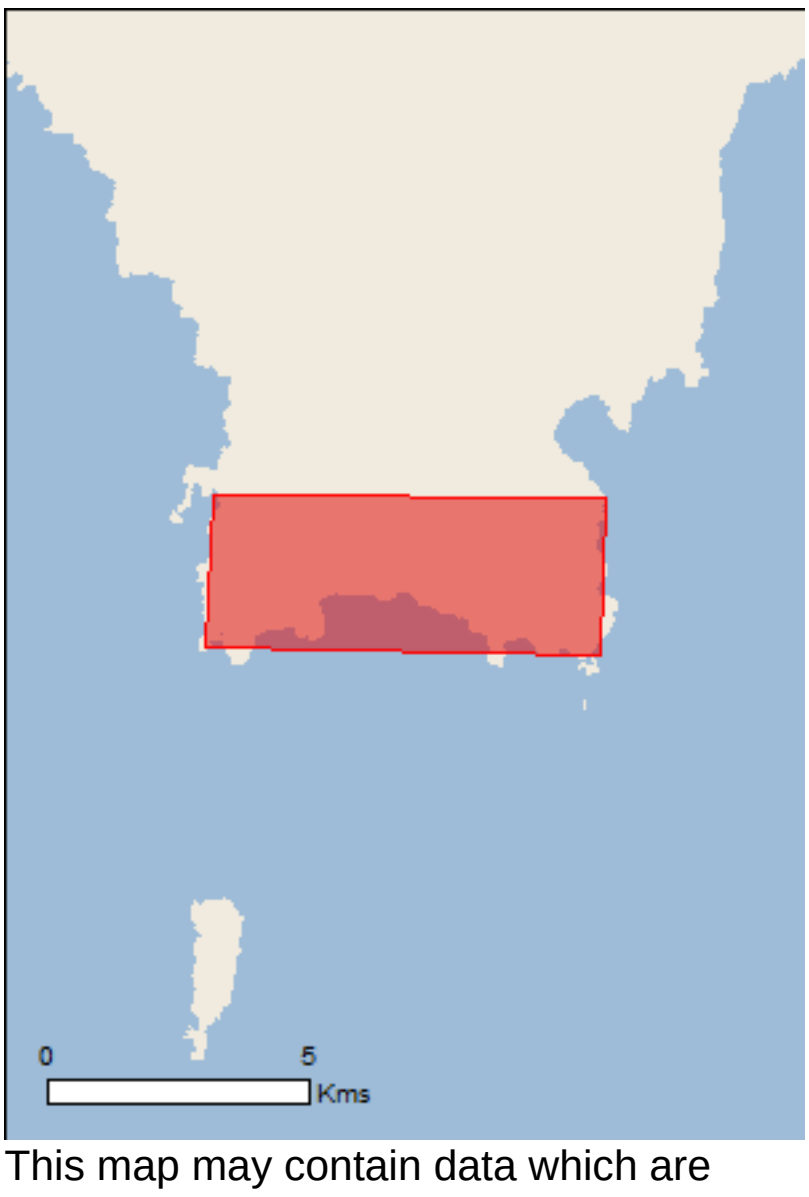

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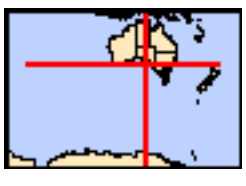

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	44
Listed Migratory Species:	45

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	78
Whales and Other Cetaceans:	14
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	6
Regional Forest Agreements:	None
Invasive Species:	21
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	2

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Extinct within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Psophodes leucogaster leucogaster Mallee Western Whipbird [81025]	Vulnerable	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Stipiturus malachurus parimeda Southern Emu-wren (Eyre Peninsula) [26006]	Vulnerable	Species or species habitat known to occur within area
Thalassarche cauta cauta Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Plants		
Acacia pinguifolia Fat-leaved Wattle, Fat-leaf Wattle [5319]	Endangered	Species or species habitat may occur within area
Caladenia tensa Greencomb Spider-orchid, Rigid Spider-orchid [24390]	Endangered	Species or species habitat likely to occur within area
Pleuropappus phyllocalymmeus Silver Candles [21123]	Vulnerable	Species or species habitat may occur within area
Prostanthera calycina West Coast Mintbush, Limestone Mintbush, Red Mintbush [9470]	Vulnerable	Species or species habitat likely to occur within area
Ptilotus beckerianus Ironstone Mulla Mulla [3787]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus tenuirostris Short-tailed Shearwater [1029]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Thalassarche cauta Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur

Name	Threatened	Type of Presence within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus horridus Shaggy Pipefish, Prickly Pipefish [66244]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Vanacampus vercoi Verco's Pipefish [66286]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Lincoln	SA
Sleaford Mere	SA
Unnamed (No.HA1291)	SA
Unnamed (No.HA148)	SA
Unnamed (No.HA1493)	SA
Unnamed (No.HA152)	SA

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Sleaford Mere	SA

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 90-120m depth	South-west
Kangaroo Island Pool, canyons and adjacent shelf	South-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-34.922461 135.621141,-34.922461 135.621313,-34.922461 135.621313,-34.923164 135.688089,-34.945259 135.687059,-34.943993 135.619596,-34.922461 135.621141

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix E

Likelihood of Occurrence - Flora

Appendix E Likelihood of Occurrence - Flora

Species	Conservation Status		Data Source	Most Recent Sighting	Habitat	Desktop Assessment/ Baseline Survey- Likelihood	Post Targeted Survey - Likelihood
	EPBC Act	NPW Act					
Acacia alcockii (Alcock's Wattle)		R	1	2009	Normally grows in sand over limestone in Mallee communities, sometimes with Melaleuca spp. Numerous records close to coastal fringe within Port Lincoln NP and Cathedral Rocks however not recorded during targeted flora survey in BDBSA location.	Likely – Record within Whalers Way however not recorded during baseline survey	Possible
Acacia dodonaeifolia (Hop-bush Wattle)		R	1	2017	Occurs with mallee habitat and also within open paddocks on hillsides and disturbed areas. Responds to fire and will grow densely following burns. Local records all around Tulka with exception of one record north of dunes at Wanna in similar habitat.	Unlikely –previous recent records within 10km however no suitable habitat occurs within Project Area	Unlikely
Acacia pinguifolia (Fat leaved Wattle)	EN	E	5		Endemic to SA and has a widely separated distribution with disjunct populations located on Eyre Peninsula and Fleurieu Peninsula. Specimens from the southern Eyre Peninsula were collected from an undulating terrain with a westerly aspect, either on cream loam with clay subsoil, on red loam (calcareous), brown clay-loam on schist, brown clay loam on broken limestone, and pale grey sand over ironstone gravel. No records within 20km.	Unlikely – No previous records and no suitable habitat occurs within Project Area	Unlikely

Anthocercis anisantha ssp. anisantha (Port Lincoln Ray-flower)		R	1	1995	Spinescent shrub to 3 m, leafy to almost leafless, pubescent with predominantly glandular or non-glandular hairs, rarely glabrous. Occurs in south-western W.A. and on the mainland and offshore islands in the Port Lincoln area, S.A. Usually grows in woodland or shrubland on undulating plains, associated with granite.	Unlikely – one record within 20km within Port Lincoln NP and no suitable habitat present	Unlikely
Asplenium trichomanes (Common Spleenwort)		R	1	2002	Maidenhair spleenwort is a small fern in the spleenwort genus *Asplenium*. It is a widespread and common species, occurring almost worldwide in a variety of rocky habitats.	Unlikely – no suitable habitat occurs within Project Area	Unlikely
Caladenia bicalliata ssp. bicalliata (Western Daddy-long-legs)		R	1	1995	Occurs singly or in small clumps in calcareous sands or in leaf litter on limestone and chiefly coastal. Recorded from Fishery Bay to Cape Jervis on light brown sand growing near *Leucopogon parviflorus*, *Caladenia latifolia* and *Asparagus asparagoides*. Flowers from August to September.	Likely – preferred habitat present and nearby records	Unlikely
Caladenia tensa (Greencomb Spider-orchid)	E	-	5	-	Bates (2009) considers this species to be widespread in SA from the west coast, throughout Eyre Peninsula and adjacent pastoral zone, the Flinders Ranges, rare in the Mt Lofty Ranges and more common in the Murray and upper south-east. The Greencomb Spider-orchid grows on red-brown sandy loams on rises in open woodland dominated by Yellow Gum (*Eucalyptus leucoxylon* and Rottnest Island Pine (*Callitris preissii*).	Unlikely – no records within 20km and no suitable habitat occurs within Project Area	Unlikely
Drosera stricticaulis (Erect Sundew)		V	1	1982	Erect, robust tuberous, perennial, herb, to 0.25 m high. Fl. pink, Jul to Oct. Sandy clay, loam. Along watercourses, granite outcrops. Sites where D. stricticaulis is known to occur are mainly erosional or plains landforms with sodosolic brown or red duplex or red loam soils over Precambrian rocks.	Unlikely – No suitable habitat present	Unlikely

Eucalyptus conglobata ssp. conglobata (Port Lincoln Mallee)		R	1	2018	Occurs in dense Mallee scrub on fertile loam soils over limestone. Nearest record just within 20km and located on lower less exposed sites with orange and red loams.	Unlikely- no suitable habitat occurs within Project area	Unlikely
Eucalyptus gillenii (Mount Lindsay Mallee)		R	1	1958	Was known from only Mount Wooltarlinna and Birksgate Range in far north -west of the state. Unknown whether local records are planted specimens. Last record being 1958 suggests something may be awry with this record.	Unlikely, no recent records and no suitable habitat occurs within Project area	Unlikely
Hibbertia cinerea (Port Lincoln Guinea-flower)		R	1	2004	Decumbent habit with cane-like branches that scramble into other vegetation. Can be up to 2m high. Grows usually on sandy soil often with limestone outcrops in more or less coastal scrub to low mallee vegetation on the southern point of Eyre Peninsula, SA. Conservation status: Although restricted in its distribution H. cinerea is locally common and conserved in Lincoln NP. Record within Whalers Way associated with few other records which appear to wrong coordinate.	Likely – Suitable habitat and records within Port Lincoln NP and north of Whalers Way	Unlikely
Leucopogon clelandii (Cleland's Beard-heath)		R	1	1985	Diffuse shrub, 13-30 cm high; stems and branchlets glabrous; leaves spreading to reflexed, broadly ovate, sometimes triangular or orbicular.	Unlikely – No records in past 35 years	Unlikely
Lobelia heterophylla (NC)		R	1	1995	Annual herbs with a distinct tap root and often with only one erect stem to 30 cm high, glabrous.	Unlikely - only the single unconfirmed record	Unlikely
Myoporum parvifolium (Creeping Boobialla)		R	1	1995	Prostrate mat-forming shrub usually less than 0.1 m tall. Known from coastal mallee habitat around Port Lincoln.	Unlikely - no suitable habitat present	Unlikely
Olax obcordata		R	1	1967	The flowering period is September to October (Jessop ed 1986) and fruit develop and mature in December to January. SA Seed Conservation Centre (SCC) located populations of plants on Kangaroo Island. No plants have been located from the searches undertaken on Eyre Peninsula.	Unlikely – No records in past 40 years	Unlikely

Phyllanthus calycinus (Snowdrop Spurge)		R	1	2015	Erect shrub, 0.2-1.2 m high. Fl. white-cream/pink, Jun to Dec or Jan. Often on sandy soils. Appears to be associated with *Acacia paradoxa* based on local records.	Possible – recent records but lack of associated *Acacia paradoxa*	Unlikely
Pleuropappus phyllocalymmeus (Silver Candles)	V	V	5	-	On Eyre Peninsula, the species occurs in nine subpopulations with an extent of occurrence of 2900 km2. Occurs on sandy loams to clay loams or light clays Sites are sometimes gypseous. The species occurs on the margins of coastal saline lakes and depressions. On Eyre Peninsula the species predominantly occurs in shrubland and grassland.	Unlikely- no records within 20km and no suitable habitat present	Unlikely
Poa fax (Scaly Poa)		R	1	1997	Known from dune mallee and gypsum plains and near-coastal sands (Vicflora 2020).	Possible – recent records within 5km and habitat present	Unlikely
Prasophyllum calcicola (Limestone Leek-orchid)		V	1	1995	Flowers September to early October. Flowering is not dependent on fire or disturbance. As the name calcicola (growing in calcium rich soils) suggests, plants occur only in calcareous soils, either in leaf litter on travertine limestone, in calcareous sand or in red-brown loam over limestone, usually within a few kilometres of the sea, either in scrubby heath or under mallee, but uncommonly, usually as single plants or small groups widely spread.	Possible – Records within 20km and suitable habitat present	Unlikely
Prasophyllum fecundum (Self-pollinating Leek-orchid)		R	1	2004	Mallee-broombush or Callitris scrub in the more fertile terra-rossa soils, or in deep yellow sands, which have largely been cleared for farming so that only small, isolated populations of *P. fecundum* remain.	Unlikely – records within 20km but no suitable habitat present	Unlikely
Prasophyllum goldsackii (Goldsack's Leek-orchid)	EN	E	1	1982	Goldsack's leek orchid grows in hard terra rossa soil on the lower Eyre Peninsula and on the Yorke Peninsula. It is difficult to observe because the flowers rarely open and when they do open, appear withered.	Unlikely – No records in past 40 years	Unlikely

Prasophyllum occultans (Hidden Leek-orchid)		R	1	1995	Plants occur singly or in small groups in well-grassed open forests. Habitats recorded include: mallee-broombush or in low scrub about rock, outcrops in the Lower North wheat-belt, on shallow soils over rock, including limestone, often with other Leek-orchids. near Native Pine woodland with mixed shrubs on sandy soil, along with *Prasophyllum occidentale* and *P. pallidum.*	Possible – record within Whalers HA, no suitable habitat within Project areas	Unlikely
Prostanthera calycina (West Coast Mintbush)	VU	V	1	1990	Occurs in association with *Eucalyptus diversifolia* Mallee. Records in nearby heritage agreements. Intensive targeted search for this species returned no individuals. Recorded *Prostanthera serpyllifolia* along coast fringe in similar preferred habitat. Definitely not recorded within project footprints.	Likely – Records within 20 km and suitable habitat present	Unlikely
Pteris tremula (Tender Brake)		R	1	2002	Fern species occurs in wet shaded gullies or gorges, sinkholes or in caves.	Unlikely - No suitable habitat present within Project area	Unlikely
Ptilotus beckerianus (Ironstone Mulla Mulla)	VU	V	1, 5	1984	Occurs in the central and western regions of Kangaroo Island and in the southern part of Eyre Peninsula, from near Marble Range to a railway line near the Hyde Road and Lincoln Highway intersection, near Port Lincoln. The Ironstone Mulla Mulla occurs in association with several plant communities including Sugar Gum (*Eucalyptus cladocalyx*) open woodland, Drooping She-oak (*Allocasuarina verticillata*) woodland and Broombush (*Melaleuca uncinata*) shrubland on Eyre Peninsula. Previous personal knowledge of this species has seen it largely confined to gravelly soils around Wanilla on southern Eyre Peninsula. Very different habitat to that found within Project area.	Unlikely- no records within 20km and no suitable habitat present	Unlikely

Sphaerolobium minus (Leafless Globe-pea)		R	1	1995	Rush-like shrub usually <50 cm high; stems terete, mostly leafless, sometimes with a few linear leaves. Sclerophyll forests, woodlands and heathlands.	Possible- records within 20km, suitable habitat present	Unlikely
Spyridium bifidum ssp. bifidum (Marble Range Spyridium)		V	1	2013	There is no literature available on the habitat preferences for this species however the author has recorded this species in high abundance south of Cummins in *Eucalyptus incrassata* Mallee associated with *Acacia pinguifolia* and *Daviesia pectinata*.	Unlikely, no suitable habitat present within Project area	Unlikely
Spyridium leucopogon (Silvery Spyridium)		R	1	1967	Small slender shrub; leaves narrow-linear, 3-6 mm long, 0.5-0.75 mm wide, more or less erect.	Unlikely – No records in past 40 years	Unlikely
Spyridium spathulatum (Spoon-leaf Spyridium)		R	1	2018	Erect shrub, 1-2 m high; leaves spathulate, 5-15 mm long, more or less glabrous above, silky- or golden-pubescent below, margins recurved, apex mucronate.	Unlikely – All records near Port Lincoln	Unlikely
Stackhousia annua (Annual Candles)	VU	V	1	1995	Annual herb, may be confused with perennial *Stackhousia aspericocca*.	Possible, no records within 15km. Suitable habitat present	Unlikely
Tecticornia lepidosperma		R	1	1996	Decumbent to erect, robust shrub, 0.15-1.3 m high. Fl. Sep to Nov. Coastal & inland saline areas, tidal mud flats.	Unlikely - records within 20km however no suitable habitat present within Whalers Way	Unlikely
Thelymitra epipactoides (Metallic Sun-orchid)	EN	E	1, 5	2001	Occurs largely on fertile red loams ideally suited to cropping, hence the high levels of fragmentation, with most remnant populations occurring within road reserves and other easements such as rail, power and water corridors. It is likely the historical disturbance from grazing has all but destroyed any real chance of this species occurring within area.	Unlikely- No suitable habitat present within Project areas	Unlikely

Thysanotus nudicaulis		E	1	1967	Perennial herb, rhizome small and more or less erect; roots swollen into tubers. Flowers purple, Nov to Dec. Sand, lateritic clay, sandy clay	Unlikely – No records in past 40 years	Unlikely
Thysanotus wangariensis (Eyre Peninsula Fringe-lily)		R	1	1995	Perennial, with small (5-10 mm diam.) rhizome with stiff fibrous non-tuberous roots; plant leafless at maturity. Recorded within 10km, on limestone outcropping with *Eucalyptus angulosa.*	Possible – records within previous 25 years, potentially suitable habitat	Unlikely
Wurmbea decumbens (Trailing Nancy)		R	1	1991	Records at Lincoln NP where found growing on stony limestone ledges.	Unlikely – No records within 10km and no suitable habitat present within Project area	Unlikely
Xanthorrhoea semiplana ssp. tateana (Tate's Grass-tree)		R	1	2018	Widespread throughout southern Eyre Peninsula, most often in association with Mallee / Banksia, *Hysterobaeckea* on inland consolidated white sand dunes and low rises. Species observed in road reserve not far from Fishery Beach. Record near Groper Bay associated with some other doubtful records and observation description does not match site location. No Yaccas present within coastal fringe of HA nor within Project areas. No Yaccas recorded within HA at all however may be present in northern sections as present on Fisheries Beach Road reserve.	Unlikely - not observed during the baseline assessment	Unlikely

Source; 1- BDBSA, 2 – Atlas of Living Australia, 3 – NatureMaps 4 – Observed/recorded in the field, 5 - Protected matters search tool, 6 – others

Conservation codes:

EPBC Act: E Endangered V Vulnerable

NPW Act: V Vulnerable R Rare

Appendix F

Likelihood of Occurrence - Fauna

Appendix F Likelihood of Occurrence - Fauna

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Birds						
Actitis hypoleucos	Common Sandpiper	Mi	R	Edges of saltwater to fresh waterbodies and wetlands, including estuaries, lakes, drainage lines, tidal watercourses and mudflats; occasionally beaches and rocky headlands; mainly spring-summer non-breeding migrant.	Unlikely	Unlikely
Apus pacificus	Fork-tailed Swift	Mi, Ma	-	In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines.	Possible	Unlikely
Ardea alba	Great Egret	Ma	-	The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2003). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2007).	Unlikely	Unlikely
Ardea ibis	Cattle Egret	Ma	R	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
				numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. The Cattle Egret is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation.		
Ardenna carneipes	Flesh-footed Shearwater	Mi, Ma	R	The Flesh-footed Shearwater mainly occurs in the subtropics over continental shelves and slopes and occasionally inshore waters. They breed on islands in burrows on sloping ground in coastal forest, scrubland, shrubland or grassland.	Unlikely	Unlikely
Ardenna grisea	Sooty Shearwater	Mi, Ma	-	The Sooty Shearwater forages in pelagic (open ocean) sub-tropical, sub-Antarctic and Antarctic waters.	Unlikely	Unlikely
Ardenna tenuirostris	Short-tailed Shearwater	Mi, Ma	-	Found in coastal waters. Likely to be present on adjacent offshore islands potentially.	Possible	Unlikely
Ardeotis australis	Australian Bustard	-	V	Ground dweller, common in grasslands, woodland and in agricultural areas (Birdlife, 2020). Not likely to utilise shrubland community or if does would be very unfrequently. The project areas are highly unlikely to constitute critical habitat for this species and there are no records within project areas. This species has a habit of turning up unexpectedly in random locations so is always a possibility almost anywhere.	Known	Unlikely/ possible as vagrant

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Botaurus poiciloptilus	Australasian Bittern	E	V	Favours wetlands with tall dense vegetation where it forages in still shallow water at the edge of pools and waterways or from platforms or mats of vegetation over deep water (TSSC, 2019).	Unlikely	Unlikely
Calidris acuminata	Sharp-tailed Sandpiper	Mi	-	Prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewage farms, flooded fields, mudflats, mangroves, rocky shores and beaches.	Unlikely	Unlikely
Calidris alba	Sanderling	Mi, Ma	R	Coastal species, open sandy beaches exposed to open sea-swell and exposed sandbars and spits and shingle banks where they forage in wave-wash zone amongst rotting seaweed. May occur on sheltered sandy shorelines of estuaries, inlets and harbours.	Possible	Unlikely
Calidris canutus	Red Knot	E, Mi, Ma	-	Intertidal mudflats, sandflats and sandy beaches of sheltered coasts. Sometimes seen on terrestrial saline wetlands.	Unlikely	Unlikely
Calidris ferruginea	Curlew Sandpiper	CE, Mi, Ma	-	Coastal estuaries, bays and shallow wetlands, tidal mudflats and sandflats; mainly spring-summer non-breeding migrant.	Unlikely	Unlikely
Calidris melanotos	Pectoral Sandpiper	Mi, Ma	R	Shallow freshwater or brackish wetlands, including swamps, flooded grasslands, sewage ponds, occasionally tidal flats and saltmarshes.	Unlikely	Unlikely
Calidris ruficollis	Red-necked Stint	Mi, Ma	-	Coastal areas, sheltered inlets, intertidal mudflats, protected sandy or coralline shores.	Unlikely	Unlikely
Catharacta skua	Great Skua	Ma	-	Marine species, breeds on islands.	Unlikely	Unlikely
Cereopsis novaehollandiae (NC)	Cape Barren Goose	-	R	Coastal grasslands and wetlands (Birdlife, 2020). Noted grazing in open paddocks adjacent to Whalers Way. Have taken advantage of grain left in paddocks and roost in Sleaford Mere. Commonly occurring in local area but unlikely to use Whalers	Known	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
				as habitat area. No observations over three site visits.		
Charadrius ruficapillus	Red-capped Plover	Ma	-	Coastal species on bare sand or mudflats at margins of saline, brackish or freshwater wetlands (Birdlife, 2020).	Unlikely	Unlikely
Charadrius veredus	Oriental Plover	Mi	-	A non-breeding visitor to Australia, they spend a few weeks in coastal habitats such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands, before dispersing further inland. Thereafter they usually inhabit flat, open, semi-arid or arid grasslands, where the grass is short and sparse, and interspersed with hard, bare ground, such as claypans, dry paddocks, playing fields, lawns and cattle camps.	Unlikely	Unlikely
Chrysococcyx osculans	Black-eared Cuckoo	Ma	-	Dry country in mulga and mallee open woodlands and shrublands. Often found in vegetation along creekbeds.	Unlikely	Unlikely
Diomedea antipodensis	Antipodean Albatross	V, Mi, Ma	-	Marine, pelagic and aerial. Nests on New Zealand islands in open patch vegetation among tussock grassland or shrubs on ridges, slopes and plateaus.	Unlikely	Unlikely
Diomedea epomophora	Southern Royal Albatross	V, Mi, Ma	V	Predoiminantly marine, breeds on a few select islands in tussock grassland, plateaus or ridges (Birdlife, 2020).	Unlikely	Unlikely
Diomedea exulans	Wandering Albatross	V, Mi, Ma	V	Marine, pelagic and aerial. Breeds on islands.	Unlikely	Unlikely
Diomedea sanfordi	Northern Royal Albatross	E, Mi, Ma	E	Marine, pelagic and aerial. Nests on Chatham Islands.	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Falco peregrinus	Peregrine Falcon	-	R	A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and Migratory (Pizzey & Knight, 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests (Bamford, 2009). Possibly fly through however project not likely to impact on this species. More likely to encourage this species and provide advantageous benefit if towers used as part of project.	Known	Possible fly through Project Area
Falco subniger	Black Falcon	-	R	Sparsely spread across inland Australia where it is found along tree-lined watercourses and isolated woodlands. It may move to coastal areas and is known to have regular seasonal movements (Birdlife, 2020). Possibly fly through only, uncommon species unlikely to use whalers as part of critical habitat.	Known	Possible fly through Project Area
Gallinago hardwickii	Latham's Snipe	Mi, Ma	R	Wet grasslands and pastures, open and wooded swamps; spring-summer non-breeding migrant.	Unlikely	Unlikely
Haematopus fuliginosus	Sooty Oystercatcher	-	R	Occurs over the Southern Ocean. Non-breeding visitor to Australia. Breeds on Campbell I and Auckland Island (Birdlife, 2020). None recorded within area including targeted searches at Redbanks where beach was available, probably not extent of habitat required for permanent habitat. Definitely at Fishery Bay and may very infrequently utilise Redbanks Bay.	Known	Unlikely
Haliaeetus leucogaster	White-bellied Sea-Eagle	Ma	E	Occupies all coastal areas extending inland through main waterways, coastal islands, coastal lakes and along some inland rivers. It forages primarily for fish over large areas of open water. Was recorded flying along cliffs and probably does so frequently.	Known	Known

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
				Requires ongoing surveys to determine extent of use of Whalers area and potential impacts relating to rocket launching facility. Requires EPBC referral.		
Halobaena caerulea	Blue Petrel	V, Ma	-	Breeds offshore stacks near Macquarie Island. It forages in Antarctic and subantarctic waters (TSSC, 2015).	Unlikely	Unlikely
Hydroprogne caspia	Caspian Tern	Mi, Ma	-	Breeding in SA has been recorded along the coast from the Coorong north-west to Ceduna, and inland at Lake Eyre and Lake Goyder. It forages in open wetlands including lakes and rivers. Prefers sheltered shallow water near margins.	Unlikely	Unlikely
Larus pacificus	Pacific Gull	Ma	-	Prefers sandy beaches or sometimes rocky coasts and/or areas that are protected from ocean swells including estuaries, bays and harbours. It has also been seen on farmland and rubbish piles (Birdlife, 2020).	Possible	Unlikely
Leipoa ocellata	Malleefowl	V	V	Mallee woodlands, scrubland and heathlands, often with sandy substrate. Breed in areas with good leaf litter layer. Occasional forage in open areas, including farmland and clearing amongst mallee.	Unlikely	Unlikely
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater	-	R	Inhabits mallee heathlands and sometimes mallee with open understorey. Preferred habitat present along with historical records. Other honeyeater species present within project areas in high abundance. No individuals recorded however would utilise area periodically and targeted approach to identifying this species would likely be successful.	Known	Likely
Limosa lapponica	Bar-tailed Godwit	Mi, Ma	R	Coastal habitats including large intertidal sandflats, banks, mudflats, estuaries, inlets and harbours. Forages near edge of water, prefers soft mud.	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
				Roosts on sandy beaches, sandbars, spits and near-coastal saltmarsh.		
Limosa lapponica baueri	Bar-tailed Godwit	V	-	Non-breeding visitor to Australia where it occurs in coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (TSSC, 2016a).	Possible	Unlikely
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE	-	Non-breeding visitor to Australia where it occurs in coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays (TSSC, 2016b).	Possible	Unlikely.
Macronectes giganteus	Southern Giant-Petrel	E, Mi, Ma	V	This species breeds on subantarctic and Antarctic islands in Australian territory.	Unlikely	Unlikely
Macronectes halli	Northern Giant Petrel	V, Mi, Ma	-	Breeds in the sub-Antarctic and visits Australian mainland during winter months. Commonly seen in waters around Fremantle (Western Australia) to Sydney (New South Wales).	Unlikely	Unlikely
Merops ornatus	Rainbow Bee-eater	Ma	-	Spring-summer migrants to Victoria where they occur in many wooded habitats with an annual rainfall of less than 800mm, especially north of the Great Divide; often along vegetated watercourses and cuttings or banks along watercourses. Lack of cuttings and nesting areas for species. Lack of historical records suggests unlikely.	Unlikely	Unlikely
Motacilla cinerea	Grey Wagtail	Mi, Ma	-	The grey wagtail is found around fast-flowing mountain streams, often in forested areas, as well as lowland watercourses such as canals and rivers.	Unlikely	Unlikely
Motacilla flava	Yellow Wagtail	Mi, Ma	-	The yellow wagtail occurs in a variety of damp or wet habitats with low vegetation, from rushy pastures, meadows, hay fields and marshes to damp steppe and grassy tundra.	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Neophema elegans	Elegant Parrot	-	R	Inhabits open areas including grasslands, shrublands, mallee, woodlands and thickets, bluebush plains, heathlands, saltmarsh and farmland (Birdlife, 2020). Suitable habitat present. One sighting in 2004.	Known	Likely
Neophema petrophila	Rock Parrot	-	R	Restricted to coastlines and offshore rocky islands, frequenting windswept coastal dunes, mangroves, saline swamps and rocky islets (Birdlife, 2020). Suitable habitat present. Sighted 17 times in 2004 comprising 479 individuals and other surveys have noted high abundance and frequency of this species within coastal fringe and low dune swales. One of the more common species at Whalers Way.	Known	Present
Numenius madagascariensis	Eastern Curlew	CE, Mi, Ma	V	Coastal lakes, estuaries, tidal mudflats and sandflats, mangroves and saltmarshes; occasionally fresh or brackish lakes near coast; mainly spring-summer non-breeding migrant.	Unlikely	Unlikely
Pachyptila turtur subantarctica	Fairy Prion (southern)	V	-	Breeds on Macquarie Island and other subantarctic islands.	Unlikely	Unlikely
Pandion haliaetus	Osprey, Eastern Osprey	Mi, Ma	E	Occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia. Found in coastal areas of open fresh, brackish or saline water for foraging. Four records, five individuals. Lack of data to determine level of habitat utilisation. Requires EPBC referral.	Known	Present
Pezoporus occidentalis	Night Parrot	E	E	Extinct in south-eastern Australia; historical records from arid and semi-arid chenopod shrublands, spinifex (Triodia) on stony rises, flats around salt lakes and flooded claypans. Lack of suitable habitat.	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Phalacrocorax fuscescens	Black-faced Cormorant	Ma	-	Coastal waters where they are found in flocks in large bays, deep inlets, rocky headlands and islands.	Possible	Unlikely
Phoebetria fusca	Sooty Albatross	Mi, Ma	E	This species is marine and pelagic and breeds on subtropical and subantarctic islands in the Indian and Atlantic Oceans.	Unlikely	Unlikely
Psophodes leucogaster	Mallee Whipbird (eastern subspecies)	V	E	Occupies mallee and thicket vegetation in coastal and inland areas of southern SA (DAWE, 2020b). 80 records and heard with high frequency during targeted surveys. Very difficult to determine how many individuals present due to inconspicuous nature however appear to be relatively abundant within Whalers Way area.	Known	Present
Pterodroma mollis	Soft-plimaged Petrel	Ma		Marine, oceanic species that is a non-breeding visitor to Australia.	Unlikely	Unlikely
Rostratula australis	Australian Painted Snipe	Ma	V	Inhabits shallow terrestrial freshwater wetlands and inundated or waterlogged grassland or saltmarsh. Exposed bare wet mud with ample canopy cover nearby are preferred.	Unlikely	Unlikely
Stagonoleura guttata	Diamond Firetail	-	V	Open grassy woodland, heath and farmland or grassland with scattered trees (Birdlife, 2020). One record of 10 individuals in BDBSA as well as additional record during baseline assessments.	Known	Present
Sternula nereis nereis	Australian Fairy Tern	V	V	Nests in southern Australia on sheltered sandy beaches, spits and banks above the high tide line and below vegetation between October and February. Occupies a variety of habitats including offshore, estuarine or lacustrine islands, wetlands and mainland coastline. Sighted in 2004. Likely to be around.	Likely	Likely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Stipiturus malachurus parimeda	Southern Emu-wren (Eyre Peninsula)	V	E	This species is confined to the extreme south of the Eyre Peninsula. It occurs in shrubland/heathland, mallee and sedgeland. 74 sightings in 2004 comprising 109 individuals. Targeted surveys identified presence within project area and also along all areas of suitable habitat within 50m of coast edge. See targeted survey assessment report. EPBC referral required.	Known	Present
Thalassarche cauta cauta	Shy Albatross	V, Mi, Ma	V	Marine species that occurs in subantarctic and subtropical waters. It is a non-breeding visitor to Australia.	Unlikely	Unlikely
Thalassarche cauta steadi	White-capped Albatross	V, Mi, Ma	-	Marine species that occurs in subantarctic and subtropical waters. It is a non-breeding visitor to Australia.	Unlikely	Unlikely
Thalassarche impavida	Campbell Albatross	V, Mi, Ma	V	Marine sea bird and specialised shelf feeders. They are non-breeding visitors to Australian waters.	Unlikely	Unlikely
Thalassarche melanophris	Black-browed Albatross	V, Mi, Ma	-	Marine sea bird that inhabits Antarctic, subantarctic and temperate waters and occasionally enters the tropics. It forages around breaks of continental and island shelves and across nearby underwater banks.	Unlikely	Unlikely
Thinornis rubricollis rubricollis	Eastern Hooded Plover	V, Ma	V	Mainly occurs on wide beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. Suitable habitat present. Sighted 20 times in 2004 comprising 50 individuals. No records within Redbanks Bay where beach has lack of refuge sites with boulders present at base of cliff at high tide mark. Sure to be present at Fisheries Beach however unlikely within close proximity to project area.	Likely	Unlikely
Tringa nebularia	Common Greenshank	Mi, Ma	-	Found in a variety of inland wetlands and sheltered coastal habitats. It occurs in sheltered coastal	Likely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
				habitats, typically with large mudflats and saltmarsh, mangroves or seagrass.		
Turnix varius	Painted Buttonquail	-	R	Prefer closed canopies with understorey cover in temperate and eastern tropical forests and woodlands (Birdlife, 2020). Also known from scrub and grassy habitat. Suitable habitat present. Sighted three times in 2004 comprising 23 individuals. Likely within mallee habitats within Whalers Way.	Likely	Likely
Zanda (Calyptorhynchus) funerea whiteae	Yellow-tailed Black Cockatoo	-	V	Favours Eucalypt woodland and pine plantations (Birdlife, 2020). Six records sighted in 2004 comprising 14 individuals. Potentially flyover, the project area does not support habitat for this species however they may infrequently fly through area to foraging patches on southern EP.	Likely	Possible
Fish						
Acentronura australe	Southern Pygmy Pipehorse	Ma	-	Not considered	-	Marine
Campichthys galei	Gale's Pipefish	Ma	-	Not considered	-	Marine
Carcharodon carcharias	White Shark	V, Mi, Ma	-	Not considered	-	Marine
Filicampus tigris	Tiger Pipefish	Ma	-	Not considered	-	Marine
Heraldia nocturna	Upside-down Pipefish	Ma	-	Not considered	-	Marine
Hippocampus abdominalis	Big-belly Seahorse	Ma	-	Not considered	-	Marine
Hippocampus breviceps	Short-head Seahorse	Ma	-	Not considered	-	Marine

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Histiogamphelus cristatus	Rhino Pipefish	Ma	-	Not considered	-	Marine
Hypselognathus horridus	Shaggy Pipefish	Ma	-	Not considered	-	Marine
Hypselognathus rostratus	Knifesnout Pipefish	Ma	-	Not considered	-	Marine
Kaupus costatus	Deepbody Pipefish	Ma	-	Not considered	-	Marine
Lamna nasus	Porbeagle	Mi, Ma	-	Not considered	-	Marine
Leptoichthys fistularius	Brushtail Pipefish	Ma	-	Not considered	-	Marine
Lissocampus caudalis	Australian Smooth Pipefish	Ma	-	Not considered	-	Marine
Lissocampus runa	Javelin Pipefish	Ma	-	Not considered	-	Marine
Maroubra perserrata	Sawtooth Pipefish	Ma	-	Not considered	-	Marine
Notiocampus ruber	Red Pipefish	Ma	-	Not considered	-	Marine
Phycodurus eques	Leafy Seadragon	Ma	-	Not considered	-	Marine
Phyllopteryx taeniolatus	Common Seadragon	Ma	-	Not considered	-	Marine
Pugnaso curtirostris	Pugnose Pipefish	Ma	-	Not considered	-	Marine
Solegnathus robustus	Robust Pipehorse	Ma	-	Not considered	-	Marine
Stigmatopora argus	Spotted Pipefish	Ma	-	Not considered	-	Marine

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Stigmatopora nigra	Widebody Pipefish	Ma	-	Not considered	-	Marine
Stipecampus cristatus	Ringback Pipefish	Ma	-	Not considered	-	Marine
Urocampus carinirostris	Hairy Pipefish	Ma	-	Not considered	-	Marine
Vanacampus margaritifer	Mother-of-pearl Pipefish	Ma	-	Not considered	-	Marine
Vanacampus phillipi	Port Phillip Pipefish	Ma	-	Not considered	-	Marine
Vanacampus poecilolaemus	Longsnout Pipefish	Ma	-	Not considered	-	Marine
Vanacampus vercoi	Verco's Pipefish	Ma	-	Not considered	-	Marine
Mammals						
Arctocephalus forsteri	Long-nosed Fur-seal	Ma	-	Not considered	-	Marine
Balaena glacialis australis	Southern Right Whale	E, Mi, Ma	V	Not considered	-	Marine
Balaenoptera acutorostrata	Minke Whale	Ma	R	Not considered	-	Marine
Balaenoptera borealis	Sai Whale	V, Mi, Ma	V	Not considered	-	Marine
Balaenoptera edeni	Bryde's Whale	Mi, Ma	R	Not considered	-	Marine
Balaenoptera musculus	Blue Whale	E, Mi, Ma	E	Not considered	-	Marine
Balaenoptera physalus	Fin Whale	V, Mi, Ma	V	Not considered	-	Marine

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Caperea marginata	Pygmy Right Whale	Mi, Ma	R	Not considered	-	Marine
Delphinus delphis	Common Dolphin	Ma	-	Not considered	-	Marine
Grampus griseus	Risso's Dolphin	Ma	R	Not considered	-	Marine
Lagenorhynchus obscurus	Dusky Dolphin	Mi, Ma	-	Not considered	-	Marine
Megaptera novaeangliae	Humpback Whale	V, Mi, Ma	V	Not considered	-	Marine
Neophoca cinerea	Australian Sea-lion	E, Ma	V	Not considered	-	Marine
Orcinus orca	Killer Whale	Mi, Ma	-	Not considered	-	Marine
Tursiops aduncus	Indian Ocean Bottlenose Dolphin	Ma	-	Not considered	-	Marine
Tursiops truncatus s. str.	Bottlenose Dolphin	Ma	-	Not considered	-	Marine
Reptiles						
Caretta caretta	Loggerhead Turtle	E, Mi, Ma	E	Non-breeding visitor to SA waters. They live at or near the surface of the ocean and move with currents.	Unlikely	No suitable habitat present.
Chelonia mydas	Green Turtle	V, Mi, Ma	V	A non-breeding visitor to SA waters. They drift on ocean currents and are often found with driftlines and rafts of *Sargassum* sp.	Unlikely	No suitable habitat present.
Dermochelys coriacea	Leatherback Turtle	E, Mi, Ma	V	A non-breeding visitor to most Australian waters. This species is highly pelagic and only comes close to shore during nesting season.	Unlikely	No suitable habitat present.

Conservation codes:

EPBC Act: CE Critically endangered, E Endangered, V Vulnerable, Mi Migratory, Ma Marine
NPW Act: E Endangered, V Vulnerable, R Rare

Appendix G

Vegetation Associations

Appendix G Vegetation Associations

1.0 Vegetation Associations

Six vegetation associations were observed within the Project Areas (Table 32). These were all typical of coastal communities commonly occurring within the southern Eyre Peninsula region.

Table 32 Vegetation Associations Observed within the Project Area

Number	Description
1	*Beyeria lechenaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Tea-tree) Low Shrubland over sclerophyllous shrubs
2	*Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland
3	*Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs
4	*Eucalyptus angulosa* (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee
5	*Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses
6	*Callitris* sp. 'Limestone' (Native Pine) Low Shrubland

Vegetation associations are discussed in further detail on the following pages.

Vegetation Association 1: *Beyeria lechenaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Teatree) Low Shrubland over sclerophyllous shrubs.

Vegetation Association 1 was largely and primarily dominant on the near cliff zone where stable dune habitats were present intertwined with exposed sheet limestone which was generally devoid of vegetation or contained only sparse sclerophyllous shrubs. Cover within Association 1 was generally high with the most diverse floristic community observed across the area with a mix of primarily coast front species co-habiting with other taller shrubs which were persisting in the hollows resulting in a mixed community. This association had the highest visual incidence of small skinks and dragons observed opportunistically.

Low bird species richness was present with the windy conditions meaning many species were retreating to lower or more dense cover during the day.

A summary of floristic composition including weeds and Threatened species is presented in Table 33 with photographs in Plate 1 and Plate 2.

Table 33 *Beyeria lechenaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Teatree) Low Shrubland over sclerophyllous shrubs summary

Stratum	Dominating Species
Overstorey species	*Beyeria lechenaultii* (Coastal Turpentine) *Melaleuca lanceolata* (Moonah) *Acacia anceps* (Port Lincoln Wattle) *Acacia nematophylla* (Coast Wallowa) *Pomaderris obcordata* (Wedge leaf Pomaderris)
Midstorey species	*Spyridium phylicoides* (Narrow Leaf Spyridium) *Dodonaea humilis* (Dwarf Hopbush) *Acrotriche patula* (Prickly Ground-berry) *Acrotriche cordata* (Blunt leaf Ground-berry) *Eutaxia microphylla* (Common Eutaxia)
Understorey species	*Goodenia varia* (Sticky Goodenia) *Lomandra effusa* (Scented Mat Rush) *Carpobrotus rossii* (Pigface)
Threatened species	None observed
Exotic species	Limonium companyonis (Sea lavender)

Plate 1 Vegetation Association 1 mixed structure

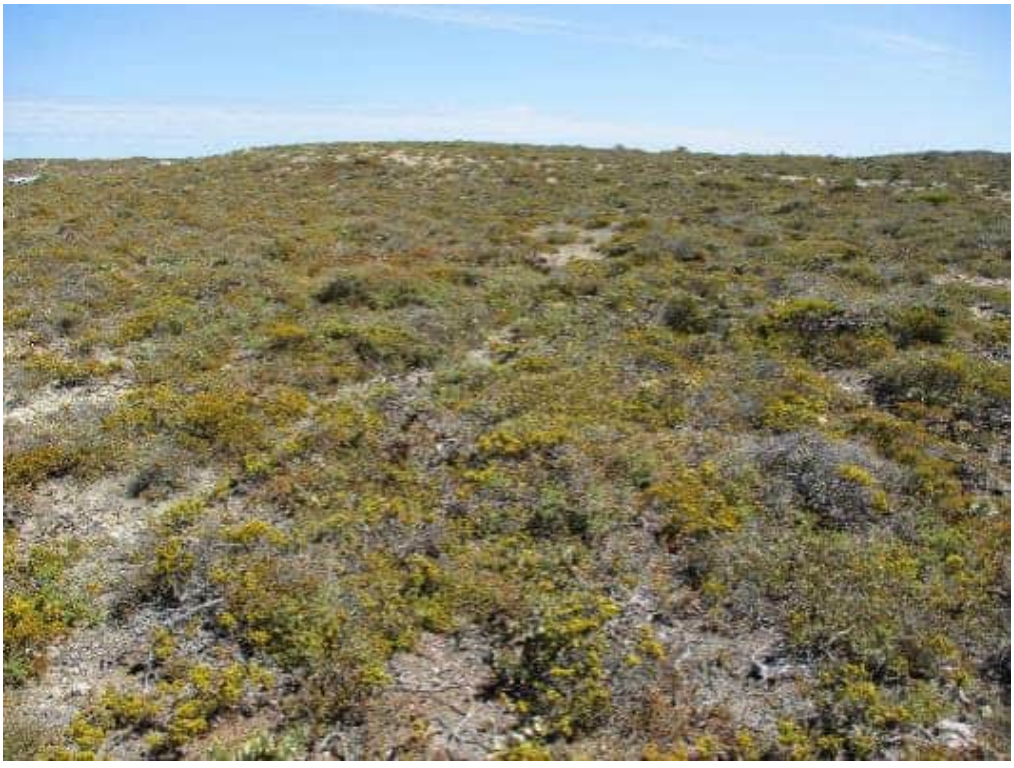

Plate 2 Vegetation Association 1 on grey sandy loam soils in semi sheltered low depressions or swales

Vegetation Association 2: *Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland.

Vegetation Association 2 occupies exposed and/or elevated sections of clifftop where a lack of soil, high alkalinity and salt laden winds result in specific niche communities dominated by ground hugging shrubs and mat plants. The average overstorey height in these areas is less than 300 mm in most instances.

A summary of floristic composition including weeds and Threatened species is presented in Table 34 with photographs in Plate 3 and Plate 4.

Table 34 *Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland summary

Stratum	Dominant Species
Overstorey species	*Acrotriche patula* (Prickly Ground-berry) *Acrotriche cordata* (Blunt leaf Ground-berry) *Eutaxia microphylla* (Common Eutaxia) *Spyridium phylicoides* (Narrow Leaved Spyridium)
Midstorey species	*Gahnia lanigera* (Black Grass Saw Sedge) *Pultenaea tenuifolia* (Narrow-leaf Bush Pea)
Understorey species	*Scaevola crassifolia* (Coast Fanflower) *Goodenia varia* (Sticky Goodenia) *Carpobrotus rossii* (Pigface)
Threatened species	None observed
Exotic species	*Limonium companyonis* (Sea Lavender)

Plate 3 **Vegetation Association 2 *Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland increasing cover with reduced topography**

Plate 4 **Vegetation Association 2 showing sparse cover on exposed stony rise**

Vegetation Association 3: *Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs.

Vegetation Association 3 communities were recorded on stable dunes where grey sandy loams overlay sheet limestone. These were often transitional between the low coastal shrublands of the clifftop edges and the higher elevation calcareous clay loam soils. Association 3 occurs in patches, varying from circular 'hummocks' to linear lunettes further from the coast. The interpatch spaces were generally sheet limestone occupied by Association 1. With distance from the coastline, the community structure changed by way of a more continuous and taller stratum with average heights of 3.5 m and a denser canopy cover.

A summary of floristic composition including weeds and Threatened species is presented in Table 35 with photographs in Plate 5 and Plate 6.

Table 35 *Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs summary

Stratum	Dominant Species
Overstorey species	*Eucalyptus diversifolia* (Coastal White Mallee) *Melaleuca lanceolata* (Moonah) *Melaleuca decussata* (Totem Poles)
Midstorey species	*Rhagodia candolleana* subsp. (Sea-berry Saltbush) *Olearia axillaris* (Coastal Daisy) *Exocarpos syrticola* (Coastal Ballart)
Understorey species	*Correa pulchella* (Salmon Correa) *Dianella revoluta* (Flax Lily) *Lasiopetalum discolor* (Coast Velvet-bush)
Threatened species	None observed
Exotic species	*Limonium companyonis* (Sea Lavender)

Plate 5 Vegetation Association 3 with Mixed Mallee and interpatch shrubland

Plate 6 Vegetation Association 3 Taller Eucalyptus diversifolia community approximately 2 km from coastline

Vegetation Association 4: *Eucalyptus angulosa* (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee

Vegetation Association 4 was present where soils were largely a calcareous silty loam. The soil surface was highly stable and formed a thick crust with high levels of biocrust and Moss species. *Melaleuca* species were a common species in this Association compared to those on lighter soils with *Eucalyptus diversifolia* (Coastal White Mallee). Inter-patches were dominated largely by Association 6 (*Callitris* sp. limestone). In areas where the community was protected from high coastal winds the strata were taller, with an average of 3 m compared to 2 m near the coast.

A summary of floristic composition including weeds and Threatened species is presented in Table 36 with photographs in Plate 7and Plate 8.

Table 36 *Eucalyptus angulosa* (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee summary

Stratum	Species
Overstorey species	*Eucalyptus angulosa* (Ridge-fruited Mallee) *Eucalyptus rugosa* (Coastal White Mallee) *Melaleuca lanceolata* (Moonah)
Midstorey species	*Callitris* subsp. Limestone (Native Pine) *Melaleuca decussata* (Totem Poles) *Exocarpos sparteus* (Broom Ballart) *Calytrix tetragona* (Fringe Myrtle) *Acacia nematophylla* (Coast Wallowa)
Understorey species	*Spyridium phylicoides* (Narrow Leaved Spyridium) *Carpobrotus rossii* (Pigface) *Gahnia lanigera* (Black Grass Saw-sedge)
Threatened species	None observed
Exotic species	None observed

Plate 7 Vegetation Association 4 approximately 2 km from coastline with taller canopy height and high litter cover

Plate 8 Vegetation Association 4 near coastline with low litter cover and canopy height of approximately 2 m

Vegetation Association 5: *Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses.

Vegetation Association 5 was a disturbed regenerating association with pioneer species such as *Adriana quadripartita* (Coast Bitter Bush) present that were otherwise absent from the intact sections of the Project site. Numerous environmental weed species were present throughout the area and grass species were overwhelmingly annual exotic species such as *Bromus* (Brome), *Vulpia* (Fescue) and Avena (Wild Oat). Overall, the condition was very poor and regeneration of local species was patchy.

A summary of floristic composition including weeds and Threatened species is presented in Table 37 with photographs in Plate 9 and Plate 10.

Table 37 Leucopogon *parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses summary

Stratum	Species
Overstorey species	*Leucopogon parvifolius* (Coastal Bearded-heath) *Acacia longifolia* subsp. (Coastal Wattle)
Midstorey species	*Adriana quadripartita* (Coast Bitter bush) *Clematis microphylla* (Old Mans Beard) *Ficinia nodosa* (Knobby Club Rush) *Acacia cupularis* (Cup Wattle)
Understorey species	Exotic annual grasses *Vittadinia cuneata* (Fuzzy New Holland Daisy) *Pimelea serpyllifolia* (Thyme Riceflower) *Gahnia deusta* (Limestone Saw Sedge)
Threatened species	None observed
Exotic species	*Marrubium vulgare* (Horehound) *Asphodelus fistulosus* (Onion Weed) *Dittrichia graveolens* (Stinkweed) *Asparagus asparagoides* (Bridal Creeper) - WONS

Plate 9 **Vegetation Association 5 Looking south with highly disturbed area with intact coastal vegetation in background**

Plate 10 **Vegetation Association 5 -Sparsely scattered regenerating coastal vegetation within interpatch of exotic grass and forbs. Note windmill and bore in left rear of image where vehicles parked**

Vegetation Association 6: *Callitris* sp. 'Limestone' (Native Pine) Low Shrubland.

Vegetation Association 6 was dominated by *Callitris* sp. 'Limestone' mixed with other sclerophyllous shrubs. It occurred exclusively with Association 4 on calcareous silty loam soils. Condition of these communities was generally good with the only perennial exotic species present *Limonium companyonis* (Sea Lavender) which increased with proximity to the coast.

A summary of floristic composition including weeds and Threatened species is presented in Table 38 with photographs in Plate 11.

Table 38 *Callitris* sp. 'Limestone' (Native Pine) Low Shrubland summary

Stratum	Species
Overstorey species	*Callitris* sp. 'Limestone' *Acacia nematophylla* (Coast Wallowa) *Exocarpos syrticola* (Coast Ballart) *Melaleuca lanceolata* (Dryland Teatree) *Melaleuca decussata* (Totem Poles) *Acacia anceps* (Port Lincoln Wattle)
Midstorey species	*Acrotriche patula* (Prickly Ground-berry) *Acacia triquetra* (Mallee Wreath Wattle) *Beyeria lechenaultii* (Pale Turpentine Bush) *Dodonaea humilis* (Dwarf Hop-bush)
Understorey species	*Carpobrotus rossii* (Pigface) *Lomandra effusa* (Scented Mat Rush *Eutaxia microphylla* (Common Eutaxia) *Gahnia lanigera* (Black Grass Saw-sedge)
Threatened species	None observed
Exotic species	*Limonium companyonis* (Sea Lavender)

Plate 11 Vegetation Association 6 near access road at Launch Site B patchy community structure

Appendix H

Fauna Species Recorded List

Appendix D Fauna Species List

Scientific Name	Common Name	Habitat Comment	EPBC Act	NPW Act	Exotic
Birds					
Morus serrator	Australasian Gannet	Cliffs			
Corvus coronoides	Australian Raven	Northern extent			
Cinclosoma castanotum	Chestnut-backed Quailthrush (Chestnut Quailthrush)	Association 4			
Phaps chalcoptera	Common Bronzewing	Widespread			
Sturnus vulgaris	Common Starling	Widespread			*
Stagonopleura guttata	Diamond Firetail	Block C, water trough		V	
Artamus cyanopterus	Dusky Woodswallow	Association 4			
Dromaius novaehollandiae	Emu	Widespread			
Pachycephala pectoralis	Golden Whistler	Northern Extent			
Eolophus roseicapilla	Galah	Widespread			
Cracticus torquatus	Grey Butcherbird	Northern extent			
Strepera versicolor	Grey Currawong	Block B			
Rhipidura albiscapa	Grey Fantail	Northern Extent			
Colluricincla harmonica	Grey Shrikethrush	Association 4			
Falco cenchroides	Nankeen Kestrel	Cliffs			
Phylidonyris novaehollandiae	New Holland Honeyeater	Widespread			
Pandion haliaetus	Osprey	Cliffs	Mi, Ma	E	
Larus pacificus	Pacific Gull	Cliffs			
Neophema petrophila	Rock Parrot	Widespread		R	
Zosterops lateralis	Silvereye	Widespread			
Gavicalis virescens	Singing Honey Eater	Widespread			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	Widespread			
Malurus cyaneus	Superb Fairywren	Widespread			
Petrochelidon nigricans	Tree Martin	Widespread			
Hirundo neoxena	Welcome Swallow	Widespread			
Psophodes nigrogularis leucogaster	Western Whipbird (Eastern)	Heard only, Association 4, Block D	V	E	
Haliaeetus leucogaster	White-bellied Sea Eagle	Western cliffs	Ma	E	
Pomatostomus superciliosus	White-browed Babbler	Block C, water trough			
Sericornis frontalis	White-browed Scrubwren	Widespread			
Rhipidura leucophrys	Willie Wagtail	Widespread			
Mammals					
Felis catus	Cat	Tracks / Widespread			*
Macropus fuliginosuss	Western Grey Kangaroo	Observed / Widespread			
Oryctolagus cuniculus	European Rabbit	Observed / Widespread			*
Vulpes vulpes	Red Fox	Scats / Widespread			*
Reptiles					
Tiliqua rugosa	Shingleback Lizard	Few obs. tracks			
Ctenophorus chapmani	Mallee Heath Dragon	Widespread			

Appendix I

Test Launch Campaign - Site Selection Survey Report

ECOSPHERE
Ecological Solutions

Whalers Way Orbital Launch Complex

Test Launch Campaign - Site Selection Survey

November 2021

Document information and distribution

Document information	
Item	Detail
Project number	-
Document title	Whalers Way Orbital Launch Complex Test Launch Campaign - Site Selection Survey
Client	Southern Launch
Prepared by	Marina Louter, Andrew Sinel
Reviewed by	Andrew Sinel and Matt McDonnell
Review date	09/07/2021
Document status	Final Updated (November 2021)
Version number	1

Document distribution				
Authors	Document status	Version no	Date of issue	Issued to
M Louter	Draft V1	1	05/07/2021	Matt McDonnell, AECOM
M Louter	Draft V1	1	09/07/2021	Andrew Curran, Southern Launch
M Louter	Final	1	28/07/2021	Andrew Curran, Southern Launch
M Louter	Final Updated	1	03/11/2021	Matt McDonnell, AECOM, Andrew Curran, Southern Launch

Acronyms and definitions

Abbreviation	Description
BOM	Bureau of Meteorology
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPSEW	Eye Peninsula Southern Emu-wren
GPS	Global Positioning System
km	Kilometre(s)
NPW Act	*National Parks and Wildlife Act 1972*
SA	South Australia(n)
sp.	Species
spp.	Species (plural)
ssp.	Sub-species
unk	Unknown
WBWB	White-bellied Whipbird
WWOLC	Whalers Way Orbital Launch Complex

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1 Introduction

Southern Launch is proposing to construct the Whalers Way Orbital Launch Complex (WWOLC). The WWOLC is proposed to be situated at the tip of the Eyre Peninsula in South Australia and is to be built as an orbital rocket launch facility. Southern Launch is proposing to undertake up to three test launches over a period of three (3) to six (6) months using non-explosive rockets (the Test Launch Campaign).

Data collection of the Test Launch Campaign will include a detailed series of works around noise and vibration monitoring, air quality monitoring and assessment of terrestrial and marine ecological effects to: (1) validate modelled data; and (2) determine the impact of launches on the environment with detailed monitoring and investigations undertaken prior, during and after each launch event.

To measure potential impacts of the Test Launch Campaign on avian fauna, a *Proposal for Southern Launch rocket testing, impacts on local avian fauna*, was prepared for the Project by Ecosphere Ecological Solutions in May 2021, detailing the proposed methodology (refer to Attachment 1 for details).

The primary avian species of concern within the Whalers Way area are the Nationally threatened Eyre Peninsula Southern Emu-wren (EPSEW) *Stipiturus malachurus parimeda* and the White-bellied Whipbird (WBWB) *Psophodes leucogaster leucogaster*, both of which have historical observations and suitable habitat within and surrounding the Project site. These bird species are listed as 'vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) and 'endangered' under the *National Parks and Wildlife Act 1972* (SA). Both subspecies have suffered major range-reduction from habitat loss from land clearance, and habitat degradation due to large fires and are now predominantly confined to the southern tip of Eyre Peninsula, in South Australia.

Both EPSEW and WBWB have been observed at the site of the Project in 2020 during a baseline vegetation survey and a targeted bird survey (Ecosphere Ecological Solutions 2020a,b). The targeted bird survey undertaken in May 2020 recorded 18 EPSEW at 12 independent sites. EPSEW were observed in pairs (n = 4), in groups of three (n = 1) and as individuals (n = 7). A total of 8 WBWB were recorded at seven (7) independent sites, and birds were almost exclusively heard and not seen (n =6). At one site a WBWB was observed flying low across one of the tracks within the Whalers Way Project Area.

In summary, the proposed methodology of *Proposal for Southern Launch rocket testing* consists of:

- the establishment of Control and Impact sites that can be used to monitor the impact of Test Launch Campaign activities and collect baseline data from these sites (before and after test launches).
- At Control and Impacts sites:
    - Undertake avian surveys including, 20min/2ha active searches to determine presence of common avian species and target species EPSEW and WBWB.
    - Undertake playback experiments before and after test launches to record impacts on local avian fauna including the behaviour of EPSEW and WBWB.

Data will be collected during five surveys, as per the below proposed schedule:

- Survey 1 - Site Selection Survey
- Survey 2 - Test Launch 1 - PRE Launch Survey
- Survey 3 - Test Launch 1 - POST Launch Survey
- Survey 4 - Test Launch 2 - POST Launch Survey
- Survey 5 - Test Launch 3 - POST Launch Survey

This summary report details the results of Survey 1 – the Site Selection Survey.

1.1 Objectives

The specific objectives of the Site Selection Survey were to:

- Re-visit sites within the Project Area (Impact Sites) where the two target species had previously been observed in 2020;
- Establish new sites within Lincoln National Park (Control Sites);
- Locate EPSEW and WBWB at each of the Control and Impacts Sites to:
    - Record song and vocalisations of individual birds of each species (as many individual independent songs as possible);
    - Determine occupancy of EPSEW and WBWB of sites (presence/absence);
    - Record the number of EPSEW and WBWB observed (abundance);
    - Where possible, record other local avifauna at sites (occupancy and abundance).
- Report the findings of the Site Selection Survey in a short Summary Report.

2 Methods

The site selection survey was conducted utilising methods consistent with Birdlife Australia Systematic Bird Surveys (2-ha, 20 minute Search) (Birdlife 2021a) and Department of Environment and Water (DEW) biological survey methods (Heard and Channon 1997; Owens 2000). The field survey was conducted under the following research and ethics permits/licenses:

- Scientific Research Permit No. E27057-1 (Department for Environment and Water);
- Wildlife Ethics Committee (WEC) Approval No. 6/2021, (Wildlife Ethics Committee); and
- Scientific Licence No. 370 (Animal Welfare, National Parks and Wildlife SA).

The survey methods are summarised in the following sections.

2.1 Establishing Impact and Control Sites

The focus of the Site Selection Survey was establishing Impact and Control Sites, with the aim to find individuals and record individual song of each of the target species. Known locations within Whalers Way (Impact Sites) were surveyed and previous locations of EPSEW and WBWB records in Lincoln National Park were surveyed to establish Control Sites, away from potential impacts of the Test Launch Campaign.

Surveys at sites were undertaken from 7am onwards with a focus on early mornings and late afternoons but continued throughout the day, due to changing weather conditions (rain and windy conditions – see Section 3.1).

At each site the following information was recorded for the two target species (if present):

- Location (hand-held GPS);
- Detection method (heard or seen); and
- Number of individuals.

2.2 Song recordings of focal bird species

Detection of birds: At each site a quick audio playback was used to initially detect if EPSEW or WBWB were present at sites. At each EPSEW site one surveyor briefly broadcasted either the '*malachurus* AM -song' (32 seconds) or the '*littleri* AM – song and contact calls' (29 seconds) from the electronic *Michael Morcombe eGuide to the Birds of Australia*. At each WBWB site audio playback was used initially (songs from electronic *Michael Morcombe eGuide to the Birds of Australia*), however given the lack of response to these stimuli surveyors stopped using playback. Instead surveyors would listen for song at previously identified WBWB sites.

As soon as a focal bird(s) were heard and/or seen the broadcast of playback was discontinued. Both surveyors would then aim to approach the location of the focal bird species as best and quietly as possible, stand still and record any vocalisations (calls and or songs) that were elicited in response to the broadcast. A surveyor would spend up to 15 minutes at a site to gain multiple song recordings of the focal species.

Song recordings: To record vocalisations, a High-Resolution Digital Audio Recorder 702 or 722 with 151 a 48 kHz sampling rate and 24 bit-depth (Sound Devices, LLC, Reedsburg, WI) connected to 7 152 a NTG8 shotgun microphone (RODE Microphones, LLC, Long Beach, CA; frequency 153 response 0.04 – 20 kHz) was used (Figure 1).

Figure 1. Dr M Louter recording EPSEW bird song within the Project Area, using a Digital Audio Recorder and NTG8 shotgun microphone.

All sound recordings were made using a sample rate of 48 kHz in 16 bit. The recordings were saved as .WAV sound files, transferred to an Apple Mac Pro (Apple Corporation, U.S.A), and visualized as spectrograms (see Figure 4, p13) using the software Amadeus Pro 1.5 (Hairersoft Inc, Switzerland) and Raven Pro 1.5 (Bioacoustics Research Program, 2011). We created

spectrograms in Raven Pro 1.5 using the Hann algorithm (16-bit sample format; Discrete Fourier Transform, DFT = 512 samples; frequency resolution = 135 Hz; time resolution 5.33 ms; frame overlap = 50 %).

2.3 Opportunistic bird observations

Throughout the survey period, avian species opportunistically observed were recorded and a bird list was prepared for Whalers Way and Lincoln National Park. Where possible, the presence of other avian species was recorded at EPSEW and WBWB sites, but this was not the focus of this survey and these observations were at times limited to opportunistic observations (i.e. non-systematic).

2.4 Limitations

The proposed avian methodology (as per the Proposal for Southern Launch rocket testing, impacts on local avian fauna) aims to collect invaluable baseline data of the target species populations, including song data, occupancy, numbers of birds and behaviour at Impact Sites and Control Sites.

Seasonal and weather have impact on avian surveys as birds are generally less active in the nonbreeding season and when climatic conditions are challenging (i.e. low temperatures, strong winds/rain).

Song recording data is generally difficult to obtain and requires suitable conditions (i.e. calm weather and limited/no background noise, suitable season to detect birds). Under challenging conditions (i.e. bad weather, nonbreeding season) it may be difficult to obtain sufficient song recording data to prepare playback stimuli for follow-up surveys.

Furthermore EPSEW are shy and secretive and birds are usually first detected by call, although their voice is feeble. Birds are difficult to flush from cover (Higgins *et al.* 2001), but do respond to playback. WBWB are timid, elusive and cryptic, occupy dense habitat and are more often heard than seen. Individual WBWB elicit distinctive song, which is usually the only indication of presence. Detection of EPSEW and WBWB is anticipated to be mainly by calls and brief sightings, although call detection requires calm conditions and results are dependent on season. It is known that detection of both species is most effective during the breeding season. Due to the difficulty in observing EPSEW and WBWB, surveys undertaken in the nonbreeding season may not represent the actual number of birds present at a site.

The data collected will not be exhaustive and has known limitations, as the proposed Test Launch Campaign avian survey work will be undertaken over a relatively short period of time (3-6 months), and at this stage surveys are limited to be undertaken over a period of 4 days per survey.

The first monitoring period (Survey 2 - Test Launch 1 - PRE Launch Survey) is proposed to occur over four days for a total of four monitoring surveys are proposed. The proposed methodology will be trialled during the PRE Launch Survey. Survey and/or playback protocols will be adapted where deemed required with the aim to collect statistically sound data and sample sizes are maximized as much as possible.

Results of the PRE Launch Survey and the first POST launch survey may dictate refinement of the proposed methodologies described above for subsequent Test Launches 2 and 3. Additional data may need to be collected, if deemed required.

3 Results

3.1 Survey timing

The Site Selection Survey was conducted from 15 to 18 June 2021, by ecologists A. Sinel and Dr M. Louter. Surveys were undertaken from 7am onwards with a focus on early mornings and late afternoons but continued throughout the day, due to changing weather conditions (rain and windy conditions – see below).

3.2 Climate and weather conditions

Port Lincoln is the nearest weather station with historical climate data for comparative purposes (station 018192, open since 1992). Weather conditions during the Site Selection Survey period were suboptimal and unfavourable for avian surveys with strong winds and gusts, cold conditions and low temperatures in the daytime through to the evenings (Table 1).

Maximum temperatures reached 19.0 C on 15 June 2021 and the coolest minimum reached 8.7˚C on 16 of June 2021. Strong winds and gusts of up to 59 km/hour were recorded during the survey period. A total of 15.8 mm of rainfall was recorded on 16 and 18 June, but rainfall was patchy with isolated heavy showers at the site on 16, 17 and 18 June 2021.

Table 1. Weather variables during the survey, as recorded at Port Lincoln weather station (BOM 2021).

Date	Min air temp (degrees ˚C)	Max air temp (degrees ˚C)	Rainfall (mm)	Max wind gust			9 am			3 pm		
				Direction	Speed (km/h)	Time (local)	Temp (degrees ˚C)	Direction	Speed	Temp (degrees ˚C)	Direction	Speed
15 June 2021	10.3	19.0	0.0	WNW	56	14:26	13.0	NNE	11	12.8	W	30
16 June 2021	8.7		3.4				9.8	NW	15	15.4	W	20
17 June 2021		16.0	0.0	SSW	59	21:35	12.3	WNW	17	12.2	SW	35
18 June 2021	9.4	15.2	12.4	S	56	3:49	12.8	SSW	28	13.6	S	31

3.3 Control and Impact Sites

The number of sites visited per species is presented below in Table 2.

EPSEW: A total of 17 EPSEW sites were visited during the Site Selection Survey, of which 5 sites were new locations (Table 2). EPSEW were observed at 9 out of the 17 sites. We observed 16 individuals: 1 single bird, 6 pairs and one group of three individuals. At 8 sites EPSEW could not be located, but it was deemed likely that the EPSEW could still be present there, as conditions were too windy to detect the species reliably. Some of the Impact Sites (EPSEW sites 7, 8 and 9) could not be visited due to bad weather and time limitations.

In summary, we anticipate that there are 14 EPSEW Impact sites at Whalers Way (Figure 2) and 5 EPSEW Control sites at Lincoln National Park (Figure 3). Song of EPSEW was recorded at 6 sites (described in Section 3.4 below).

WBWB: A total of 16 WBWB sites were visited, of which 10 sites were new locations. WBWB were heard or observed at 12 of these sites (Table 2, Figure 2-Figure 3). We recorded a minimum of 17 individuals: 4 single bird and 5 pairs and at 3 sites we heard at least one bird (unsure if 2). At the 4 sites where WBWB could not be located, it was deemed likely that the species could still be present, as conditions were too windy to detect the species reliably. Some of the Impact Sites (WBWB sites 2, 4-7) could not be visited due to bad weather and time limitations.

In summary, we anticipate that there are 13 WBWB Impact sites at Whalers Way (Figure 2) and 8 WBWB Control sites at Lincoln National Park (Figure 3). Song of WBWB was recorded at 8 sites (described in Section 3.4 below).

Table 2. Overview of EPSEW and WBWB survey effort during the Site Selection Survey in June 2021. Unk = unknown.

Site type	SITE ID	GPS Location	June Survey	Birds present ?	# of birds	Song recor d?	Comments
Impact	EPSEW1	53 H 557328 6133639	✓	×		×	
	EPSEW2	53 H 557334 6133535	✓	×		×	
	EPSEW3	53 H 557406 6133466	✓	✓	3	✓	
	EPSEW4	53 H 557477 6133947	✓	✓	2	✓	
	EPSEW5	53 H 557638 6134098	✓	×		×	
	EPSEW6	53 H 562434 6133039	✓	×		×	
	EPSEW7	53 H 561617 6133309	×	NA	NA	NA	Too windy
	EPSEW8	53 H 561326 6133327	×	NA	NA	NA	Too windy
	EPSEW9	53 H 560789 6133447	×	NA	NA	NA	Too windy
	EPSEW10	53 H 560561 6133729	✓	×		×	
	EPSEW11	53 H 556878 6133739	✓	✓	unk	×	Heard only
	EPSEW12	53 H 558655 6134055	✓	✓	2	✓	
	EPSEW13 (new)	53 H 557563 6133742	✓	✓	2	✓	
	EPSEW14 (new)	53 H 558305 6133903	✓	✓	1	×	Male only
Control	EPSEW15 Control Site 1 (new)	53 H 578946 6136022	✓	✓	2	✓	
	EPSEW16 Control Site 2 (new)	53 H 571873 6148112	✓	✓	2	✓	
	EPSEW17 Control Site 3 (new)	53 H 571889 6147543	✓	✓	2	×	Samphire site
	EPSEW18 Control Site 4	53 H 592760 6149185	✓	×		×	Too windy
	EPSEW19 Control Site 5	53 H 592010 6148026	✓	×		×	Too windy
	EPSEW20 Control Site 6	53 H 591444 6146916	✓	×		×	Too windy
Impact	WBWB1	53 H 557618 6134086	✓	✓	2	✓	
	WBWB2	53 H 557177 6134694	×	NA	NA	NA	Too windy
	WBWB3	53 H 560304 6133991	✓	✓	2	✓	
	WBWB4	53 H 560422 6134448	×	NA	NA	NA	Rain & wind
	WBWB5	53 H 560896 6133755	×	NA	NA	NA	Rain & wind
	WBWB6	53 H 562470 6135285	×	NA	NA	NA	Rain & wind
	WBWB7	53 H 557241 6134935	×	NA	NA	NA	Rain & wind
	WBWB8 (new)	53 H 559871 6134195	✓	✓	2	✓	
	WBWB9 (new)	53 H 560044 6134158	✓	✓	2	✓	
	WBWB10 (new)	53 H 559906 6134256	✓	✓	2	✓	
	WBWB11 (new)	53 H 557901 6133777	✓	✓	1	✓	
	WBWB12 (new)	53 H 562027 6133200	✓	✓	1	✓	
	WBWB13 (new)	53 H 562611 6134344	✓	✓	unk	×	Heard only
Control	WBWB14 Control site 1 (new)	53 H 578632 6144747	✓	✓	1	✓	Crossed road
	WBWB15 Control site 2 (new)	53 H 579225 6135850	✓	✓	1	×	On recording
	WBWB16 Control site 3 (new)	53 H 579223 6143522	✓	✓	unk	×	Heard only
	WBWB17 Control site 4 (new)	53 H 574400 6146800	✓	✓	unk	×	Samphire site
	WBWB18 Control site 5	53 H 579703 6141530	✓	×		×	Rain & wind
	WBWB19 Control site 6	53 H 585998 6146300	✓	×		×	Rain & wind
	WBWB20 Control site 7	53 H 586287 6145533	✓	×		×	Rain & wind
	WBWB21 Control site 8	53 H 587750 6142600	✓	×		×	Rain & wind

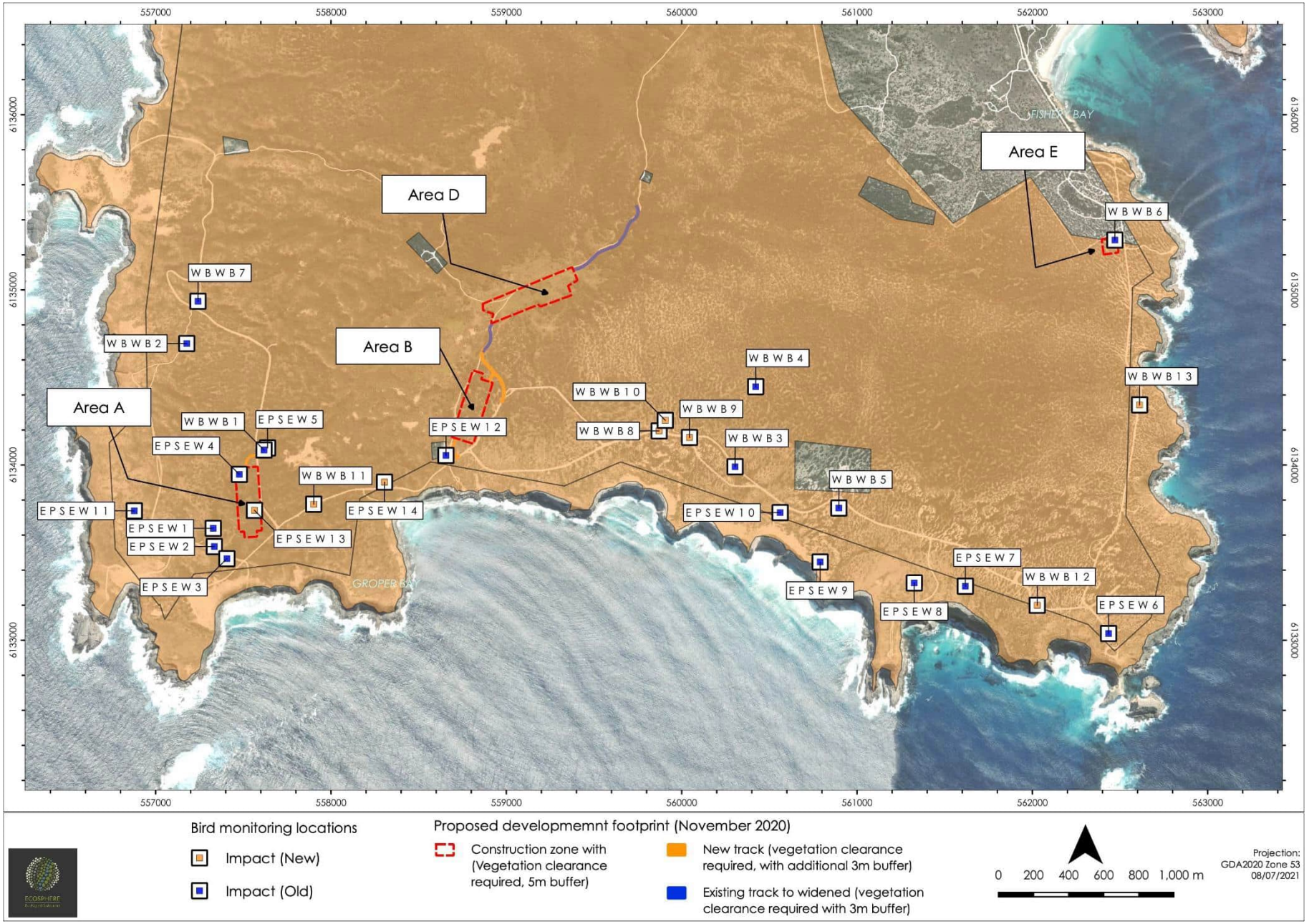

Figure 2. Location of EPSEW and WBWB Impact sites within the Project area in Whalers Way.

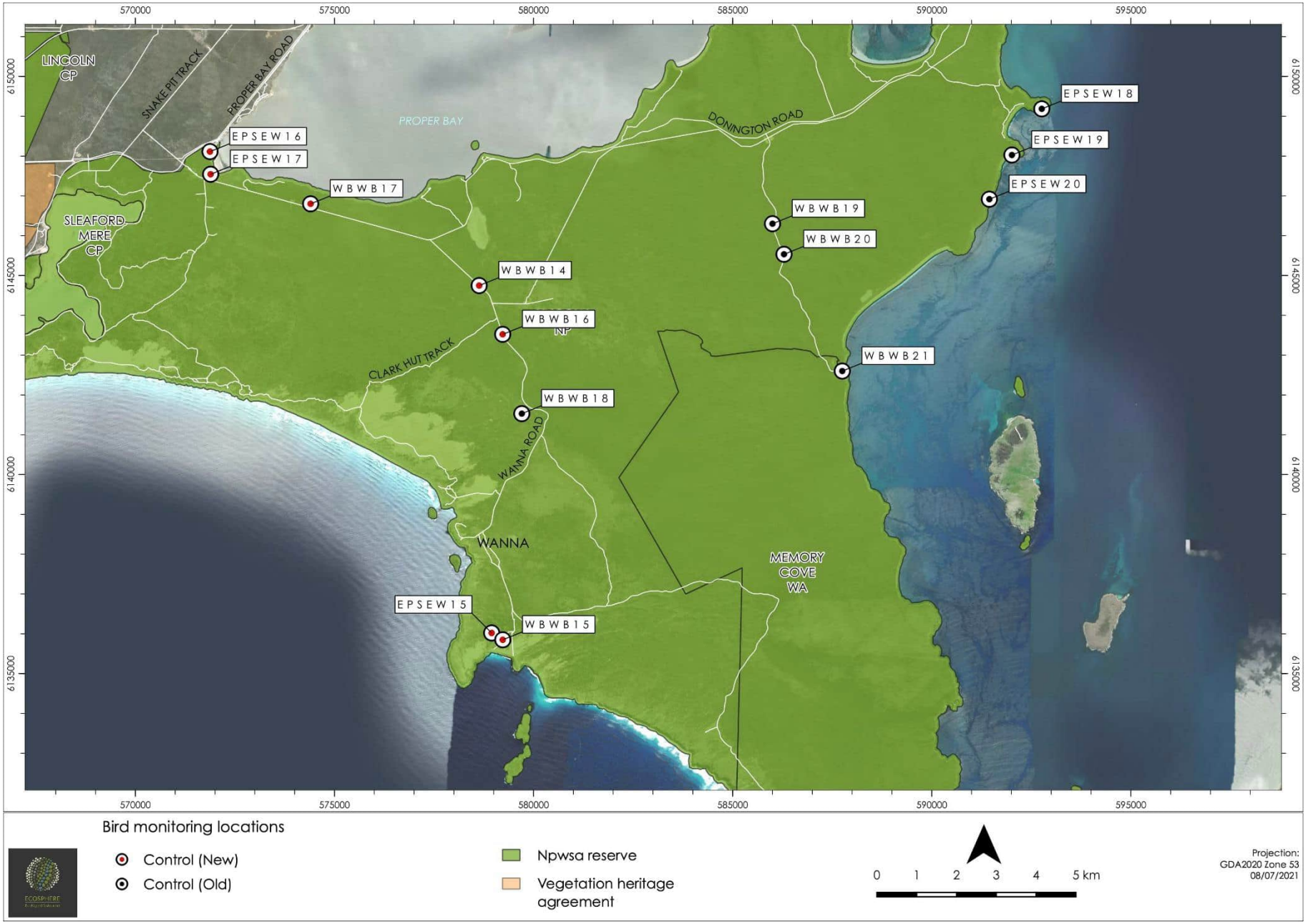

Figure 3. Location of EPSEW and WBWB Control sites within Lincoln National Park.

3.4 Song recordings

We recorded a total of 21 tracks with EPSEW and WBWB vocalisations, at 14 independent sites (6 EPSEW and 8 WBWB sites) (Table 3, Figure 2-Figure 3). The quality of recordings varied greatly due to the challenging conditions in the field (e.g. strong winds and rain), which resulted in a lot of background noise on some tracks. In many instances vocalisations or the target species were overlapping with song broadcasted by other avian species (e.g. New Holland Honey-eater, White-Browed Scrubwren, Silvereye and Welcome Swallow) at the sites. The quality of vocalisations on all 21 tracks was analysed by listening to the recordings, as well as visualizing song data as spectrograms in Raven Pro 1.5. Each track was assigned a broad quality rating (good, fair, bad). Examples of good quality songs (i.e. no background noise or overlap with other species) are presented below in (Figure 4).

It was found that EPSEW have at least 3 different types of vocalisations: song (Figure 4 – top), contact calls (Figure 5 – left)and high frequency alarm thrills (Figure 5 - right). For EPSEW 9 songs were recorded from 6 independent sites, consisting of 6 songs of good quality and 3 songs of fair quality (Table 3).

WBWB 15 songs were recorded from 8 independent sites, consisting of 4 songs of good quality and 11 songs of fair quality (Table 3). The quality of three tracks was too low (bad) to extract WBWB songs from.

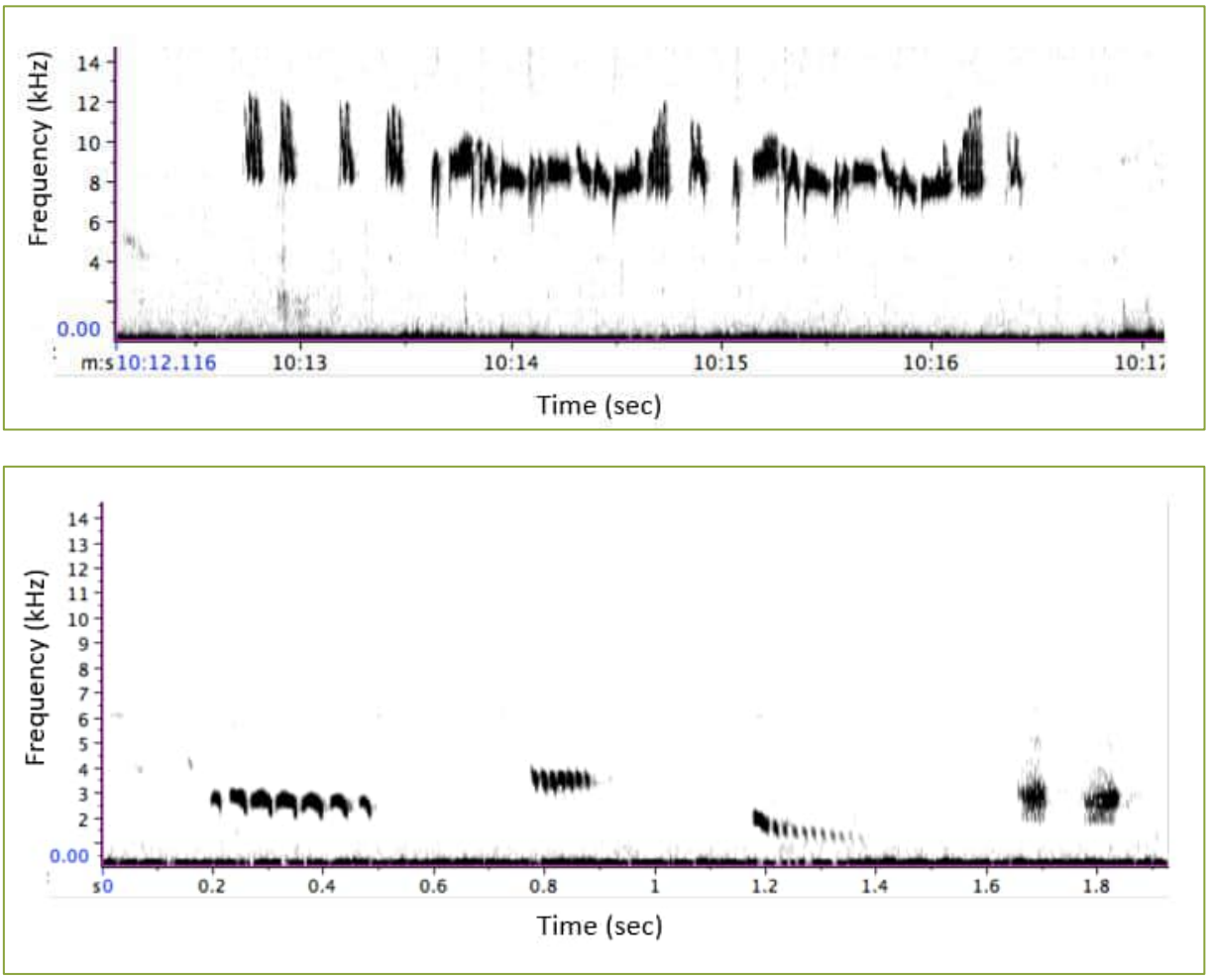

Figure 4. Example Raven Pro 1.5 spectrographs of EPSEW song (top) and WBWB song (bottom), recorded at Whalers Way in June 2021.

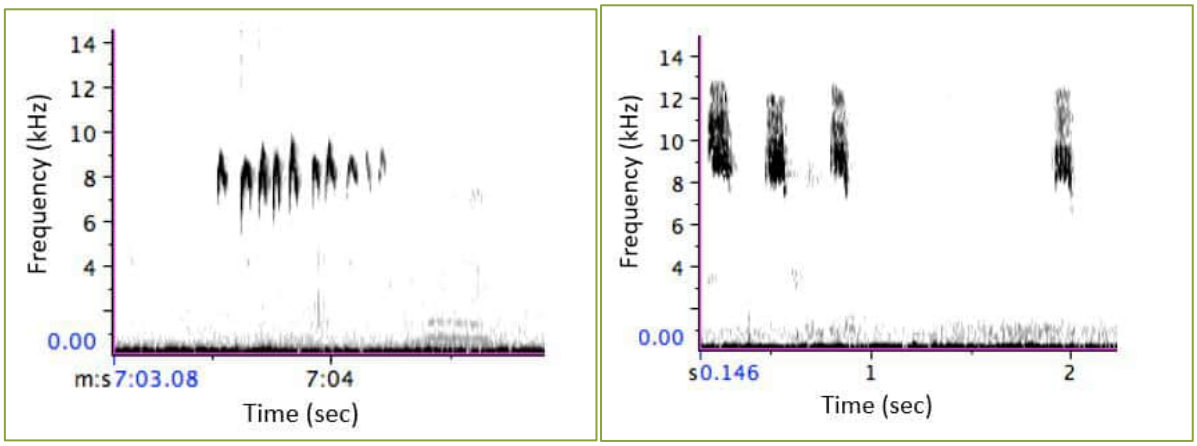

Figure 5. Example Raven Pro 1.5 spectrographs of a EPSEW contact call (left) and EPSEW alarm thrills (right), recorded at Whalers Way in June 2021.

Table 3. Overview of tracks and song data recorded for EPSEW and WBWB in June 2021.

#	Track name	SITE ID	Song type	Quality	Time on track
1	T10.WAV	EPSEW4	EPSEW Song	Fair	05'23"461
2	T10.WAV	WBWB1	WBWB Song	Fair	07'31"389
3	T10.WAV	WBWB1	WBWB Song	Fair	08'50"129
4	T10.WAV	WBWB1	WBWB Song	Good	06'45"855
5	T10.WAV	WBWB1	WBWB Song	Good	08'30"546
6	T10.WAV	WBWB1	WBWB Song	Good	09'12"163
7	T11.WAV	EPSEW4	EPSEW Song	Good	02'23"805
8	T11.WAV	EPSEW4	EPSEW Song	Good	05'26"088
9	T11.WAV	EPSEW4	EPSEW Song	Good	06'00"117
10	T11.WAV	EPSEW4	EPSEW contact calls	Good	06'31"526
11	T18.WAV	WBWB1	WBWB Song	Fair	00'24"219
12	T20.WAV	EPSEW12	EPSEW Song	Good	08'41"637
13	T20.WAV	EPSEW12	EPSEW contact calls	Good	05'14"032
14	T21.WAV	EPSEW Control site 1	EPSEW Song	Good	10'12"074
15	T21.WAV	EPSEW Control site 1	EPSEW contact calls	Good	07'03"171
16	T24.WAV	EPSEW Control Site 2	EPSEW Song	Fair	02'08"898
17	T24.WAV	EPSEW Control Site 2	EPSEW contact calls	Good	01'18"474
18	T24.WAV	EPSEW Control Site 2	EPSEW contact calls	Good	01'29"054
19	T24.WAV	EPSEW Control Site 2	EPSEW contact calls	Good	01'39"194
20	T27.WAV	WBWB3	WBWB Song	Bad	00'25"046
21	T28.WAV	WBWB3	WBWB Song	Bad	00'03"466
22	T29.WAV	WBWB9	WBWB Song	Fair	00'02"118
23	T29.WAV	WBWB9	WBWB Song	Fair	01'04"675
24	T30.WAV	WBWB10	WBWB Song	Fair	00'03"871
25	T30.WAV	WBWB10	WBWB Song	Fair	00'42"234
26	T31.WAV	WBWB8	WBWB Song	Fair	00'00"632
27	T32.WAV	WBWB10	WBWB Song	Fair	00'01"918
28	T35.WAV	EPSEW3	EPSEW Song	Good	00'59"054
29	T39.WAV	WBWB11	WBWB Song	Fair	00'00"257
30	T40.WAV	WBWB12	WBWB Song	Good	00'13"313
31	T42.WAV	WBWB14 Control site 1	WBWB Song	Bad	00'01"100
32	T7_1.WAV	EPSEW13	EPSEW Song	Fair	03'48"416
33	T7_1.WAV	WBWB8	WBWB Song	Fair	02'30"487
30	T40.WAV	WBWB12	WBWB Song	Good	00'13"313

3.5 Bird observations

3.5.1 Species observed at Whalers Way and Lincoln National Park

Desktop and database searches identified 61 species in the general area of Whalers Way and Lincoln National Park (Ecosphere 2020). These species and their conservation status under commonwealth and SA state legislation are listed in Table 4 below.

Avian diversity at Whalers Way increased slightly between 2020 and 2021, with 31 species observed in June 2020 and 36 species observed in June 2021 (Table 4). During the Site Selection Survey a total of 47 bird species were observed from 15 to 18 June 2021. Avian diversity did not differ much between Whalers Way Lincoln and National Park, with 36 and 32 species recorded respectively.

3.5.2 Species observed at ESPSEW sites

At each EPSEW site avian species were recorded as much as possible. A total of 24 different bird species were observed at EPSEW sites. Avian species diversity at sites varied, from a minimum of one species, to a maximum of 15 species per site (Table 5). The large variation is likely due to differences in weather conditions as some sites were only surveyed for a short time, as they were cut short due to rain. Time constraints did not permit to re-visit survey sites more than once.

3.5.3 Species observed at WBWB sites

At each WBWB site avian species were recorded as much as possible. A total of 13 different bird species were observed at WBWB sites. Avian species diversity at sites varied, from a minimum of one species, to a maximum of 8 species per site (Table 6). The large variation is likely due to differences in weather conditions as some sites were only surveyed for a short time, as they were cut short due to rain. Time constraints did not permit to re-visit survey sites more than once.

Table 4. Number of bird species overserved at Whalers Way (2020 and 2021 data) and Lincoln National Park (2021 data). * Denotes exotic species. Species shaded in grey have not been observed at any of the sites.

Scientific Name	Common Name	Conservation status		Whalers Way (June 2020)	Whalers Way (June 2021)	Lincoln NP (June 2021)
		EPBC Act	NPW Act			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater			✓		✓
Acanthiza apicalis	Inland Thornbill				✓	
Accipiter cirrocephalus cirrocephalus	Collared Sparrowhawk					
Accipiter fasciatus fasciatus	Brown Goshawk					
Anthochaera carunculata woodwardi	Red Wattlebird				✓	✓
Anthus australis	Australian Pipit				✓	✓
Aquila audax	Wedge-tailed eagle				✓	
Artamus cyanopterus	Dusky Woodswallow			✓	✓	✓
Barnardius zonarius	Australian Ringneck				✓	
Cacomantis flabelliformis	Fan-tailed Cuckoo			✓	✓	✓
Calamanthus (Calamanthus) campestris	Rufous Fieldwren			✓	✓	✓

Scientific Name	Common Name	Conservation status		Whalers Way (June 2020)	Whalers Way (June 2021)	Lincoln NP (June 2021)
		EPBC Act	NPW Act			
Chroicocephalus novaehollandiae	Silver Gull					
Circus approximans	Swamp Harrier					
Colluricincla harmonica	Grey Shrikethrush			✓		
Coracina novaehollandiae	Black-faced Cuckooshrike					✓
Corvus coronoides	Australian Raven			✓	✓	✓
Cracticus torquatus	Grey Butcherbird			✓		
Dromaius novaehollandiae	Emu			✓	✓	
Drymodes brunneopygia	Southern Scrub Robin				✓	✓
Egretta novaehollandiae	White-faced Heron					✓
Eolophus roseicapilla	Galah				✓	
Eopsaltria griseogularis	Western Yellow Robin				✓	✓
Falco cenchroides	Nankeen Kestrel			✓	✓	
Gavicalis virescens	Singing Honeyeater			✓	✓	
Gliciphila melanops	Tawny-crowned Honeyeater				✓	✓
Grallina cyanoleuca	Magpie Lark				✓	
Gymnorhina tibicen	Australian Magpie				✓	
Haematopus fuliginosus	Sooty Oystercatcher		R			✓
Haliaeetus leucogaster	White-bellied Sea Eagle		E	✓	✓	
Hirundo neoxena	Welcome Swallow			✓	✓	✓
Hydroprogne caspia	Caspian Tern					
Larus pacificus	Pacific Gull			✓	✓	
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater		R			
Malurus cyaneus leggei	Superb Fairywren			✓	✓	✓
Malurus pulcherrimus	Blue-breasted Fairywren					✓
Morus serrator	Australasian Gannet			✓	✓	✓
Neophema elegans	Elegant Parrot		R			
Neophema petrophila	Rock Parrot		R	✓	✓	✓
Pachycephala pectoralis	Australian Golden Whistler			✓		✓
Pandion haliaetus	Osprey			✓	✓	✓
Pardalotus striatus	Striated Pardalote					✓
Petrochelidon nigricans	Tree Martin			✓		
Phaps chalcoptera	Common Bronzewing			✓	✓	✓
Phaps elegans	Brush Bronzewing			✓	✓	✓
Phylidonyris novaehollandiae	New Holland Honeyeater			✓	✓	✓
Pomatostomus superciliosus	White-browed Babbler			✓	✓	✓
Psophodes nigrogularis leucogaster	White-bellied Whipbird	VU	E	✓	✓	✓
Rhipidura albiscapa	Grey Fantail			✓		✓
Rhipidura leucophrys	Willie Wagtail			✓	✓	✓
Sericornis maculatus mellori	Spotted scrubwren			✓	✓	✓
Stagonopleura guttata	Diamond Firetail			✓		
Sternula nereis	Fairy Tern	VU	E			
Stipiturus malachurus parimeda	southern Eyre Peninsula Southern Emuwren	VU	E	✓	✓	✓
Strepera versicolor	Grey Currawong				✓	
**Sturnus vulgaris*	Common Starling			✓	✓	✓
**Turdus merula*	Common Blackbird					
Turnix varius	Painted Buttonquail		R			
Zosterops lateralis	Silvereye			✓	✓	✓
			TOTALS	**31**	**36**	**32**

Table 5. Number of bird species overserved at EPSEW sites in June 2021. * Denotes exotic species. Species shaded in grey have not been observed at any of the sites. Sites in red text have not been surveyed due to weather and time constraints.

Scientific Name	Common Name	Conservation status		EPSEW1	EPSEW2	EPSEW3	EPSEW4	EPSEW5	EPSEW6	EPSEW7	EPSEW8	EPSEW9	EPSEW10	EPSEW11	EPSEW12	EPSEW13	EPSEW14	EPSEW15 Control Site 1	EPSEW16 Control Site 2	EPSEW17 Control Site 3	EPSEW18 Control Site 4	EPSEW19 Control Site 5	EPSEW20 Control Site 6
		EPBC Act	NPW Act																				
Acanthagenys rufogularis	Spiny-cheeked Honeyeater																						
Acanthiza apicalis	Inland Thornbill						Y																
Accipiter cirrocephalus cirrocephalus	Collared Sparrowhawk																						
Accipiter fasciatus fasciatus	Brown Goshawk																						
Anthochaera carunculata woodwardi	Red Wattlebird														Y				Y				
Anthus australis	Australian Pipit																						
Aquila audax	Wedge-tailed eagle																						
Artamus cyanopterus	Dusky Woodswallow																						
Barnardius zonarius	Australian Ringneck														Y								
Cacomantis flabelliformis	Fan-tailed Cuckoo																						
Calamanthus (Calamanthus) campestris	Rufous Fieldwren			Y	Y	Y			Y					Y	Y	Y							
Chroicocephalus novaehollandiae	Silver Gull																						
Circus approximans	Swamp Harrier																						
Colluricincla harmonica	Grey Shrikethrush																						
Coracina novaehollandiae	Black-faced Cuckooshrike																						
Corvus coronoides	Australian Raven			Y	Y			Y							Y								
Cracticus torquatus	Grey Butcherbird																						
Dromaius novaehollandiae	Emu																						
Drymodes brunneopygia	Southern Scrub Robin																				Y	Y	
Egretta novaehollandiae	White-faced Heron																						
Eolophus roseicapilla	Galah							Y															

Scientific Name	Common Name	Conservation status		EPSEW1	EPSEW2	EPSEW3	EPSEW4	EPSEW5	EPSEW6	EPSEW7	EPSEW8	EPSEW9	EPSEW10	EPSEW11	EPSEW12	EPSEW13	EPSEW14	EPSEW15 Control Site 1	EPSEW16 Control Site 2	EPSEW17 Control Site 3	EPSEW18 Control Site 4	EPSEW19 Control Site 5	EPSEW20 Control Site 6
		EPBC Act	NPW Act																				
Eopsaltria griseogularis	Western Yellow Robin					Y																	
Falco cenchroides	Nankeen Kestrel																						
Gavicalis virescens	Singing Honeyeater				Y																		
Gliciphila melanops	Tawny-crowned Honeyeater												Y		Y	Y		Y					
Grallina cyanoleuca	Magpie Lark																						
Gymnorhina tibicen	Australian Magpie																						
Haematopus fuliginosus	Sooty Oystercatcher		R																				
Haliaeetus leucogaster	White-bellied Sea Eagle		E										Y			Y							
Hirundo neoxena	Welcome Swallow					Y	Y	Y							Y	Y							
Hydroprogne caspia	Caspian Tern																						
Larus pacificus	Pacific Gull																						
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater		R																				
Malurus cyaneus leggei	Superb Fairywren			Y	Y	Y		Y						Y	Y	Y		Y		Y			
Malurus pulcherrimus	Blue-breasted Fairywren																				Y	Y	
Morus serrator	Australasian Gannet																						
Neophema elegans	Elegant Parrot		R																				
Neophema petrophila	Rock Parrot		R					Y							Y			Y					
Pachycephala pectoralis	Australian Golden Whistler																						
Pandion haliaetus	Osprey						Y											Y					Y
Pardalotus striatus	Striated Pardalote																						
Petrochelidon nigricans	Tree Martin																						
Phaps chalcoptera	Common Bronzewing																						
Phaps elegans	Brush Bronzewing																						

Scientific Name	Common Name	Conservation status		EPSEW1	EPSEW2	EPSEW3	EPSEW4	EPSEW5	EPSEW6	EPSEW7	EPSEW8	EPSEW9	EPSEW10	EPSEW11	EPSEW12	EPSEW13	EPSEW14	EPSEW15 Control Site 1	EPSEW16 Control Site 2	EPSEW17 Control Site 3	EPSEW18 Control Site 4	EPSEW19 Control Site 5	EPSEW20 Control Site 6
		EPBC Act	NPW Act																				
Phylidonyris novaehollandiae	New Holland Honeyeater			Y	Y	Y	Y	Y	Y				Y	Y	Y	Y			Y		Y	Y	
Pomatostomus superciliosus	White-browed Babbler														Y	Y							
Psophodes nigrogularis leucogaster	White-bellied Whipbird	VU	E			Y	Y										Y	Y	Y	Y			
Rhipidura albiscapa	Grey Fantail																						
Rhipidura leucophrys	Willie Wagtail														Y								
Sericornis maculatus mellori	Spotted scrubwren			Y	Y	Y	Y	Y					Y	Y	Y			Y					
Stagonopleura guttata	Diamond Firetail																						
Sternula nereis	Fairy Tern	VU	E																				
Stipiturus malachurus parimeda	southern Eyre Peninsula Southern Emuwren	VU	E				Y							Y	Y	Y		Y		Y			
Strepera versicolor	Grey Currawong														Y								
**Sturnus vulgaris*	Common Starling																						
**Turdus merula*	Common Blackbird																						
Turnix varius	Painted Buttonquail		R																				
Zosterops lateralis	Silvereye			Y	Y	Y	Y	Y					Y		Y	Y							
			TOTALS	6	7	8	8	8	2	0	0	0	5	5	15	9	1	7	3	3	3	3	1

Table 6. Number of bird species overserved at WBWB sites in June 2021. * Denotes exotic species. Species shaded in grey have not been observed at any of the sites. Sites in red text have not been surveyed due to weather and time constraints.

Scientific Name	Common Name	Conservation status		WBWB1	WBWB2	WBWB3	WBWB4	WBWB5	WBWB6	WBWB7	WBWB8	WBWB9	WBWB10	WBWB11	WBWB12	WBWB13	WBWB14 Control site 1	WBWB15 Control site 2	WBWB16 Control site 3	WBWB17 Control site 4	WBWB18 Control site 5	WBWB19 Control site 6	WBWB20 Control site 7	WBWB21 Control site 8
		EPBC Act	NPW Act																						
Acanthagenys rufogularis	Spiny-cheeked Honeyeater																								
Acanthiza apicalis	Inland Thornbill			Y																					
Accipiter cirrocephalus cirrocephalus	Collared Sparrowhawk																								
Accipiter fasciatus fasciatus	Brown Goshawk																								
Anthochaera carunculata woodwardi	Red Wattlebird																								
Anthus australis	Australian Pipit																								
Aquila audax	Wedge-tailed eagle																								
Artamus cyanopterus	Dusky Woodswallow																								
Barnardius zonarius	Australian Ringneck																								
Cacomantis flabelliformis	Fan-tailed Cuckoo																								
Calamanthus (Calamanthus) campestris	Rufous Fieldwren																								
Chroicocephalus novaehollandiae	Silver Gull																								
Circus approximans	Swamp Harrier																								
Colluricincla harmonica	Grey Shrikethrush																								
Coracina novaehollandiae	Black-faced Cuckooshrike																								
Corvus coronoides	Australian Raven																								
Cracticus torquatus	Grey Butcherbird																								
Dromaius novaehollandiae	Emu																								
Drymodes brunneopygia	Southern Scrub Robin										Y	Y	Y												
Egretta novaehollandiae	White-faced Heron																								
Eolophus roseicapilla	Galah																								

Scientific Name	Common Name	Conservation status		WBWB1	WBWB2	WBWB3	WBWB4	WBWB5	WBWB6	WBWB7	WBWB8	WBWB9	WBWB10	WBWB11	WBWB12	WBWB13	WBWB14 Control site 1	WBWB15 Control site 2	WBWB16 Control site 3	WBWB17 Control site 4	WBWB18 Control site 5	WBWB19 Control site 6	WBWB20 Control site 7	WBWB21 Control site 8
		EPBC Act	NPW Act																						
Eopsaltria griseogularis	Western Yellow Robin																								
Falco cenchroides	Nankeen Kestrel																								
Gavicalis virescens	Singing Honeyeater					Y					Y	Y	Y												
Gliciphila melanops	Tawny-crowned Honeyeater																	Y							
Grallina cyanoleuca	Magpie Lark																								
Gymnorhina tibicen	Australian Magpie																								
Haematopus fuliginosus	Sooty Oystercatcher		R																						
Haliaeetus leucogaster	White-bellied Sea Eagle		E																						
Hirundo neoxena	Welcome Swallow			Y										Y											
Hydroprogne caspia	Caspian Tern																								
Larus pacificus	Pacific Gull																								
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater		R																						
Malurus cyaneus leggei	Superb Fairywren																	Y							
Malurus pulcherrimus	Blue-breasted Fairywren																								
Morus serrator	Australasian Gannet																								
Neophema elegans	Elegant Parrot		R																						
Neophema petrophila	Rock Parrot		R															Y							
Pachycephala pectoralis	Australian Golden Whistler																								
Pandion haliaetus	Osprey			Y														Y							
Pardalotus striatus	Striated Pardalote																								
Petrochelidon nigricans	Tree Martin																								
Phaps chalcoptera	Common Bronzewing																								
Phaps elegans	Brush Bronzewing																								
Phylidonyris novaehollandiae	New Holland Honeyeater			Y										Y	Y										
Pomatostomus superciliosus	White-browed Babbler																								

Scientific Name	Common Name	Conservation status		WBWB1	WBWB2	WBWB3	WBWB4	WBWB5	WBWB6	WBWB7	WBWB8	WBWB9	WBWB10	WBWB11	WBWB12	WBWB13	WBWB14 Control site 1	WBWB15 Control site 2	WBWB16 Control site 3	WBWB17 Control site 4	WBWB18 Control site 5	WBWB19 Control site 6	WBWB20 Control site 7	WBWB21 Control site 8
		EPBC Act	NPW Act																						
Psophodes nigrogularis leucogaster	White-bellied Whipbird	VU	E	Y		Y					Y	Y	Y	Y	Y		Y	Y	Y	Y				
Rhipidura albiscapa	Grey Fantail																							
Rhipidura leucophrys	Willie Wagtail																							
Sericornis maculatus mellori	Spotted scrubwren			Y		Y							Y					Y						
Stagonopleura guttata	Diamond Firetail																							
Sternula nereis	Fairy Tern	VU	E																					
Stipiturus malachurus parimeda	southern Eyre Peninsula Southern Emuwren	VU	E	Y														Y						
Strepera versicolor	Grey Currawong																							
**Sturnus vulgaris*	Common Starling																							
**Turdus merula*	Common Blackbird																							
Turnix varius	Painted Buttonquail		R																					
Zosterops lateralis	Silvereye			Y									Y											
TOTALS				8	0	3	0	0	0	0	3	3	5	3	2	0	1	7	1	1	0	0	0	0

4 Discussion

4.1 Playback stimuli

Recordings of local songs of the two focal species will be utilized to prepare the playback stimuli to be used during follow-up playback broadcast trials during surveys 2 to 5. Amadeus Pro 1.5 (Hairersoft Inc, Switzerland) will be used to make playback stimuli. Files containing each stimulus will be saved in the format of 16-bit WAV files with a sampling rate of 44100 Hz.

Where possible and practical, birds will not be tested with their own song and playback stimuli will only be used once at each site. To avoid effects of habituation, playback experiments will be done at least one day apart and direct neighbours will not be tested on the same day.

Ideally, we would have ~10 songs (of different individuals) for each of the two focal species to prepare playback stimulus. Currently we have 6 good quality songs of 5 different EPSEW individuals (i.e. we need songs of another 5 birds) and 4 good quality WBWB songs of 2 different individuals (i.e. we need songs of another 8 birds).

A H5n Zoom Handy Recorder (Zoom Corporation, Australia) will be used in the PRE and POST launch surveys, with the aim to collect and record more vocalisations of both focal species during playback experiments (Figure 6). In order to record additional song of EPSEW and WBWB the H5n Zoom Handy Recorder will be placed in vegetation near the speaker. Observers will conceal themselves as much as possible in the vegetation during playback experiments to minimise any potential effect of their presence. If focal birds respond to the playback experiment via song and songs are successfully recorded, these can be utilized for future playback stimuli and experiments.

Figure 6. A H5n Zoom Handy Recorder with accessories.

5 References and Bibliography

AECOM Australia (2020). Whalers Way Orbital Launch Complex Flora and Fauna Assessment and Preliminary Impact Assessment. Report to Southern Launch.

Birdlife (2021a). Survey Techniques - 2-ha, 20 min Search. Accessed in June 2021: https://birdata.birdlife.org.au/survey-techniques

Birdlife (2021b). Southern Emu-wren *Stipiturus malachurus* Maluridae. Accessed in June 2021: https://www.birdlife.org.au/bird-profile/southern-emu-wren.

Birdlife International (2021c). Western Whipbird *Psophodes nigrogularis*. Accessed in June 2021: http://datazone.birdlife.org/species/factsheet/22705330.

Bureau of Meteorology (2020). Port Lincoln, South Australia, Daily Weather observations.

Department of Agriculture, Water and the Environment (DAWE) (2020). Species Profile and Threats Database *Psophodes leucogaster leucogaster* — Mallee Whipbird. SPRAT Profile Online resource [viewed 1 July 2020].

Department of Agriculture, Water and the Environment (2020). Species Profile and Threats Database *Stipiturus malachurus parimeda* – Southern Emu-wren - Eyre Peninsula. SPRAT Profile Online resource [viewed 1 July 2020].

Department of Environment Water Heritage and Agriculture (DEWHA) (2010). Survey guidelines for Australia's threatened birds Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*.

Department of the Environment (DotE) (2013). Approved Conservation Advice for *Stipiturus malachurus parimeda* (Southern Emu-wren - Eyre Peninsula). Canberra: Department of the Environment.

Ecosphere Ecological Solutions Pty Ltd (2020a). *Native Vegetation Assessment at Whalers Way, June 2020*. Report to Southern Launch.

Ecosphere Ecological Solutions Pty Ltd (2020b). *Broadscale Distribution and Status of the Eyre Peninsula Southern Emu-wren (Stipiturus malachurus parimeda) and Western Whipbird (eastern) (Psophodes leucogaster leucogaster) at Whalers Way, June 2020*. Report to Southern Launch.

Higgins, P.J., Peter, J.M., Steele, W.K. (Eds.), (2001). Handbook of Australian, New Zealand and Antarctic Birds, vol. 5. *Oxford University Press*, Melbourne.

Osenberg, C.W., Schmitt, R.J., Holbrook, S.J., Abu-Saba, K.E. & Flegal, A.R. (1994). Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecological Applications* 4:16– 30.

Pickett, M. (2006). Habitat Management Guidelines for the Eyre Peninsula Southern Emu-wren. Department for Environment and Heritage, PO Box 22 Port Lincoln SA 5606. October 2006.

Thiault, L., Kernaleguen L., Osenberg C.W., Claudet J. (2017). Progressive-Change BACIPS: a flexible approach for environmental impact assessment. *Methods in Ecology and Evolution* 8:288–296.

Underwood, A.J. (1992). Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. *Journal of Experimental Marine Biology and Ecology* 161:145– 178.

Appendix J

Test Launch Campaign – Avian Survey Report Test Launch 1

Revision 9 – 03-Aug-2022
Prepared for – Southern Launch – ABN: 33 621 420 504

ECOSPHERE
Ecological Solutions

Whalers Way Orbital Launch Complex

Test Launch Campaign – Avian Survey Report Test Launch 1

February 2022

Document information and distribution

Document information	
Item	Detail
Project number	-
Document title	Whalers Way Orbital Launch Complex Test Launch Campaign – Avian Survey Report Test Launch 1
Client	Southern Launch
Prepared by	Marina Louter, Andrew Sinel
Reviewed by	Andrew Sinel and Matt McDonnell
Review date	30/11/2021
Document status	Draft
Version number	4

Document distribution				
Authors	Document status	Version no	Date of issue	Issued to
M Louter	Draft V1 (in prep)	1	04/11/2021	Matt McDonnell, AECOM
M. Louter	Draft V2	2	30/11/2021	Matt McDonnell, AECOM
M. Louter	Draft V3	3	02/12/2021	Southern Launch
M. Louter	Final	4	03/02/2022	Matt McDonnell, AECOM, Southern Launch

Acronyms and definitions

Abbreviation	Description
AECOM	AECOM Australia Pty Ltd
ARU's	Autonomous Recording Unit
BOM	Bureau of Meteorology
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPSEW	Eyre Peninsula Southern Emu-wren
GPS	Global Positioning System
km	Kilometre(s)
NPW Act	*National Parks and Wildlife Act 1972*
SA	South Australia(n)
Southern Launch	Southern Launch Space Pty Ltd
sp.	Species
spp.	Species (plural)
ssp.	Sub-species
unk	Unknown
WBWB	White-bellied Whipbird
WWOLC	Whalers Way Orbital Launch Complex

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1 Introduction

1.1 Background

Southern Launch Space Pty Ltd (Southern Launch) is proposing to construct the Whalers Way Orbital Launch Complex (WWOLC). The WWOLC is proposed to be situated at the tip of the Eyre Peninsula in South Australia and is to be built as an orbital rocket launch facility. Southern Launch proposes to launch up to 36 orbital and 6 sub orbital launches per year from Whalers Way. Launch vehicles will range from a total lift off mass of approximately 20kg (and be less than 3 meters long) up to over 100 tonnes (and be over 30 meters tall). The engine types that will power these rockets include solid, liquid and hybrid configurations. At this time, Southern Launch cannot specify what dimensions the launch vehicles will be as the company is still negotiating with customers to use the WWOLC. The typical launch vehicle will likely range in height from 9m to 30m, but it is possible that vehicles will be taller than 30m. The factor limiting vehicle size is total lift off mass, which will be less than 120 tonnes. This mass consists of rocket structure (airframe), rocket components, payloads, propellants (rocket fuel) and other gases/liquids required for the operation of the rocket systems.

Southern Launch is proposing to undertake up to three test launches over a period of three (3) to six (6) months using non-explosive rockets (the Test Launch Campaign). Data collection of the Test Launch Campaign will include a detailed series of works around noise and vibration monitoring, air quality monitoring and assessment of terrestrial and marine ecological effects to: (1) validate modelled data; and (2) determine the impact of vehicle launches on the environment with detailed monitoring and investigations undertaken prior, during and after each test launch event.

To measure potential impacts of the Test Launch Campaign on avian fauna, a *Proposal for Southern Launch rocket testing, impacts on local avian fauna*, was prepared for the Project by Ecosphere Ecological Solutions in May 2021, detailing the proposed methodology. Avian data will be collected during a series of standardized surveys, as per the below proposed schedule:

- Site Selection survey
- Test Launch 1 - PRE Launch survey
- Test Launch 1 - POST Launch survey
- Test Launch 2 - POST Launch survey
- Test Launch 3 - POST Launch survey

The primary avian species of concern within the Whalers Way area are the Nationally threatened Eyre Peninsula Southern Emu-wren (EPSEW) *Stipiturus malachurus parimeda* and the White-bellied Whipbird (naming as per suggestions by Burbidge *et. al* 2017) (WBWB) also known as Mallee Whipbird *Psophodes leucogaster leucogaster*, both of which have historical observations and suitable habitat within and surrounding the Project site.

Both EPSEW and WBWB have been observed at the Whalers Way site of the Project in 2020 during a baseline vegetation survey and a subsequent targeted bird survey (Ecosphere Ecological Solutions 2020a,b). A site selection survey was undertaken in June 2021(Ecosphere Ecological Solutions 2021) to set up EPSEW and WBWB impact (Whalers Way) and control (Lincoln National Park) monitoring sites to be used for avian monitoring.

1.2 Description of first test launch attempt

The first test launch attempt was undertaken in September 2021. At 16:08 hours on the 16th September 2021, TiSpace attempted to launch the experimental VS01 sub orbital rocket from Pad 1 at the WWOLC. VS01 is a hybrid rocket that uses non-toxic, non-explosive nitrous oxide (laughing gas) and rubber as rocket propellants. During the launch attempt only one of the four engines completed ignition and produced 'launch' thrust. With less than full 'launch' thrust being produced by all four engines, the lift-off command was not sent to the rocket and all engines were shut down. Southern Launch's emergency response system was enacted with standard shut down and 'safeing' procedures started with the nitrous oxidiser released from the onboard tanks. Residual heat from the rocket engines caused a fire to break out in the base of the rocket which damaged the rocket structure, causing it to fall off the rocket launcher. The fall and fire damaged the first stage oxidiser tank resulting in a pressure induced explosive rupture of the tank pushing the rocket off the launch pad. Emergency services extinguished a small fire at the launch pad and the area was made safe. Noise and vibration data was collected during the first test launch attempt.

This report details the results of the Pre- and Post-launch Avian survey of the first test launch attempt.

1.3 Objectives

The specific objectives of the Pre- and Post-launch Avian survey of the first test launch attempt were to:

- Re-visit all impact sites (Whalers Way) and control sites (Lincoln National Park) that were established during the site selection survey;
- Before and after the first test launch attempt at EPSEW and WBWB control and impacts Sites:
    - Undertake avian surveys including, 20min/2ha active searches to determine presence of common avian species and target species EPSEW and WBWB.
    - Undertake playback experiments to record the behavioural response of EPSEW and WBWB before and after the test launch attempt.
- Map noise and vibration monitoring data of the test launch attempt at Whalers Way in relation to the test launch site and EPSEW and WBWB sites.
- Report the findings of the Pre- and Post-launch avian survey in a short Summary Report.

2 Methods

The 2021 Pre- and Post-launch avian surveys were conducted utilising methods consistent with Birdlife Australia Systematic Bird surveys (2-ha, 20 minute search) (Birdlife 2021a), recommended survey method (as per the Guidelines for Detecting Birds Listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010 - see Appendix 1) and Department of Environment and Water (DEW) biological survey methods (Heard and Channon 1997; Owens 2000).

Field surveys were conducted under the following research and ethics permits/licenses:

- Scientific Research Permit No. E27057-1 (Department for Environment and Water);
- Wildlife Ethics Committee (WEC) Approval No. 6/2021, (Wildlife Ethics Committee); and
- Scientific Licence No. 370 (Animal Welfare, National Parks and Wildlife SA).

The survey methods are summarised below in the following sections.

2.1 Timing of events

The Pre-launch avian survey was undertaken from 18 – 21 August 2021. The first test launch attempt was undertaken by Southern Launch on 16 September 2021. The Post-launch avian survey was undertaken from 21 – 24 September 2021.

2.2 Control and impact sites

An overview of impact sites at Whalers Way and control sites at Lincoln National Park is presented in Table 1. The location of impact sites and control sites are presented in Figure 1and Figure 2. Figure 1 includes the proposed infrastructure footprint of the WWOLC.

Table 1. Overview of EPSEW and WBWB control and impact sites.

Site type	SITE ID	GPS Location
Whalers Way (impact)	EPSEW01	53 H 557328 6133639
	EPSEW02	53 H 557334 6133535
	EPSEW03	53 H 557406 6133466
	EPSEW04	53 H 557477 6133947
	EPSEW05	53 H 557638 6134098
	EPSEW06	53 H 562434 6133039
	EPSEW07	53 H 561617 6133309
	EPSEW08	53 H 561326 6133327
	EPSEW09	53 H 560789 6133447
	EPSEW10	53 H 560561 6133729
	EPSEW11	53 H 556878 6133739
	EPSEW12	53 H 558655 6134055
	EPSEW13	53 H 557563 6133742
	EPSEW14	53 H 558305 6133903
Lincoln National Park (control)	EPSEW15	53 H 578946 6136022
	EPSEW16	53 H 571873 6148112
	EPSEW17	53 H 571889 6147543
	EPSEW18	53 H 592760 6149185
	EPSEW19	53 H 592010 6148026
	EPSEW20	53 H 591444 6146916
Whalers Way (impact)	WBWB01	53 H 557618 6134086
	WBWB02	53 H 557177 6134694
	WBWB03	53 H 560304 6133991
	WBWB04	53 H 560422 6134448
	WBWB05	53 H 560896 6133755
	WBWB06	53 H 562470 6135285
	WBWB07	53 H 557241 6134935
	WBWB08	53 H 559871 6134195
	WBWB09	53 H 560044 6134158
	WBWB10	53 H 559906 6134256
	WBWB11	53 H 557901 6133777
	WBWB12	53 H 562027 6133200
	WBWB13	53 H 562611 6134344
Lincoln National Park (control)	WBWB14	53 H 578632 6144747
	WBWB15	53 H 579225 6135850
	WBWB16	53 H 579223 6143522
	WBWB17	53 H 574400 6146800
	WBWB18	53 H 579703 6141530
	WBWB19	53 H 585998 6146300
	WBWB20	53 H 586287 6145533
	WBWB21	53 H 587750 6142600

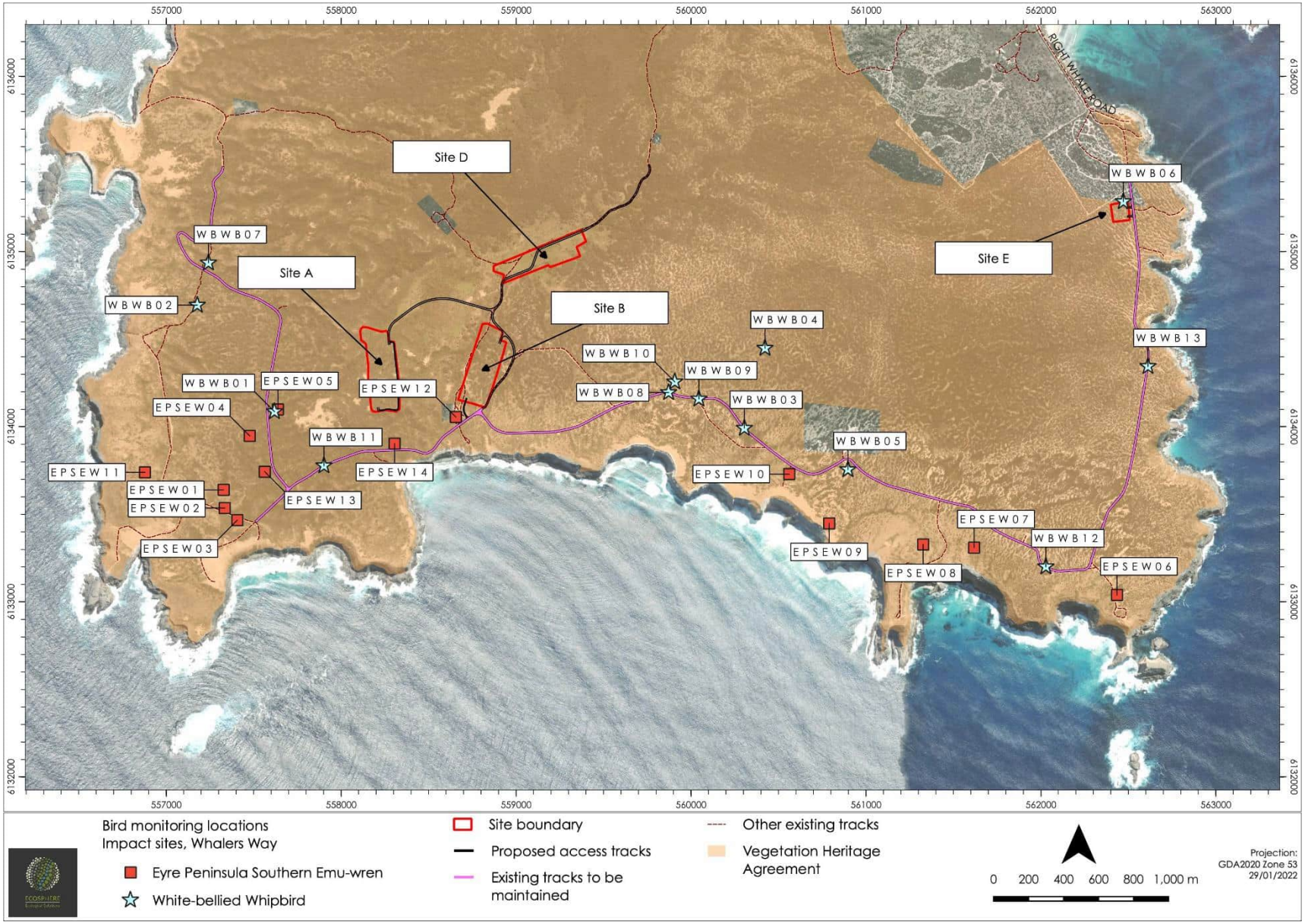

Figure 1. Location of EPSEW and WBWB impact sites within Whalers Way.

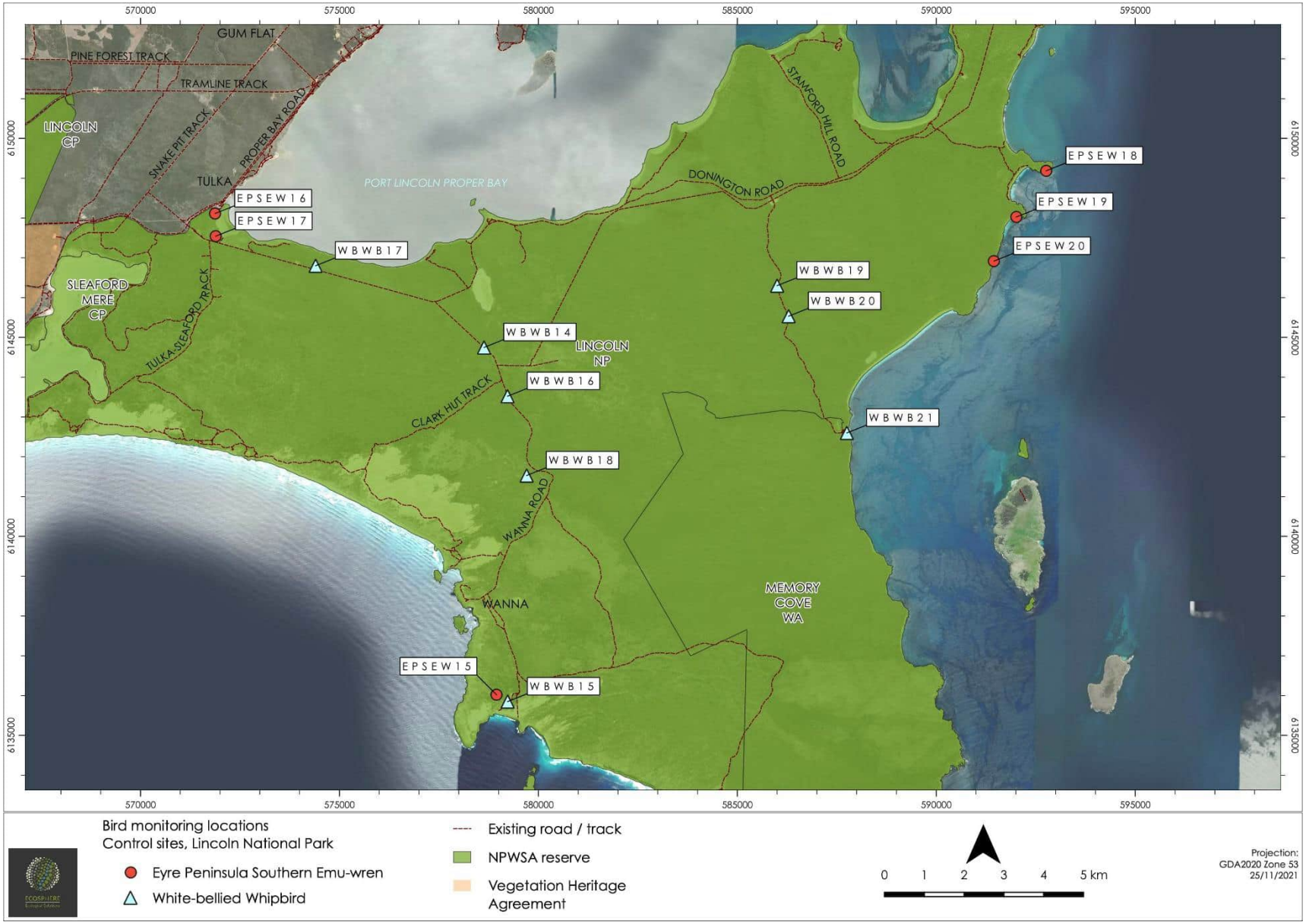

Figure 2. Location of EPSEW and WBWB control sites within Lincoln National Park.

2.3 Avian surveys

2.3.1 Active searches surveys (20min/2ha)

Avian surveys were undertaken at control and impact sites to determine presence and abundance of common avian species and target species Eyre Peninsula Southern Emu-wren (EPSEW) *Stipiturus malachurus parimeda* and White-bellied Whipbird (WBWB) *Psophodes leucogaster leucogaster* at each site. surveys of control and impact sites where undertaken concurrently by two teams of two surveyors.

Active searches surveys (20min/2ha) (Birdlife 2021a) were undertaken from 7am onwards with a focus on early mornings and late afternoons, but surveys continued throughout the day, due to changing weather conditions (rain and windy conditions – see Section 3.1). Avian surveys were limited to one survey per site a day, to eliminate the possibility of double counting a particular bird. If focal birds were not present during the initial first survey, follow-up surveys were undertaken.

At each site the following information was recorded for the two target species (if present):

- Location (hand-held GPS)
- Detection method (heard and/or seen)
- Number of individuals

2.4 Playback experiments

2.4.1 Playback stimuli

Local EPSEW and WBWB songs collected during the site selection survey in June 2021(*see* Ecosphere Ecological Solutions Pty Ltd, 2021 for details) were used to prepare playback stimuli for playback experiments. EPSEW playback stimuli consisted of songs lasting between 4–10 seconds, which were repeated at approximately 5-10 second intervals resulting in a series of six vocalisations per minute. WBWB playback stimuli consisted of a song bout, lasting for one minute, as WBWB males defend their territory with singing bouts of 3–15 minutes duration (Webster 1966; A.L. McGuire 2021). Each playback was 3 minutes in length, consisting of 1 minute song - 1 minute silence – 1 minute song. A total of 6 EPSEW and 7 WBWB playback tracks were created.

2.4.2 Playback experiments

To determine EPSEP/WBWB occupancy and to measure behavioural response audio playback of local EPSEW/WBWB song (playback experiment hereafter) was undertaken at each site. Playback experiment were performed before (Pre-launch) and after the test launch attempt

(Post-launch) at sites where there was a territorial group. WBWB and EPSEW sites were suspected of being a territory according to previous surveys performed in 2020 and 2021, where there were multiple sightings of a focal species at the same location within a year or between surveys. To control for pseudo-replication, we did not perform replicate playback experiments of the same treatment at a territory either within or between survey periods. To avoid effects of habituation, playback experiments were undertaken at least one day apart and close direct neighbours were not tested on the same day.

Playback experiments were performed with a portable Ultimate Ears Wonderboom 2 Deep speaker (Ultimate Ears) with a frequency range of 75 Hz - 20 kHz connected to an iPhone (Apple Inc., Cupertino, CA) via Bluetooth. We placed the speaker on the ground, concealed in vegetation. During playback experiments surveyors concealed themselves as much as possible amongst vegetation to minimise any potential effect of their presence. The set-up of the iPhone and speaker did not take longer than 2 minutes. Playback experiment duration was for 3 minutes following 1 minute of silence (Pre-trial) to perform Pre-playback observations. The 3 minutes of broadcast, consisted of 1 minute song - 1 minute silence – 1 minute song. Surveyors spend less than 10 minutes at a site for to perform a playback experiment (including set-up and data collection).

We documented Pre-playback and playback experiment observations separately. The variables recorded were: 1) latency (in seconds) of the focal bird to come within 20 m of the speaker, 2) latency (in seconds) of the focal bird to come within 10 m of the speaker, 3) minimum distance (in metres) to the speaker, 4) number of observed speaker crosses, and 5) number of vocalisations.

2.5 Opportunistic song recordings

A H5n Zoom Handy Recorder (Zoom Corporation, Australia) was used in the Pre- and Post-launch avian surveys, with the aim to opportunistically collect and record more vocalisations of both focal species during playback experiments. In order to record additional song of EPSEW and WBWB the small H5n Zoom Handy Recorder was placed and concealed in vegetation near the speaker during playback experiments.

2.6 Noise data

AECOM Australia Pty Ltd (AECOM) were engaged by Southern Launch to undertake environmental noise monitoring at WWOLC for the three test launches of the Test Launch Campaign planned at the site. This monitoring aims to quantify the level of noise that nearby sensitive receptors would be exposed to during launch operations at the site. For all information relating to noise monitoring of the first test launch attempt (methodology, results, noise

modelling etc.) refer to the *Whalers Way Test Launch September 2021 - Acoustic review* (AECOM 2021). Estimated sound power level and noise contours for the predicted Maximum Sound Level (L_{Amax}) levels for the test launch event at the site was provided to Ecosphere. These data were incorporated in tables and maps of this report, to determine octave band and overall sound power levels at bird impact and control sites (referred to as 'bird receptors points' in AECOM (2021)) during the test launch attempt.

2.7 Limitations

The data that is collected during the Test Launch Campaign is considered to be not exhaustive and has known limitations, as the proposed avian survey work for the campaign is planned to be undertaken over a relatively short period of time (3-6 months). Avian survey data collected for each Pre- and Post-launch survey is limited to a 4-day period per survey. Seasonality and variation in local weather conditions may impact on avian survey results as birds are generally less active in the nonbreeding season and when climatic conditions are challenging (i.e. low temperatures, strong winds/rain).

Avian data collected as part of the first test launch attempt includes song recordings, site occupancy, abundance and behaviour of focal species EPSEW and WBWB at impact Sites and control Sites. Data was collected over two 4-day periods (in August and September) and thus only represent a snapshot of current conditions at the time of the surveys. The behavioural response data of EPSEW and WBWB collected is considered to be short-term behavioural response data related to the first test launch attempt.

The avian data presented in this report consist of data collected during the first test launch attempt. The sound power levels presented in maps in this report should be considered relevant to the first test launch attempt only, as only one of the four engines was active during the launch attempt and the rocket did not leave the launch area.

Given that this is the first of a series of three test launches, the result detailed in this report consist of descriptive statistics (i.e. not inferential statistics) that display and summarize the observations and data collected to date at a selection of sites at a given point in time. This data sample is limited to those specific sites and cannot be used to infer potential impacts of test launches to broader/larger avian population(s).

3 Results

3.1 Climate and weather conditions

Port Lincoln is the nearest weather station with historical climate data for comparative purposes (station 018192, open since 1992). Weather conditions during the Pre-launch avian survey period were considered mild and favourable for avian surveys (Table 2). Maximum temperatures reached 21.6 C on 19 August 2021 and the coolest minimum reached 4.6 C on 18 August 2021. Strong winds and gusts of up to 48 km/hour were recorded during the survey period, but wind conditions were mild in the mornings and afternoons. A total of 1.0 mm of rainfall was recorded over 3 days, but rainfall was locally patchy with isolated light showers on most days.

Table 2. Weather variables during the Pre-launch avian survey, as recorded at Port Lincoln weather station (BOM 2021).

Date	Min air temp (degrees ˚C)	Max air temp (degrees ˚C)	Rainfall (mm)	Max wind gust			9 am			3 pm		
				Direction	Speed (km/h)	Time (local)	Temp (degrees ˚C)	Direction	Speed	Temp (degrees ˚C)	Direction	Speed
18 August 2021	4.6	16.3	0.2	E	24	12:52	9.7	NW	11	14.7	E	17
19 August 2021	6.7	21.6	0.0	NNW	48	11:41	16.0	NNW	24	20.4	NNW	20
20 August 2021	11.1	19.1	0.6	NW	43	2:48	14.5	NNW	20	18.6	WNW	22
21 August 2021	10.5	18.5	0.2	NW	41	12:50	14.3	NW	22	16.9	WNW	26

Weather conditions during the Post-launch avian survey period were considered mild and favourable for avian surveys (Table 3). Maximum temperatures reached 22.3 C on 23 September 2021 and the coolest minimum reached 2.0˚C on the night of 23 September 2021. Strong winds and gusts of up to 46 km/hour were recorded during the survey period, but wind conditions were mild in the mornings and late afternoons. A total of 0.8 mm of rainfall was recorded on 21 September.

Table 3. Weather variables during the Post-launch avian survey, as recorded at Port Lincoln weather station (BOM 2021).

Date	Min air temp (degrees **˚C)**	Max air temp (degrees **˚C)**	Rainfall (mm)	Max wind gust			9 am			3 pm		
				Direction	Speed (km/h)	Time (local)	Temp (degrees ˚C)	Direction	Speed	Temp (degrees ˚C)	Direction	Speed
21 Sept 2021	7.8	15.3	0.8	SSW	33	0:36	12.4	S	15	14.6	SW	17
22 Sept 2021	9.7	18.7	0	W	28	12:31	12.8	W	11	17.5	W	17
23 Sept 2021	2.0	22.3	0	WSW	46	12:19	14.9	NW	20	20.9	W	30
24 Sept 2021	8.8	18.2	0	SW	46	13:55	14.3	SW	24	16.4	WSW	28

3.2 Survey effort

An overview of EPSEW and WBWB survey effort undertaken to date (2020-2021) at control and impact sites, with the number of EPSEW and WBWB observed and/or heard per site is presented in Table 4. Additional ESPEW (5 EPSEW) and WBWB (7 WBWB) observation were opportunistically recorded whilst traversing the areas during surveys. These additional sites are presented in Appendix 2.

Table 4. Overview of EPSEW and WBWB survey effort undertaken to date (2020-2021) at control and impact sites.

Site type	SITE ID	Targeted avian survey June 2020	Site selection survey June 2021	Pre-launch avian survey August 2021	Post-launch survey September 2021	Comments and recommendations
		# of birds present	# of birds present	# of birds present	# of birds present	
impact	EPSEW01	2	0	0	0	Discontinue, = likely EPSEW03
	EPSEW02	1	0	1	0	Discontinue, = likely EPSEW03
	EPSEW03	1	3	2	2	
	EPSEW04	2	2	2	1	
	EPSEW05	1	0	0	0	Discontinue, = likely EPSEW04
	EPSEW06	1	0	0	2	
	EPSEW07	1	^	0	0	Discontinue, no birds detected
	EPSEW08	2	^	2	2	
	EPSEW09	1	^	3	1	
	EPSEW10	2	0	0	0	Discontinue, no birds detected
	EPSEW11	1	1*	0	0	Discontinue, no birds detected
	EPSEW12	3	2	3	2	
	EPSEW13	-	2	0	2	
	EPSEW14	-	1	3	2	
control	EPSEW15	-	2	3	2	
	EPSEW16	-	2	2	1	
	EPSEW17	-	2	2	2	
	EPSEW18	-	^	0	0	Discontinue, no birds detected
	EPSEW19	-	^	0	0	Discontinue, no birds detected
	EPSEW20	-	^	0	0	Discontinue, no birds detected
EPSEW Total		18	17	23	19	
impact	WBWB01	2	2	1**	1**	
	WBWB02	1**	^	1	1	
	WBWB03	1**	2	1**	2	
	WBWB04	1**	^	^	^	Discontinue, inaccessible
	WBWB05	1**	^	1	1	
	WBWB06	1**	^	1**	1**	
	WBWB07	1	^	1**	1**	
	WBWB08	-	2	1**	1**	
	WBWB09	-	2	1**	2	
	WBWB10	-	2	1**	1**	
	WBWB11	-	1	1**	1	
	WBWB12	-	1	1**	1**	
	WBWB13	-	1**	1	1	
control	WBWB14	-	1	1**	2	
	WBWB15	-	1**	1	1**	
	WBWB16	-	1**	1**	1**	
	WBWB17	-	1**	1**	0	
	WBWB18	-	^	0	0	Discontinue, no birds detected
	WBWB19	-	^	0	1**	
	WBWB20	-	^	0	0	Discontinue, no birds detected
	WBWB21	-	^	1	1**	
WBWB Total		8	17	17	20	

* heard only

** only male heard singing (may be female present)

^ not surveyed due to time limitation/bad conditions

3.3 EPSEW and WBWB occupancy and abundance

EPSEW: All 20 EPSEW sites were surveyed using 20min/2ha active searches during the Pre- and Post-launch avian surveys. EPSEW were observed at 10 out of the 20 sites (50.0%) during the Pre-launch avian survey, and EPSEW were present at 11 out of the 20 sites (55.0%) during the subsequent Post-launch avian survey (Table 4). During the Pre-launch avian surveys we observed a minimum of 23 individuals: 1 single bird, 5 pairs and four groups of three individuals. During the Post-launch avian survey we observed a minimum of 19 individuals, consisting of 3 single birds and 8 pairs. No groups of three birds were observed during the Post-launch survey (Table 4). At Whalers Way 7 EPSEW sites were occupied during the Pre-launch survey, versus 8 sites during the Post-launch survey. At Lincoln National Park 4 EPSEW sites were occupied during the Pre-launch survey and Post-launch survey.

WBWB: 20 out of the 21 WBWB sites were surveyed using 20min/2ha active searches during the Pre- and Post-launch avian surveys. During the Pre-launch avian survey and the subsequent Post-launch avian survey WBWB were observed at 17 out of the 20 visited sites (85.0%) (Table 4). During the Pre-launch avian survey we observed a minimum of 17 individual WBWB, compared to a minimum of 20 WBWB during the Post-launch avian survey (Table 4). At Whalers Way 12 WBWB sites were occupied during the Pre-launch and Post-launch survey. At Lincoln National Park 5 WBWB sites were occupied during the Pre-launch survey and Post-launch survey.

3.4 Playback experiments

During the Pre- and Post-launch avian survey, at total of 112 playback experiments (60 EPSEW and 52 WBWB) were conducted, at control and impact sites.

Pre-launch: During the Pre-launch avian survey, at total of 54 playback experiments were conducted, consisting of 29 EPSEW and 25 WBWB playbacks. A summary of playback experiments conducted during the Pre-launch avian survey and the percentages of EPSEW and WBWB playback experiments that elicited a response from the focal species are presented in Table 5. At control sites EPSEW responded to playback 33.3% of the time, versus 35.0% at impact sites. At control sites WBWB responded to playback 18.2% of the time versus 21.4% of the time at WBWB impact sites (Table 5).

Post-launch: During the Post-launch avian survey, at total of 58 playback experiments were conducted, consisting of 31 EPSEW and 27 WBWB playbacks. A summary of playback experiments conducted during the Post-launch avian survey and the percentages of EPSEW and WBWB playback experiments that elicited a response from the focal species are presented in Table 6. At control sites EPSEW responded to playback experiment 35.7% of the time, versus 50.0% at impact sites. WBWB responded to playback experiments 9.1% of the time at control sites, and 37.5% of the time at impact sites (Table 6).

Table 5. Summary table of playback experiments (PB) conducted during the Pre-launch avian survey.

survey	Species	Site	# of PB 'response'	# of PB 'no response'	Total PB	% of PB 'response'	% of PB 'no response'
Pre-launch	EPSEW	control (Lincoln NP)	3	6	9	33.3	66.7
	EPSEW	impact (Whalers Way)	7	13	20	35.0	65.0
		PB subtotal	10	19	29	34.5	65.5
	WBWB	control (Lincoln NP)	2	9	11	18.2	81.8
	WBWB	impact (Whalers Way)	3	11	14	21.4	78.6
		PB subtotal	5	20	25	20.0	80.0
		PB grand total	15	39	54	27.8	72.2

Table 6. Summary table of playback experiments (PB) conducted during the Post-launch avian survey.

survey	Species	Site	# of PB **'response'**	# of PB **'no response'**	Total PB	% of PB **'response'**	% of PB **'no response'**
Post-launch	EPSEW	control (Lincoln NP)	4	9	13	35.7	64.3
	EPSEW	impact (Whalers Way)	9	9	18	50.0	50.0
		PB subtotal	13	18	31	41.9	58.1
	WBWB	control (Lincoln NP)	1	10	11	9.1	90.9
	WBWB	impact (Whalers Way)	6	10	16	37.5	62.5
		PB subtotal	7	20	27	25.9	74.1
		PB grand total	20	38	58	32.1	67.9

An overview of descriptive statistics of behavioural response data to playback experiments during Pre- and Post-launch surveys is presented per species below in Table 9.

Table 7. Summary of behavioural response of ESPEW and WBWB to playback experiments.

			# of PB **'response'** (n)	Mean latency 20m (seconds)	Mean latency 10m (seconds)	Mean Minimum distance speaker (metres)	Mean number of crosses	Mean number of vocalizations
EPSEW	Pre-launch	control	3	113.0	180.0	20.0	0.0	3.7
	Post-launch		4	106.5	146.0	12.8	0.8	3.3
	Pre-launch	impact	7	108.7	115.6	5.7	0.0	3.5
	Post-launch		9	131.4	115.0	5.2	0.7	2.2
WBWB	Pre-launch	control	2	81.5	81.5	4.5	0.0	0.0
	Post-launch		1	180.0	180.0	25.0	0.0	1.0
	Pre-launch	impact	3	81.7	143.3	8.0	0.7	0.5
	Post-launch		6	102.2	137.5	11.2	0.4	0.0

The mean latency (in seconds) of focal birds to come within 20 m or 10 m of the speaker varied from 81.5 - 180 seconds for both ESPEW and WBWB, which indicates that both species generally did not

seem to respond within the first minute of playback stimulus. The mean minimum distance (in metres) to the speaker was variable for both ESPSEW (5.2 - 20.0m) and WBWB (4.5 – 25.0m), and consequently the number of observed speaker crosses was low for both species as well (range 0 – 0.8). EPSEW mean vocalisations ranged from 2.2 to 3.7 and WBWB had a limited vocal response to playback experiments (range 0.0 – 1.0)(Table 9).

3.5 Avian diversity

A total of 67 bird species have been observed from June 2021 to September 2021 at Whalers Way and Lincoln National Park, which includes the target species ESPSEW and WBWB. The species and their conservation status under commonwealth and SA state legislation are listed in Table 8 below.

Avian diversity differed between Whalers Way and Lincoln National Park during the Pre-launch avian survey, with 45 and 34 species recorded respectively. During the Post-launch avian diversity was similar between Whalers Way (47 species) and Lincoln National Park (50 species) (Table 8).

Table 8. Number of bird species observed at Whalers Way and Lincoln National Park. * Denotes exotic species.

Scientific Name	Common Name	Conservation status		Targeted avian survey	Site selection survey		Pre-launch avian survey		Post-launch survey	
		EPBC Act	NPW Act	Whalers Way June 2020	Whalers Way June 2021	Lincoln NP June 2021	Whalers Way Aug 2021	Lincoln NP Aug 2021	Whalers Way Sept 2021	Lincoln NP Sept 2021
Acanthagenys rufogularis	Spiny-cheeked Honeyeater			Y		Y		Y	Y	Y
Acanthiza apicalis	Inland Thornbill				Y					
Accipiter cirrocephalus	Collared Sparrowhawk								Y	Y
Accipiter fasciatus	Brown Goshawk							Y		
Anthochaera carunculata woodwardi	Red Wattlebird				Y	Y	Y	Y	Y	Y
Anthus australis	Australian Pipit				Y	Y	Y		Y	Y
Aquila audax	Wedge-tailed eagle				Y		Y		Y	
Artamus cyanopterus	Dusky Woodswallow			Y	Y	Y	Y	Y	Y	Y
Barnardius zonarius	Australian Ringneck				Y		Y	Y	Y	
Cacomantis flabelliformis	Fan-tailed Cuckoo			Y	Y	Y	Y	Y	Y	Y
Calamanthus (Calamanthus) campestris	Rufous Fieldwren			Y	Y	Y	Y		Y	Y
Cereopsis novaehollandiae	Cape Barren Goose	Ma	VU						Y	
Chalcites basalis	Horsfield's Bronze Cuckoo						Y	Y	Y	Y
Chroicocephalus novaehollandiae	Silver Gull							Y		Y
Circus approximans	Swamp Harrier									
Colluricincla harmonica	Grey Shrikethrush			Y			Y	Y	Y	Y
Coracina novaehollandiae	Black-faced Cuckooshrike					Y		Y	Y	
Corvus coronoides	Australian Raven			Y	Y	Y	Y	Y	Y	Y

Scientific Name	Common Name	Conservation status		Targeted avian survey	Site selection survey		Pre-launch avian survey		Post-launch survey	
		EPBC Act	NPW Act	Whalers Way June 2020	Whalers Way June 2021	Lincoln NP June 2021	Whalers Way Aug 2021	Lincoln NP Aug 2021	Whalers Way Sept 2021	Lincoln NP Sept 2021
Cracticus torquatus	Grey Butcherbird			Y				Y	Y	Y
Dromaius novaehollandiae	Emu			Y	Y		Y	Y	Y	Y
Drymodes brunneopygia	Southern Scrub Robin				Y	Y	Y	Y	Y	Y
Egretta novaehollandiae	White-faced Heron					Y				Y
Eolophus roseicapilla	Galah				Y		Y	Y	Y	Y
Eopsaltria griseogularis	Western Yellow Robin				Y	Y			Y	Y
Epthianura albifrons	White-fronted Chat								Y	
Falco berigora	Brown Falcon						Y			
Falco cenchroides	Nankeen Kestrel			Y	Y		Y		Y	
Gavicalis virescens	Singing Honeyeater			Y	Y		Y	Y	Y	Y
Gliciphila melanops	Tawny-crowned Honeyeater				Y	Y	Y	Y	Y	Y
Grallina cyanoleuca	Magpie Lark				Y					
Gymnorhina tibicen	Australian Magpie				Y					
Haematopus fuliginosus	Sooty Oystercatcher		R			Y				Y
Haliaeetus leucogaster	White-bellied Sea Eagle		E	Y	Y		Y	Y	Y	
Hirundo neoxena	Welcome Swallow			Y	Y	Y	Y	Y	Y	Y
Hydroprogne caspia	Caspian Tern									
Lalage tricolor	White-winged Triller								Y	
Larus pacificus	Pacific Gull			Y	Y		Y	Y		Y

Scientific Name	Common Name	Conservation status		Targeted avian survey	Site selection survey		Pre-launch avian survey		Post-launch survey	
		EPBC Act	NPW Act	Whalers Way June 2020	Whalers Way June 2021	Lincoln NP June 2021	Whalers Way Aug 2021	Lincoln NP Aug 2021	Whalers Way Sept 2021	Lincoln NP Sept 2021
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater (mainland SA)		R							Y
Malurus cyaneus leggei	Superb Fairywren (Mainland SA)			Y	Y	Y	Y	Y	Y	Y
Malurus pulcherrimus	Blue-breasted Fairywren					Y	Y	Y	Y	Y
Melithreptus brevirostris	Brown-headed Honey-eater								Y	Y
Morus serrator	Australasian Gannet			Y	Y	Y		Y		
Neophema elegans	Elegant Parrot		R							
Neophema petrophila	Rock Parrot		R	Y	Y	Y	Y	Y	Y	Y
Pachycephala pectoralis	Australian Golden Whistler			Y		Y	Y	Y	Y	Y
Pandion haliaetus	Osprey		R	Y	Y	Y		Y		Y
Pardalotus punctatus	Spotted Pardalote							Y	Y	Y
Pardalotus striatus	Striated Pardalote					Y		Y	Y	Y
Petrochelidon nigricans	Tree Martin			Y			Y	Y	Y	
Phalacrocorax varius	Pied Cormorant							Y		Y
Phaps chalcoptera	Common Bronzewing			Y	Y	Y	Y	Y	Y	Y
Phaps elegans	Brush Bronzewing			Y	Y	Y	Y	Y	Y	Y
Phylidonyris novaehollandiae	New Holland Honeyeater			Y	Y	Y	Y	Y	Y	Y
Pomatostomus superciliosus	White-browed Babbler			Y	Y	Y		Y	Y	
Psophodes leucogaster leucogaster	Mallee (White-bellied) Whipbird	VU	E	Y	Y	Y	Y	Y	Y	Y
Rhipidura albiscapa	Grey Fantail			Y		Y		Y		Y

Scientific Name	Common Name	Conservation status		Targeted avian survey	Site selection survey		Pre-launch avian survey		Post-launch survey	
		EPBC Act	NPW Act	Whalers Way June 2020	Whalers Way June 2021	Lincoln NP June 2021	Whalers Way Aug 2021	Lincoln NP Aug 2021	Whalers Way Sept 2021	Lincoln NP Sept 2021
Rhipidura leucophrys	Willie Wagtail			Y	Y	Y			Y	Y
Sericornis maculatus mellori	Spotted Scrubwren (subspecies mellori)			Y	Y	Y	Y	Y	Y	Y
Smicrornis brevirostris	Weebill							Y		Y
Stagonopleura guttata	Diamond Firetail			Y			Y	Y	Y	
Sternula nereis	Fairy Tern	VU	E							
Stipiturus malachurus parimeda	Southern Emu-wren (southern Eyre Peninsula)	VU	E	Y	Y	Y	Y	Y	Y	Y
Strepera versicolor	Grey Currawong				Y			Y	Y	Y
Sturnus vulgaris	*Common Starling			Y	Y	Y	Y		Y	Y
Thalasseus bergii	Crested Tern									Y
Thinornis rubricollis	Hooded Plover	VU	V							Y
Trichoglossus haematodus	Rainbow Lorikeet									Y
Turdus merula	*Common Blackbird							Y	Y	Y
Turnix varius	Painted Buttonquail		R					Y		Y
Vanellus miles	Masked Lapwing							Y		Y
Zosterops lateralis	Silvereye			Y	Y	Y	Y	Y	Y	Y
TOTALS				31	36	32	34	45	47	50

A total of 108 20min/2ha active searches were undertaken at control (n = 54) and impact sites (n = 54) during Pre- and Post-launch surveys of the first test launch attempt (Table 9). Avian diversity varied from a minimum of 3 species observed at control sites, to a maximum of 20 species at impact sites. The mean bird diversity recorded at impact sites during the Pre-launch survey was 9.22 (± 1.83) and 11.83 (± 1.83) during the Post-launch results. At control sites the mean bird diversity was 10.96 (± 2.95) during the Pre-launch survey and 8.46 (± 2.14) during the Post-launch survey (Table 9).

Table 9. An overview of avian species diversity parameters at impact and control sites at Whalers Way and Lincoln National Park during Pre- and Post-launch avian surveys. n = sample size and StdDEV = standard deviation.

control/impact	# of 20min/2ha active searches		Mean bird diversity ± StdDEV		Min - Max bird diversity	Min - Max bird diversity
	Pre-launch (n)	Post-launch (n)	Pre-launch	Post-launch	Pre-launch	Post-launch
control - Lincoln NP	20	24	10.96 ± 2.95	8.46 ± 2.14	6 - 15	3 - 19
impact - Whalers Way	34	30	9.22 ± 1.83	11.83 ± 1.83	6 - 13	5 - 20
	54	54				

3.6 Opportunistic song recordings

We opportunistically recorded 26 EPSEW and WBWB tracks with vocalisations during the Pre- and Post-launch avian survey. The quality of recordings varied greatly due to challenging conditions in the field (e.g. strong winds and rain), which resulted in background noise on recordings. In some instances vocalisations or the target species were overlapping with song broadcasted by playback and/or other avian species (e.g. New Holland Honey-eater, White-Browed Scrubwren, Silvereye and Welcome Swallow) at sites. The quality of vocalisations on all 26 tracks was analysed by listening to the recordings, as well as visualizing song data as spectrograms in Raven Pro 1.5. Each track was assigned a broad quality rating (good, bad).

During the Pre-launch avian survey, we opportunistically recorded vocalisations of 8 EPSEW. Of these, the quality of 6 recordings was too low (bad), but two EPSEW recordings contained clear good quality EPSEW song. No opportunistic WBWB recordings were made during the Pre-launch avian surveys, due to site conditions and time limitations.

During the Post-launch avian survey, we opportunistically recorded vocalisations of 9 EPSEW and 9 WBWB. Of these, the quality of 6 EPSEW and 2 WBWB recordings was low (bad), but 3 EPSEW recordings and 7 WBWB recordings contained clear good quality song.

These additional EPSEW/WBWB songs can be used to create additional playback stimuli in order to increase the number of EPSEW/WBWB playback stimuli for future playback experiments during Pre- and Post-launch avian surveys.

3.7 Noise data

Noise contours for the predicted L_{Amax} levels (in dB) at EPSEW and WBWB Impact sites at Whalers Way are shown in Table 10 and Figure 3 to Figure 5.

L_{Amax} levels at impact sites varied with the lowest levels (52 - 57dB) recorded at sites EPSEW6, WBWB6, and WBWB13, which are all located along the most eastern coastline of Whalers Way (Figure 3). The highest L_{Amax} levels (87 – 92 dB and 77-82 dB) were recorded at site EPSEW12 and EPSEW14, which are located directly east and west of the rocket launch pad (Figure 4). The highest L_{Amax} levels at WBWB sites was 72-77 dB, which was recorded at WBWB11 (Figure 5).

Table 10. L_{Amax} levels (in order from high to low dB) at EPSEW and WBWB sites (source: AECOM 2021).

EPSEW Site ID	Predicted sound pressure level, dB	WBWB Site ID	Predicted sound pressure level, dB
EPSEW12	87 – 92	WBWB11	72 – 77
EPSEW14	77 – 82	WBWB10	70 – 75
EPSEW04	68 – 73	WBWB08	70 – 75
EPSEW05	68 – 73	WBWB09	69 – 74
EPSEW01	67 – 72	WBWB01	67 – 72
EPSEW13	65 – 70	WBWB04	64 – 69
EPSEW03	64 – 69	WBWB03	63 – 68
EPSEW02	63 – 68	WBWB02	62 – 67
EPSEW10	62 – 67	WBWB07	62 – 67
EPSEW09	60 – 65	WBWB05	59 – 64
EPSEW11	60 – 65	WBWB12	53 – 58
EPSEW08	57 – 62	WBWB13	52 – 57
EPSEW07	55 – 60	WBWB06	52 – 57
EPSEW06	52 – 57		

Figure 3. Overview of noise contours for the predicted L_{Amax} levels at Whalers Way.

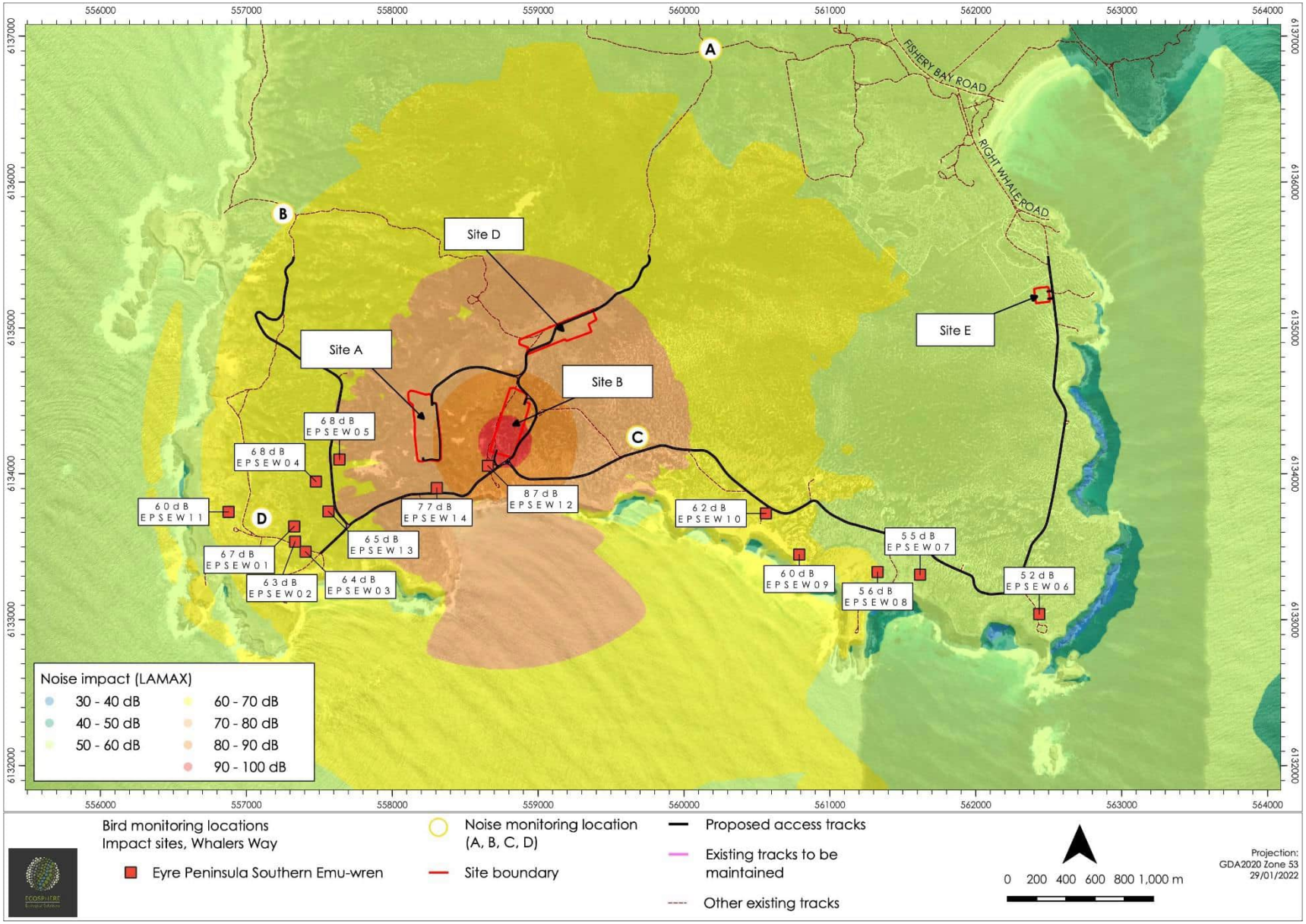

Figure 4. Noise contours for the predicted L_{Amax} levels at EPSEW Impact sites at Whalers Way.

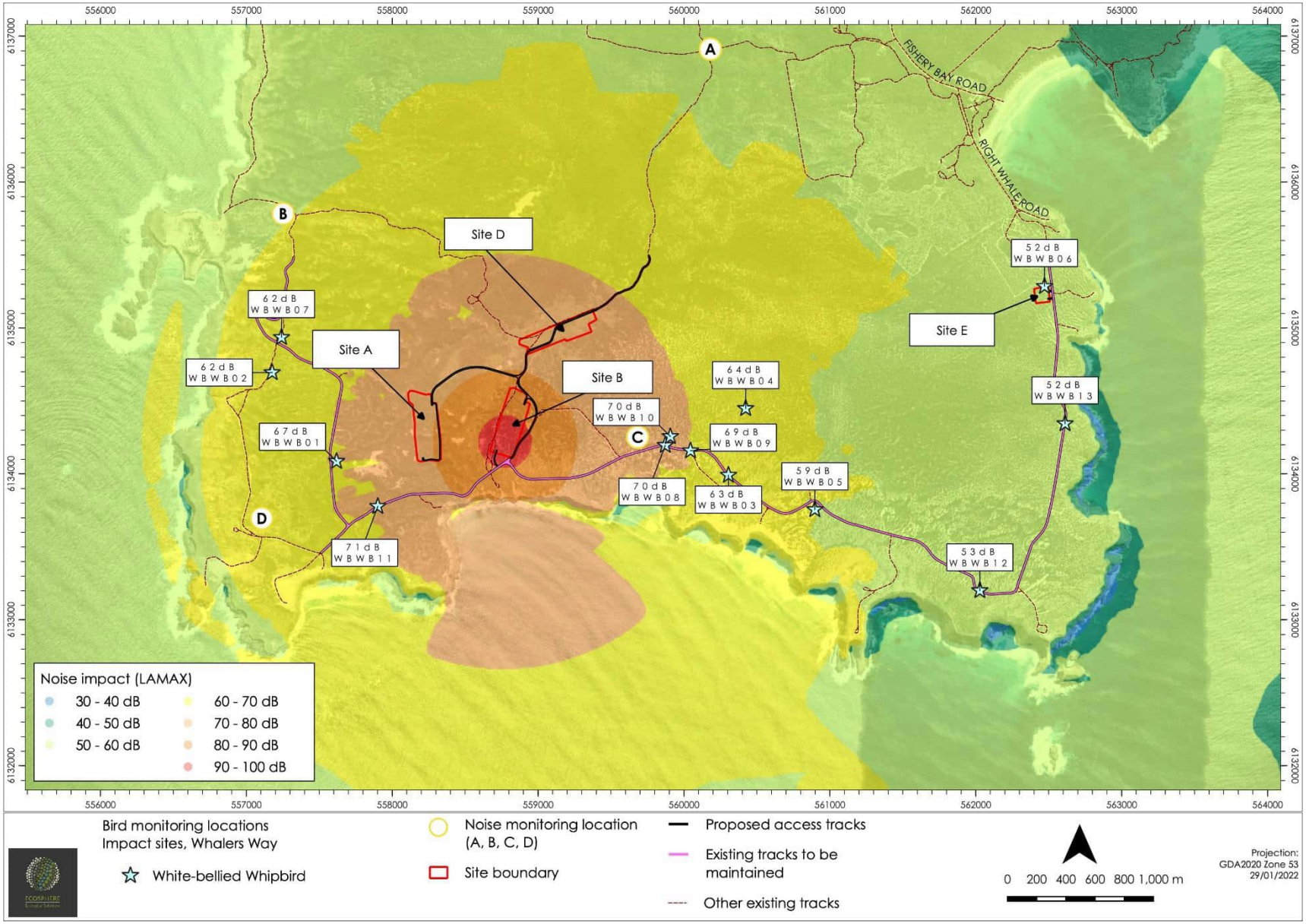

Figure 5. Noise contours for the predicted L_{Amax} levels at WBWB Impact sites at Whalers Way.

4 Discussion and recommendations

The avian and sound data presented in this report consist of data collected during the first test launch attempt only. The results from this short-term study broadly describe site occupancy, and behavioural response of EPSEW and WBWB, as well as avian diversity at impact and control sites before and after the first test launch attempt, that was undertaken at the site on 16 September 2021. The sound power levels presented in maps in this report are relevant to the first test launch attempt only. Only one of the four engines was active during the launch attempt and the rocket did not leave the launch area. As such, noise data presented in this report may not represent noise associated with an actual launch event. It is currently unclear if the full noise and vibration impact of a successful launch was achieved and thus experienced by the local bird community. Further analysis of data collected during the second and third test launches are required to quantify noise impacts to the focal species.

EPSEW

EPSEW occupancy at monitoring sites at Whalers Way was similar during the Pre-launch survey (7 out of 14 sites - 50.0%), compared to the Post-launch survey (8 out of 14 sites – 57.1%). At Lincoln National Park EPSEW site occupancy was the same during the Pre-launch survey and Post-launch survey (3 out of 6 sites – 50%). It should be noted that the number of EPSEW sites at Whalers Way is higher (14 impact sites) than the number of EPSEW sites at Lincoln National Park (6 control sites). Despite considerable survey effort to increase the number of EPSEW sites, additional EPSEW control sites were not found in Lincoln National Park. It seems that EPSEW occur at lower density at Lincoln National Park compared to Whalers Way.

EPSEW group size observed during the surveys varied from 1 to 3 individuals, but no groups of three birds were readily observed during the Post-launch survey. Group size of cryptic and secretive birds such as emu-wrens can be difficult to estimate without detailed behavioural observations repeated over an extended period of time and without marking individuals (for example by using a unique combination of coloured leg bands) for individual identification. Furthermore It should be noted that there was not always time to determine the exact number of individuals in a group by way of additional multiple follow-up observations and it is therefore possible that others may have been present at sites where a single individual or a pair of EPSEW was recorded. Breeding activity may also reduce detectability. Emu-wrens are known to be less responsive to played calls (e.g. playback experiments) and more difficult to find when they are nesting or when recently fledged juveniles are at a cryptic stage (i.e. remaining well-hidden and relatively quiet in undergrowth) (*M. Pickett unpublished data* in Pickett 2000). It is likely that the survey period coincided with the breeding season, it is possible that emu-wrens were not detected at some impact and control sites for this reason.

In south-western Victoria, the breeding season of the *Stipiturus malachurus* extends from late July to early March of the next year (Maguire and Mulder 2004). The extent of breeding season of EPSEW *Stipiturus malachurus parimeda* population is currently unknown, but it is expected that breeding season of ESPSEW is similar to that of *S. malachurus*. EPSEW breeding was opportunistically observed in September 2021 during the Post-launch survey: One active EPSEW nest with two feathered nestlings was discovered adjacent to an existing EPSEW site (Site EPSEW 14) at Whalers Way during the Post-launch avian survey. A pair of EPSEW were observed carrying food items (little insects and a caterpillar) to a small fully domed nest that was concealed in low vegetation. Signs of breeding/nesting was not observed at any of the other EPSEW monitoring sites at Whalers Way or Lincoln National Park during the Pre- and Post-surveys.

The playback experiments in combination with the 20min/2ha active searches were successful in detecting EPSEW at control and impact sites during the Pre- and Post-launch avian surveys. Of the 60 EPSEW playback experiments, EPSEW responded 23 times (38.3%). At control sites EPSEW responded to playback 33.3% of the time, versus 35.0% at impact sites.

WBWB

During the Pre-launch avian survey and the subsequent Post-launch avian survey WBWB were observed at 17 out of the 20 visited sites. During the Pre-launch avian survey we observed a minimum of 17 individual WBWB, compared to a minimum of 20 WBWB during the Post-launch avian survey. One WBWB site (site WBWB04) was established during the June 2020 survey but this site was deemed too far away to survey during subsequent visits. Vegetation was considered too dense to undertake a time-efficient survey, and as such this site was not surveyed after June 2020 (see Table 4).

WBWB occupancy was the same at monitoring sites at Whalers Way during the Pre-launch and Post-launch surveys (12 out of 13 sites - 92.3%). At Lincoln National Park WBWB site occupancy was the same during the Pre-launch survey and Post-launch survey (5 out of 8 sites - 62.5 %). Similar to the EPSEW sites, it should be noted that the number of WBWB sites at Whalers Way is higher (13 impact sites) than the number of WBWB sites at Lincoln National Park (8 control sites). Despite considerable survey effort to increase the number of WBWB control sites, additional WBWB sites were not found in Lincoln National Park. It seems that WBWB occur at lower density at Lincoln National Park compared to Whalers Way.

WBWB group size observed during the surveys varied from 1 to 2 individuals. Group size of cryptic and secretive birds such as whipbirds can be difficult to estimate without detailed behavioural observations repeated over an extended period of time and without marking individuals (for example by using a unique combination of coloured leg bands) for individual identification.

The playback experiments in combination with the 20min/2ha active searches were successful in detecting WBWB at control and impact sites during the Pre- and Post-launch avian surveys. Of the 52

WBWB playback experiments, WBWB responded only 12 times (23.1%). At control sites WBWB responded to playback 18.2% of the time versus 21.4% of the time at WBWB impact sites. However, WBWB song was heard prior to the start of 22 playback experiments (42.3%), indicating that WBWB were present in the area, but did not respond to the playback experiment itself (see Table 5 and 6). Playback experiments alone are therefore considered to be inadequate in detecting the species reliably at a site.

WBWB pairs were heard at both Whalers Way and Lincoln National Park in September during the Post-launch avian survey, but only once in response to a playback experiment. In general, male song was heard more frequently during the Pre- and Post-launch avian survey. Overall, WBWB seemed to vocalize less frequently in August than in September, which coincides with the findings by Smith (1991). WBWB are known to sing throughout the year, gradually increasing their song output from April to July, reaching a peak between July and September and from September to December there is a gradual decline in singing intensity (Smith 1991). During the breeding season, WBWB pairs often sing together to form an antiphonal duet. Females sing a shorter and less variable song than the males and female WBWB sing considerably less in August, coinciding with the nesting period for this species (Smith 1991).

In September 2021 one WBWB was seen carrying an unidentified item (presumed to be a food item, e.g. an insect) when it flew across a gravel road into dense vegetation (at impact site WBWB06). When passerine species are breeding and have a nest with nestlings or recently fledged young, adult birds can more readily be observed carrying food items or flying around with food items. The observation of a WBWB in flight, carrying something in its bill could have been an indication of a breeding event at that site. This was not confirmed as the avian surveys were not aimed at detecting breeding and/or finding nests.

Avian diversity

Overall avian diversity varied between Whalers Way Lincoln and National Park during the Pre-launch avian survey, with 45 and 34 species recorded respectively. In contrast, avian diversity was similar between Whalers Way (48 species) and Lincoln National Park (50 species) during the Post-launch avian survey. Avian diversity at impact and control sites varied, from a minimum of 3 species observed at control sites, to a maximum of 20 species at impact sites.

Variation in the number of bird species observed in August versus September could be due to breeding activity of certain bird species. Detectability of bird species may have been different in September than in August, due to differences in breeding activity and song broadcast. Furthermore the observed variation in bird diversity between Whalers Way and Lincoln National Park could be due to survey limitations (e.g. survey duration and time of day) and differences in local weather conditions during the surveys. The Pre- and Post-launch avian surveys were undertaken over a 4-day

period, which is considered a snap-shot in time. Time constraints resulted in a limited number of sites being surveyed in afternoons only (suboptimal). Some bird species were only seen/heard once during one particular survey period. Examples of bird species observed only once at a site include a flock of Cape Barren Geese (flying over the site), a pair of White-fronted Chats and a White-winged Triller, all of which were seen at Whalers Way in September 2021, during the Post-launch avian survey (see Table 8).

Conclusion

The behavioural response data of EPSEW and WBWB collected thus far is considered to be short-term behavioural response data. While we detected no immediate impacts on avifauna as a result of the first test launch attempt, the longer term impacts of rockets launches on the avian community and focal species remains unknown. No long-term behavioural data (i.e. occupancy, breeding and recruitment) was collected during the Pre- and Post-launch surveys of the first test launch attempt. The collection of such data would require a significant increase in survey time, intensity and effort (likely multiple months over multiple years). From the data collected from this first of launch of a three test launch campaign definite conclusions can't be drawn at this early stage to quantify the potential short- and long-term noise impacts on the local avian community and to the two focal species of interest. Further data collection is required to be collected from the second and third test launch to quantify impacts.

Recommendations

survey sites: As per the comments section in Table 4 (page 12), some of the original EPSEW and WBWB sites are recommended to be discontinued in future avian surveys. These locations are sites were the focal birds were not detected during the Pre- and Post-launch, despite multiple site visits per survey period. Control sites EPSEW18 to EPSEW20 in Lincoln National Park were based on historical sitings of EPSEW. The surveyors were unable to locate any EPSEW during the Pre- and Post-launch avian surveys at these 3 sites, despite considerable survey effort. Furthermore EPSEW observations made in June 2020 (during the targeted survey) at impact sites EPSEW01, EPSEW02 and EPSEW 03 are deemed likely individuals belonging to one EPSEW territory, given the close proximity of observations. The observations of EPSEW during the targeted survey in June 2020 are likely not spaced sufficiently enough to avoid multiple records of the same individual. Similarly, observations of EPSEW at sites EPSEW04 and EPSEW05 during the targeted survey (Ecosphere Ecological Solutions Pty Ltd 2020) are likely individuals belonging to one EPSEW territory only. It is therefore suggested that of these 5 EPSEW impact sites, only surveys at impact sites EPSEW03 and EPSEW05 are to be continued. WBWB sites WBWB04, WBWB18 and WBWB20 are recommended to be discontinued based on the same reasons described above.

survey timing: Due to the potential difficulty in observing EPSEW and WBWB, surveys undertaken in the nonbreeding season may not represent the actual number of birds present at a site. The detectability of both species changes throughout the year and across the breeding season. Therefore future Pre- and Post-launch avian surveys should be undertaken at the same time as the test launch attempt 1 avian surveys (i.e. in the breeding season). If it is likely that the two future test launches (and associated Post-launched surveys) will span across breeding/non breeding seasons, it is recommended to undertake a Pre-launch *and* Post-launch avian survey for each of these test launches to reduce these confounding factors as much as possible. Undertaking Pre- and Post-launches will ensure that confounding factors such as detectability and site conditions of avian surveys are similar as possible. It should be noted that further ethics permitting will be required to undertake additional Pre-launch avian survey work for the Test Launch Campaign.

Long term monitoring: The behavioural response data of EPSEW and WBWB collected thus far is considered to be short-term behavioural response data. Long term monitoring should be considered for the site, as this will gather invaluable information on the potential impact of rocket launches on local avifauna. The utilization of Autonomous Recording Units (ARU's) should be taken into consideration for the test launches phase of the project and the overall project. ARU's can be deployed in marine or terrestrial environments for bio acoustical monitoring over time. ARU's record bird vocalizations autonomously for longer periods of time, gathering data on species richness as well call frequency for all local avian species present in the area of deployment. The acoustic data collected can be part of long-term acoustic monitoring of the site, and data collected during the test launches can be analysed in the future (i.e. difference in call rates across time of day) to inform and add valuable insights into impacts of test launches, as well as future avian research projects. ARU's could be placed in the existing WBWB and EPSEW control and impact sites and they can be moved between sites between the different survey periods to cover all control and impact sites and gather information on call rates of focal species as well as all other local avian fauna.

5 References and bibliography

AECOM Australia (2020). Whalers Way Orbital Launch Complex Flora and Fauna Assessment and Preliminary impact Assessment. Report to Southern Launch.

AECOM Australia (2021). Whalers Way Test Launch September 2021 - Acoustic review. Report to Southern Launch.

Birdlife (2021a). survey Techniques - 2-ha, 20 min Search. Accessed in June 2021: https://birdata.birdlife.org.au/survey-techniques

Birdlife (2021b). Southern Emu-wren *Stipiturus malachurus* Maluridae. Accessed in June 2021: https://www.birdlife.org.au/bird-profile/southern-emu-wren.

Birdlife International (2021c). Western Whipbird *Psophodes nigrogularis*. Accessed in June 2021: http://datazone.birdlife.org/species/factsheet/22705330.

Burbidge A.H., Joseph L., Toon A., White, L.C., McGuire, A., and Jeremy J. Austin (2017). A case for realigning species limits in the southern Australian whipbirds long recognised as the Western Whipbird (*Psophodes nigrogularis*), *Emu - Austral Ornithology*,117(3): 254-263, DOI: 10.1080/01584197.2017.1313685.

Bureau of Meteorology (2020). Port Lincoln, South Australia June 2020 Daily Weather observations.

Department of Agriculture, Water and the Environment (DAWE) (2020) Species Profile and Threats Database *Psophodes leucogaster leucogaster* — Mallee Whipbird. SPRAT Profile Online resource [viewed 1 July 2020].

Department of Agriculture, Water and the Environment (DAWE) (2020) Species Profile and Threats Database *Stipiturus malachurus parimeda* – Southern Emu-wren - Eyre Peninsula. SPRAT Profile Online resource [viewed 1 July 2020].

Department of Environment Water Heritage and Agriculture (DEWHA) (2010). survey guidelines for Australia's threatened birds Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*.

Department of the Environment (DotE) (2013). Approved Conservation Advice for *Stipiturus malachurus parimeda* (Southern Emu-wren - Eyre Peninsula). Canberra: Department of the Environment.

Ecosphere Ecological Solutions Pty Ltd (2020). *Broadscale Distribution and Status of the Eyre Peninsula Southern Emu-wren (Stipiturus malachurus parimeda) and Western Whipbird (eastern) (Psophodes leucogaster leucogaster) at Whalers Way, June 2020*. Report to Southern Launch.

Ecosphere Ecological Solutions Pty Ltd (2021). *Whalers Way Orbital Launch Complex. Test Launch Campaign - Site Selection survey*. Report to Southern Launch.

Garnett, S.T., Szabo J.K., and Dutson G. (2011). The action plan for Australian birds 2010. CSIRO Publishing, Melbourne.

Heard, L. and Channon, B. (1997). Guide to a Native Vegetation survey Using the Biological survey of South Australia. Geographic Analysis and Research Unit, Department for Housing, Urban Development.

Higgins, P.J., Peter, J.M., Steele, W.K. (Eds.), (2001). Handbook of Australian, New Zealand and Antarctic Birds, vol. 5. *Oxford University Press*, Melbourne.

Maguire, G.S. (2006a). Behavioural Ecology of the Southern Emu-wren (*Stipiturus malachurus*). PhD thesis. The University of Melbourne, Melbourne.

Maguire, G.S. (2006b). Territory quality, survival and reproductive success in southern emu-wrens *Stipiturus malachurus. Journal Of Avian Biology 37: 579-593.*

Maguire, G. S. (2006c). Fine-scale habitat use by the southern emu-wren, *Stipiturus malachurus*. *Wildlife Research* 33: 137-148.

Maguire, G.S., and Mulder, R.A. (2004). Breeding biology and demography of the southern emu-wren (*Stipiturus malachurus*). *Australian Journal of Zoology* 52: 583–604. doi:doi:10.1071/ZO04043.

McGuire, A.L. (2012). Song divergence in the duetting western whipbird *Psophodes nigrogularis*: function, sex differences and the influence of habitat. PhD thesis. Flinders University, Adelaide.

McGuire, A.L., Johnston G., Robertson J., and Kleindorfer, S. (2011). Comparison of survey methods for detection of the elusive Western Whipbird *Psophodes nigrogularis* with notes on its distribution. *South Australian Ornithologist* 37(2): 49-59.

Osenberg, C.W., Schmitt, R.J., Holbrook, S.J., Abu-Saba, K.E. & Flegal, A.R. (1994). Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecological Applications* 4:16– 30.

Owens H. (Ed.) (2000). Guidelines for Vertebrate surveys in South Australia Using the Biological survey of South Australia. Biological survey and Research Section, National Parks and Wildlife SA, Department for Environment and Heritage.

Pickett, M.I. (2000). The Mount Lofty Ranges southern emu-wren *Stipiturus malachurus intermedius*: results of banding and monitoring, 1994-1998. Conservation Council South Australia, Adelaide

Pickett, M. (2006). Habitat Management Guidelines for the Eyre Peninsula Southern Emu-wren. Department for Environment and Heritage, PO Box 22 Port Lincoln SA 5606. October 2006.

Thiault, L., Kernaleguen L., Osenberg C.W., Claudet J. (2017). Progressive-Change BACIPS: a flexible approach for environmental impact assessment. *Methods in Ecology and Evolution* 8:288–296.

Webster, H.O. (1966). The western whipbird at Two Peoples Bay. *Western Australian Naturalist*, 10:25-28.

Underwood, A.J. (1992). Beyond BACI: the detection of environmental impacts on populations in the real, but variable, world. *Journal of Experimental Marine Biology and Ecology* 161:145–178.

Appendix 1 – DEWHA survey guidelines

White-bellied Whipbird

Detectability: WBWB are timid, elusive and cryptic, occupy dense habitat and are more often heard than seen. Individuals elicit distinctive song, which is usually the only indication of presence. Both sexes are known to be responsive to broadcast (playback) of calls (Higgins & Peter 2002).

Recommended survey method: Recommended survey method (as per the Guidelines for Detecting Birds Listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010) are as follows:

"*Broadcast surveys effective at eliciting response, especially during the breeding season. Transect-point surveys of suitable habitat in the early morning or late afternoon to detect distinctive calls, also most effective during the breeding season.*"

Survey effort guide

Methods	Hours	Days
Area searches or transect surveys*	12	6
Broadcast surveys*	10	4

* In areas less than 50 ha, most effective at dawn or late afternoon during breeding season.

Eyre Peninsula Southern Emu-wren

Detectability: EPSEW are shy and secretive and birds are usually first detected by call, although their voice is feeble. Birds are difficult to flush from cover (Higgins *et al.* 2001), but do responds to playback (M. Pickett *pers. comm*.). Emu-wrens usually respond well to played calls, issuing a reply and often approaching the surveyor (Pickett 2000).

Recommended survey method: Recommended survey method (as per the Guidelines for Detecting Birds Listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010) are as follows:

"*Area searches or transect surveys early in the day in suitable habitat. Detection by calls and sightings, although call detection requires good hearing and calm conditions. Also broadcast (playback) surveys effective at soliciting responses, especially before and during the breeding season. Mist-netting with nets set low in dense, heathy habitat may be useful.*"

Survey effort guide

Methods	Hours	Days
Area searches or transect surveys *	10	5
Broadcast surveys*	6	3
Mist-netting*	12	4

* In areas less than 50 ha.

Appendix 2 – Opportunistic sitings

Table 11. Opportunistic observations of EPSEW and WBWB at Whalers Way and Lincoln National Park.

	Location	SITE ID	Date	Time	GPS Location	Observations
1	Lincoln National Park	EPSEW	19/09/2021	9:45	53 H 591572 6147342	Male observed
2	Lincoln National Park	WBWB	20/09/2021	6:56	53 H 577730 6145586	Male heard singing
3	Lincoln National Park	WBWB	21/09/2021	8:47	53 H 578895 6143843	Male heard singing
4	Whalers Way	WBWB	22/09/2021	7:38	53 H 562566 6134137	Male heard singing
5	Lincoln National Park	EPSEW	22/09/2021	9:11	53 H 591670 6147710	Pair observed
6	Whalers Way	WBWB	22/09/2021	9:18	53 H 558618 6134104	Male heard and seen
7	Whalers Way	WBWB	22/09/2021	15:51	53 H 561414 6133498	Male and female seen and heard
8	Whalers Way	WBWB	23/09/2021	12:04	53 H 558252 6133891	Male heard singing
9	Whalers Way	WBWB	24/09/2021	11:20	53 H 557724 6133892	Male heard singing
10	Whalers Way	EPSEW	21/12/2021	11:06	53 H 557855 6133794	2 EPSEW (Pair) and a nest with 2 nestling
11	Whalers Way	EPSEW	21/12/2021	15:24	53 H 557112 6134716	3 seen (2 males, one female)
12	Whalers Way	EPSEW	23/12/2021	9:27	53 H 557326 6134984	2 seen (pair)

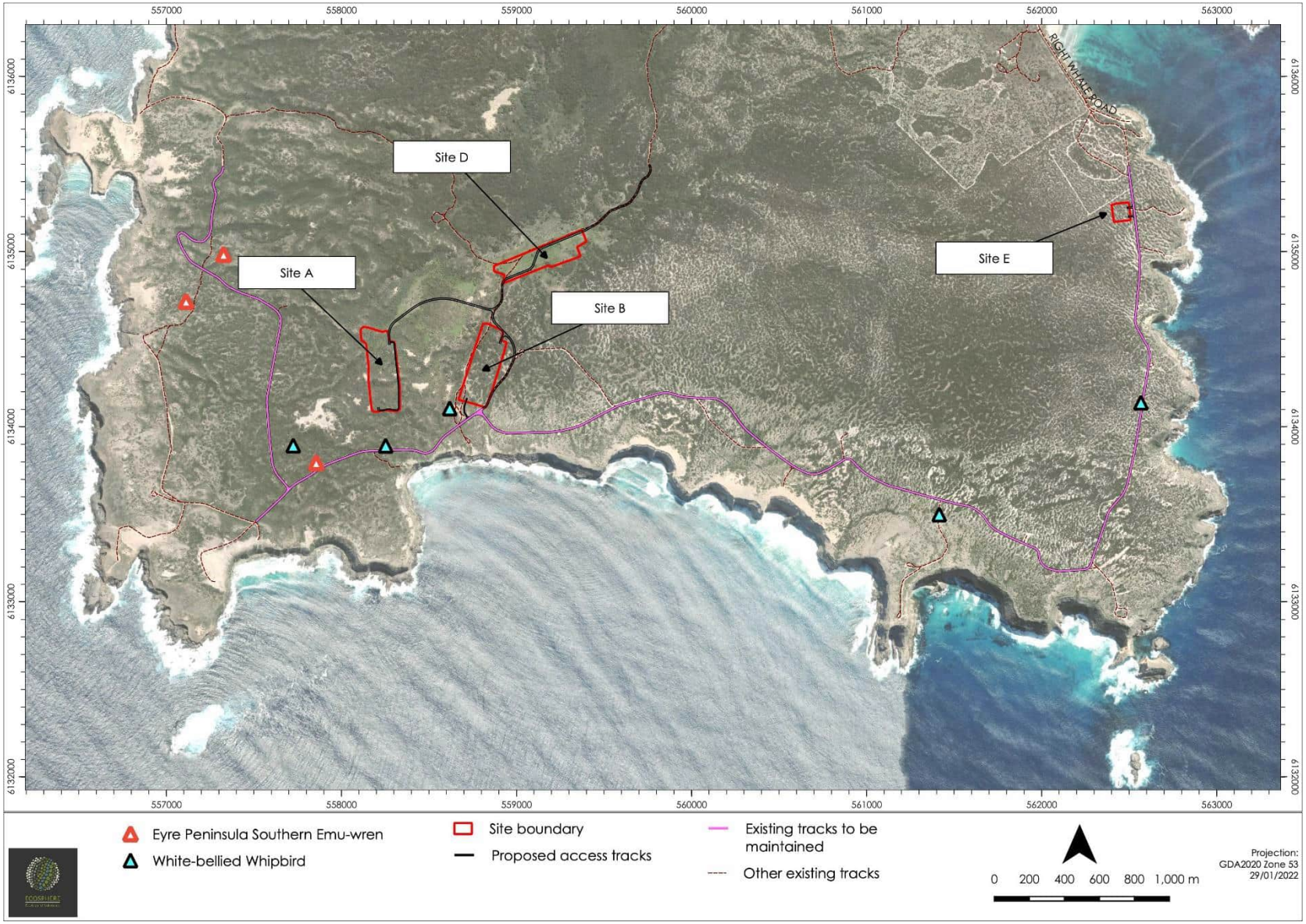

Figure 6. Additional observations of focal species at Whalers Way.

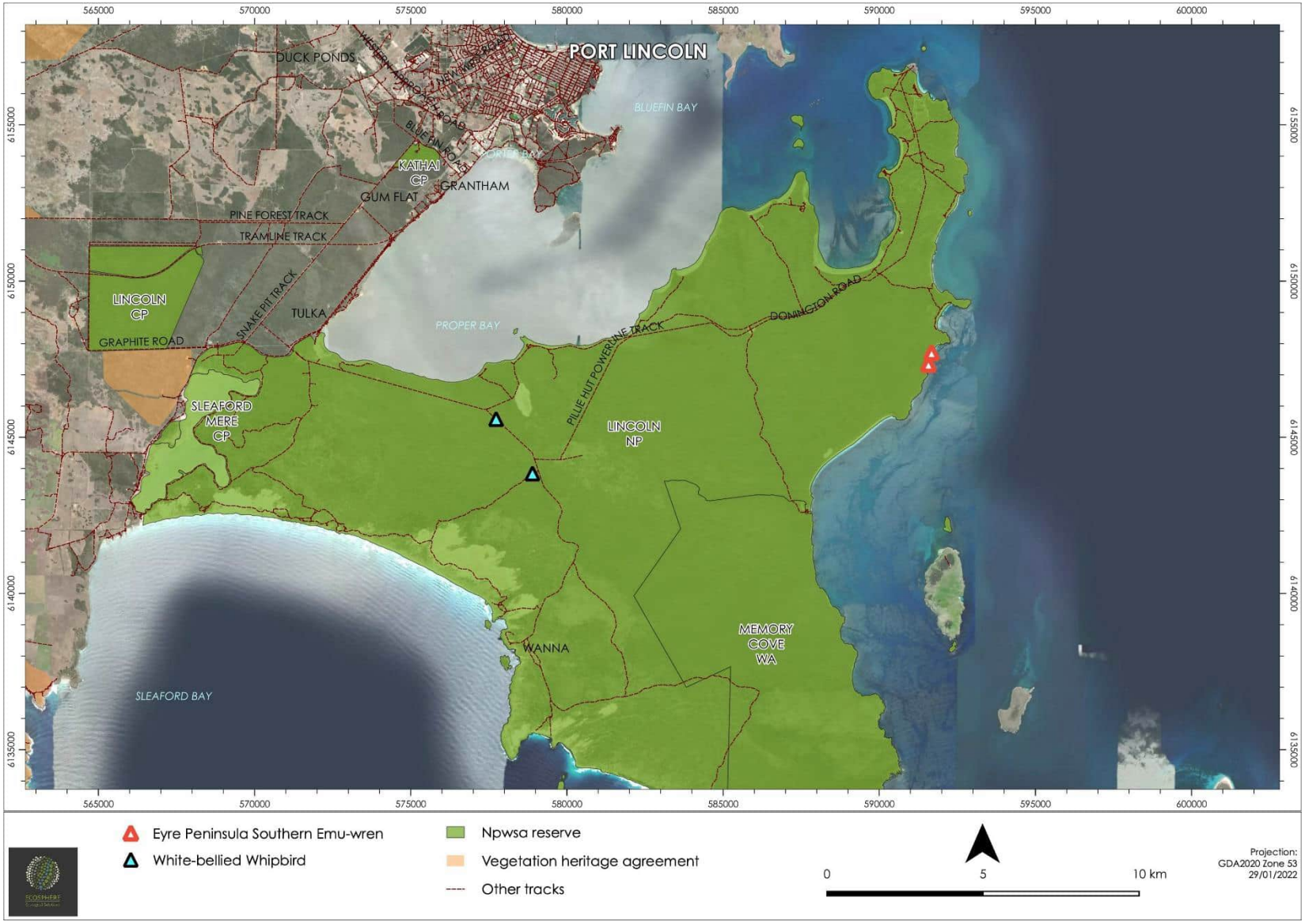

Figure 7. Additional observations of focal species at Lincoln National Park.


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Appendix K

Whalers Way Data Report - Clearance under the Native Vegetation Regulations 2017

Native Vegetation Clearance

Southern Launch Whalers Way Data Report

Clearance under the *Native Vegetation Regulations 2017*

10/01/2022

Prepared by Ecosphere Ecological Solutions

Table of contents

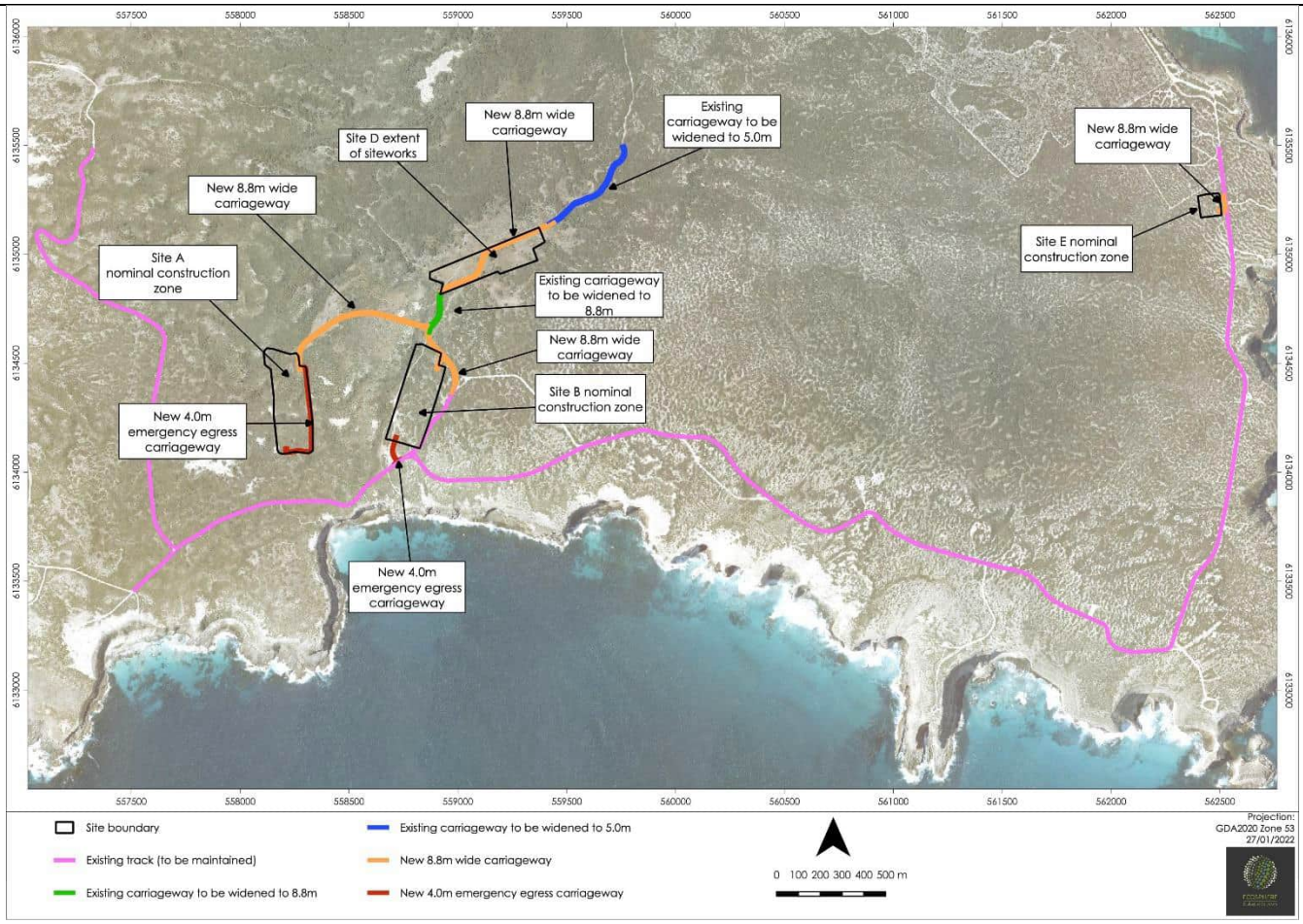
1. Application information

Application Details

Applicant:	Southern Launch Pty Ltd Level 8, 70 Pirie Street, Adelaide, South Australia 5000		
Key contact:	Andrew Curran		
Landowner:	Theakstone Property Pty Ltd		
Site Address:	Sleaford		
Local Government Area:	The District Council of the Lower Eyre Peninsula	Hundred:	Sleaford
Title ID:	CT/5993/374	Parcel ID	Sec D71437 A101

Summary of proposed clearance

Purpose of clearance	The Whalers Way Orbital Launch Complex (WWOLC) project is proposed to establish a multi-user rocket launch facility that will service the growing demand for the launch of domestic and international vehicles for Polar and Sun Synchronous orbit satellite insertion. The complex will be designed to launch the latest technology 'smallsat' satellites which are typically weighted between several kilograms ('cubesat') to a maximum of several hundred kilograms. Consequently, the launch vehicles (rockets) will also be relatively small (in comparison to earlier satellite launch vehicles and heavy-lift rockets), typically being in the range of 10 to 30 metres tall. The site will need to be prepared to accept the facility including appropriate supporting infrastructure
Native Vegetation Regulation	Schedule 1 Part 4 – Major developments and projects under *Development Act 1993* Regulation 12(27)
Description of the vegetation under application	Coastal heath and Low Mallee. All project sites are located within low coastal mixed mallee with average canopy heights between 0.5 and 2m tall. Soils are grey sand and limestone. Cover ranges from 50% to 90%. Known habitat for nationally threatened fauna species Southern Emu-wren and Western Whip bird.
Total proposed clearance - area (ha) and number of trees	23.40 hectares including the following: Launch Site A, Launch Site B, Infrastructure Site D and Range Control Site E and associated access tracks
Level of clearance	Level 4
Overlay (Planning and Design Code)	Native Vegetation Overlay or State Significant Native Vegetation Overlay



Mitigation hierarchy	Avoidance of vegetation wherever possible has occurred within the engineering constraints of a highly technical project. Reduction of the footprint as far as practicable to avoid clearing native vegetation with the size of the Project Area reduced in size from 70.58 ha to 23.40 ha from concept design The clearance footprints have been minimized to the minimum area possible and located adjacent to existing roads where possible. Existing access roads are being utilised to ensure minimum disturbance and implementing a CEMP and OEMP to manage direct and indirect impacts • Resizing and shapes of infrastructure areas refined to limit impact. • Areas minimised and located in areas of lower condition. • Future reductions in footprint are being sought. • Proposed access tracks have been aligned with existing tracks where possible. Southern Launch are enthusiastic about incorporating the restoration and conservation of the Whalers Way area as a critical part of the project. Mitigating impacts is at the forefront of the company ethos. Some measures that are in planning phases include: • Predator Proof fencing and eradication of predators including cats and foxes from the Whalers Way HA. • Firebreaks incorporated along fences to protect and mitigate one of the primary threats to EPBC listed species present.

	• Weed control and ongoing management. • Ongoing studies into risks associated with the project which have no precedent and lack of published literature such as funding PhD studies in association with state universities.
SEB Offset proposal	Payment into the fund of $1,916,884.01

2. Purpose of clearance

2.1 Description

Southern Launch intend 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.

Southern Launch currently have a number of customers who will be ready to launch from the proposed facility from early 2021. The current development proposal for the Launch Complex is anticipated to be undertaken in four phases across up to four locations on the subject site between 2022 and 2025 (Table 1).

Table 1. Main elements of initial development.

Element	Description	Timing
Launch Site – Site B	A rocket launch facility sited and designed to support small lift launch vehicles with sizes from micro to small conventional (less than 10 tonnes up to approximately 60 tonnes).	Stage 1 - 2022
Range Control Facility – Site E	A permanent range control facility which will provide facilities for launch control, range control, security, office, administration, and visitor facilities.	Stage 2 – 2022/2024
Infrastructure Site – Site D	Infrastructure facilities including a dam, magazine, and ancillary storage facilities.	Stage 3 – 2022/2024
Launch Site – Site A	A rocket launch facility which will predominantly be utilised for larger launch vehicles (greater than 30 tonnes to up to approximately 100 tonnes).	Stage 4 – 2024/2025
Access Upgrades	Existing access tracks will be upgraded as required to provide appropriate, all-weather access to each of the sites. New access connections will be provided to connect the sites to the existing and upgraded access tracks.	Progressively from the commencement of the Project.
Supporting Infrastructure	• Diesel and/or Hydrogen Fuel Cell Powered Generators. • Helicopter Pad(s). • Water Tanks. • Water Capture and Treatment Systems associated with each site. • 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.	Progressively from commencement of project as each launch site is developed.

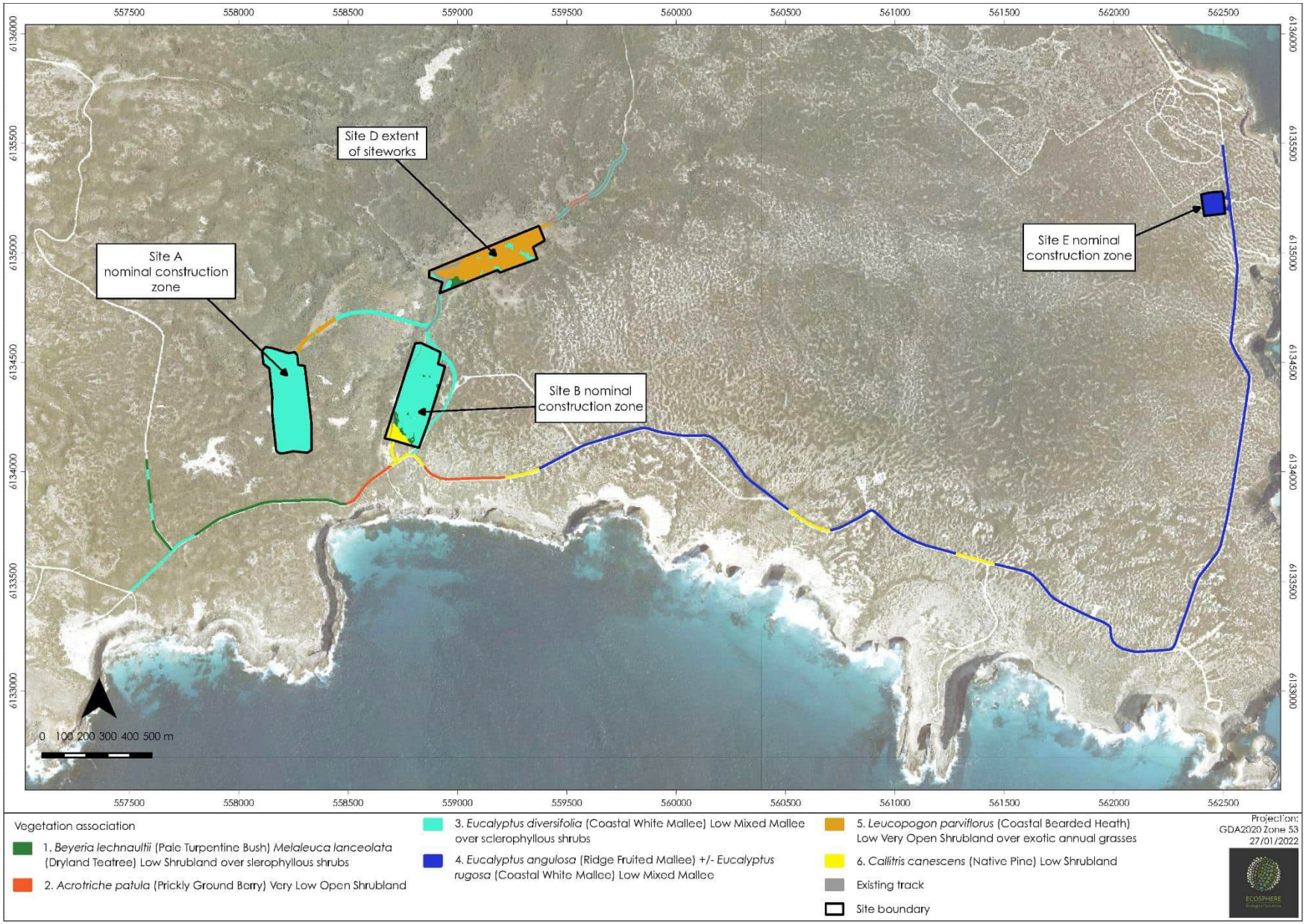
Element	Description	Timing
	• Construction of internal access roads. • Visitor viewing area and interpretative facilities. • Signage • Lighting • Noise monitoring equipment • Radar and telemetry equipment • Safety and security related upgrades including fencing, gates, cameras, sensors etc	
Temporary facilities required during construction	• Temporary concrete batching plant. • Temporary site and construction offices and facilities. • Temporary water storage • Temporary laydown areas. • Temporary access tracks.	At the commencement of each stage of construction.

2.2 Background

The Project is located at the southern tip of the Eyre Peninsula in Sleaford, commonly known as Whalers Way. It is approximately 25 km southwest of Port Lincoln, in the District Council of Lower Eyre Peninsula. The land is owned by Theakstone Property Pty Ltd. The area is zoned as Coastal Conservation under the District Council of Lower Eyre Peninsula.

The area is covered in remnant indigenous vegetation and is largely continuous apart from access roads and small areas of regenerating pasture. The site is under a Heritage Agreement (HA 148).

2.3 General location map



2.4 Details of the proposal

The Project comprises of the following key components, which hereinafter will be referred to as the Project Area (Figure 1):

- Launch Site A;
- Launch Site B, including the construction of a new road alignment to the east and south;
- Infrastructure / Workshop area (Site D), including the construction of a new road alignment to the south;
- Range Control (Site E);
- Access track upgrades to the north and west of Infrastructure / Workshop.

2.5 Approvals required *or* obtained

Environment and Biodiversity Conservation Protection Act 1999

The EPBC Act and the *Environment Protection and Biodiversity Conservation Regulations 2000* (EPBC Regs) are the main pieces of Federal legislation protecting biodiversity in Australia. The EPBC Act and EPBC Regs protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the EPBC Act as matters of national environmental significance (MNES). The nine MNES to which the EPBC Act applies are:

1. world heritage properties;
2. national heritage places;
3. wetlands of international importance (listed under the Ramsar Convention);
4. nationally threatened species and ecological communities;
5. migratory species;
6. Commonwealth marine areas;
7. the Great Barrier Reef Marine Park;
8. nuclear actions (including uranium mining); and
9. a water resource, in relation to coal seam gas development and large coal mining development.

If an action that has, will have, or is likely to have a significant impact on a MNES requires referral to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

Native Vegetation Act 1991

Native vegetation in South Australia is protected under the South Australian *Native Vegetation Act 1991* (NV Act) and *Native Vegetation Regulations 2017* (NV Regs). Any proposed clearance of native vegetation in South Australia (unless exempt under the NV Regs) is to be assessed against the NV Act Principles of Clearance and requires approval from the Native Vegetation Council (NVC). The Project is considered to fall under Part 3, Division 5, Regulation 12 & 13 Major Developments and Projects.

National Parks and Wildlife Act 1972

Native plants and animals in South Australia are protected under the South Australian *National Parks and Wildlife Act 1972* (NPW Act). It is an offence to take a native plant or protected animal without approval. Threatened plant and animal species are listed in Schedules 7 (endangered species), 8 (vulnerable species) and 9 (rare species) of the Act. Persons must not:

- Take a native plant on a reserve, wilderness protection area, wilderness protection zone, land reserved for public purposes, a forest reserve or any other Crown land.
- Take a native plant of a prescribed species on private land.
- Take a native plant on private land without the consent of the owner (such plants may also be covered by the NV Act).
- Take a protected animal or the eggs of a protected animal without approval.
- Keep protected animals unless authorised to do so.
- Use poison to kill a protected animal without approval.

2.6 Native Vegetation Regulation

Schedule 1 Part 4 – Major developments and projects under *Development Act 1993* Regulation 12(27)

To facilitate the interactions between the *Native Vegetation Act 1991* and the *Planning Development and infrastructure Act 2016* in relation to the approvals for projects of major social, economic or environmental significance. The NVC will comment on the proposal as part of the assessment for major projects as to whether it avoids and minimises clearance a far as practicable, and at the same time determine the SEB required to offset the impact of the clearance.

2.7 Development Application information

The Project was declared a Major Development by the Minister of Planning on 22 August 2019. As such, a range of environmental assessments are required to support the Major Development Application that Southern Launch is preparing.

3. Method

3.1 Flora assessment

A detailed desktop study was conducted to describe the existing environment and determine the potential environmental values present within the Survey Area. The desktop assessment considered the following resources:

- Protected Matters Search Tool – (DAWE, 2020a)
- NatureMaps flora and fauna records and vegetation mapping
- Aerial imagery
- South Australian Resources Information Gateway (SARIG, 2020)
- Eyre Peninsula fauna surveys 2004 and 2009 as published on NatureMaps (2020) and in Brandle (2010).

A likelihood of occurrence assessment was completed for all conservation significant species and communities that were identified in the desktop study. The assessment considered the Whalers Way area, which includes the Survey Area and buffer, to inform future impact assessment studies.

The likelihood assessment considers the presence of suitable habitat, number of records, date of records, and proximity of known records in relation to Whalers Way. Five categories are used for the assessment, including:

- Unlikely: No preferred/suitable habitat present. Species unlikely to be present on the site at any time or during any season. No records of species/community in Study Area.
- Low: Potentially suitable habitat present lacking condition, specific floristic or complexity data. Species may visit or fly over however habitat is unlikely to be considered critical to the survival of the species. No recent records of species/community in Study Area.
- Moderate: Preferred habitat (or parts thereof) present and is of size suitable for supporting species (individual or population).
- High: Suitable habitat is present. One or more recent records of species/community.
- Present: Species known to be present, confirmed records and suitable habitat is present.

Provide details of the flora assessment, such as database searches, date(s) of inspection, time spent on site and effort and methodology applied including searches for the presence of species listed under the NP&W Act 1972 or the EPBC Act 1999.

The vegetation survey was performed in accordance with the Bushland Assessment Method (BAM). The NVC BAM was designed for assessing vegetation that is located within the agricultural region of South Australia. The BAM uses biodiversity ‘surrogates’ or ‘indicators’ to measure biodiversity value against benchmark communities. Each area to be assessed is termed an application area (‘Block’), within which different vegetation associations (‘Sites’) are identified.

For the NVC BAM, three components of the biodiversity value of the site are measured and scored (Table 5) including vegetation condition, conservation value, and landscape context. These three component scores are combined to provide a ‘Unit Biodiversity Score’ (UBS) for a hectare and then multiplied by the size (hectares) of the site to provide a ‘Total Biodiversity Score’ for the site.

The Survey Area was traversed on foot and a complete flora species list was recorded.

Targeted searches were conducted for conservation significant flora species in areas of native vegetation. A ramble survey method was adopted (i.e., randomly walking through areas of vegetation, attempting to cover different topography and habitats) to ensure best coverage of the block of vegetation.

Where conservation significant flora species were identified, the following was recorded:

- location using a handheld GPS unit (accuracy +/-5m)
- population extent
- vegetation association
- additional habitat observations where relevant.

Additional targeted flora surveys for threatened species were undertaken in early October 2020 and follow up surveys through late winter and spring in 2021. Specific species targeted were *Caladenia* spp. and any species of the

ORCHIDACEAE family, *Prostanthera calycina* (EP Mintbush), *Euphrasia collina* ssp. *osbornii* (Osbornes Eyebright). All species recorded were added to existing species lists.

3.2 Fauna assessment

Fauna habitats were assessed for specific habitat components, including consideration of structural diversity and refuge opportunities for fauna, in order to determine the potential for these habitats to support conservation significant species. The survey focussed on searching for habitat that would be utilised by conservation significant species identified in the desktop assessment as having the potential to occur in the area.

The fauna habitat assessments included:

- location
- general habitat description
- habitat condition and disturbance types
- dominant / characteristic flora species and vegetation layers
- presence and abundance of key habitat features such as large mature trees, small and large hollows, fallen logs, course and fine litter, decorticating bark, bare ground, grass, stones and boulders, rock crevices, soil cracks, vines, dense shrubs, water bodies etc.
- presence of fauna and secondary signs (e.g., scats, digging, tracks, burrows, eggshell, bones, feathers etc.)
- connectivity of habitat.

Fauna observations focussed on avian species, using distinctive calls and direct observation. All observations were made between daylight hours of 0700 and 1700.

Targeted fauna assessments were carried out for the nationally threatened bird species, The Southern Emu-wren (Eyre Peninsula) (*Stipiturus malachurus parimeda*) and Western Whipbird (eastern) (*Psophodes leucogaster leucogaster*) in June 2020 with follow up surveys undertaken in winter and spring 2021.

Historical surveys in the area include three Eyre Peninsula biological standard surveys sites within the HA. These were undertaken from 14 December 2004 and included pitfall, Elliott, and cage trapping over four nights duration (Brandle 2010).

Other surveys within and adjacent to the area include:

- Cathedral Rocks Wind Farm Southern Emu Wren and Western Whip Bird surveys 2004-2008 (Pickett, 2004.
- Offshore Islands surveys 1980 (DEH 1980).
- Eyre Peninsula Southern Emu Wren surveys 2002-2009 (Pickett 2004).
- Numerous stakeholder and interest group avian surveys.

4. Assessment Outcomes

4.1 Vegetation Assessment

Six vegetation associations were observed within the Project areas. These were all typical of coastal communities commonly occurring within the southern Eyre Peninsula region and were intact indigenous communities with low weed cover and disturbance except for association 5. The vegetation associations recorded were:

1 -Beyeria lechenaultii (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Tea-tree) Low Shrubland over sclerophyllous shrubs.

2 -Acrotriche patula (Prickly Ground Berry) Very Low Open Shrubland.

3 -Eucalyptus diversifolia (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs.

4 -Eucalyptus angulosa (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee.

5 -Leucopogon parviflorus (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses.

6 -Callitris sp 'Limestone' (Native Pine) Low Shrubland.

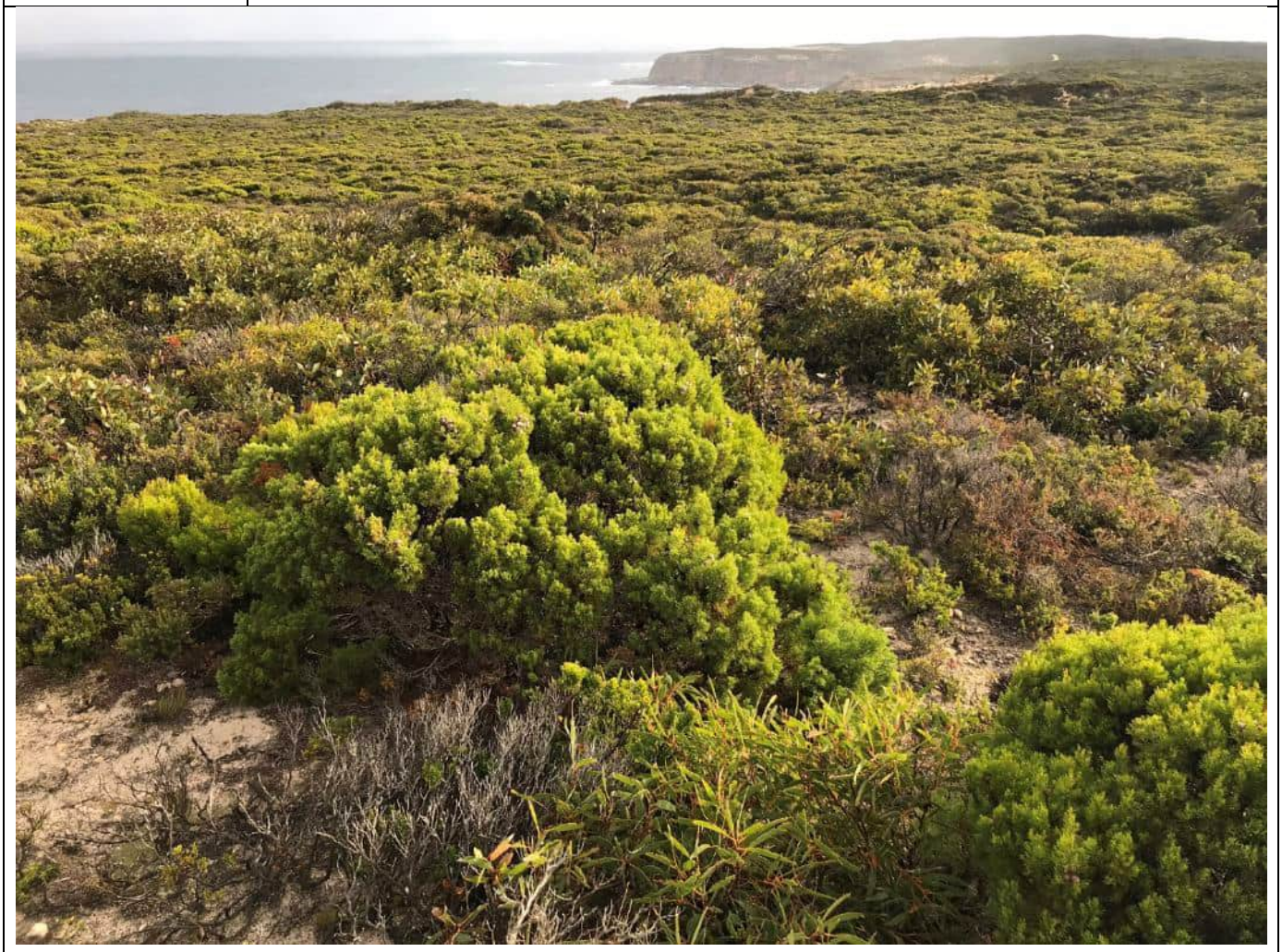
Vegetation Association 1	*Beyeria lechenaultii* (Pale Turpentine Bush) *Melaleuca lanceolata* (Dryland Teatree) Low Shrubland over sclerophyllous shrubs.				
					
General description	Vegetation association 1 was largely and primarily dominant on the near cliff zone where stable dune habitats were present intertwined with exposed sheet limestone which was generally devoid of vegetation or contained only sparse sclerophyllous shrubs. Cover within association 1 was generally high with the most diverse floristic community observed across the area with a mix of primarily coast front species co-habiting with other taller shrubs which were persisting in the hollows resulting in a mixed community. This association had the highest visual incidence of small skinks and dragons observed opportunistically.				
Threatened species or community	Habitat for Southern Emu Wren and Rock Parrot.				
Landscape context score	1.04	Vegetation Condition Score	55.08	Conservation significance score	1.10
Unit biodiversity Score	62.58	Area (ha)	0.95	Total biodiversity Score	51.94

Vegetation Association 2	*Acrotriche patula* (Prickly Ground Berry) Very Low Open Shrubland.				
					
General description	Vegetation association 2 occupies exposed and/or elevated sections of clifftop and exposed limestone outcrops where a lack of soil, high alkalinity and salt laden winds result in specific niche communities dominated by ground hugging shrubs and mat plants. The average overstorey height in these areas was less than 300 mm.				
Threatened species or community	Provides habitat for Southern Emu Wren and Rock Parrot				
Landscape context score	1.04	Vegetation Condition Score	51.17	Conservation significance score	1.10
Unit biodiversity Score	57.43	Area (ha)	0.08	Total biodiversity Score	4.24

Vegetation Association 3	*Eucalyptus diversifolia* (Coastal White Mallee) Low Mixed Mallee over sclerophyllous shrubs.				
					
General description	Vegetation association 3 communities were recorded on stable dunes where grey sandy loams overlay sheet limestone. These were often transitional between the low coastal shrublands of the clifftop edges and the higher elevation calcareous clay loam soils. Association 3 occurs in patches, varying from circular 'hummocks' to linear lunettes further from the coast. The interpatch spaces were sheet limestone occupied by Association 1. With distance from the coastline, the community structure changed by way of a more continuous and taller stratum with average heights of 3.5 m and a denser canopy cover.				
Threatened species or community	Provide habitat for Southern Emu-wren, Western Whip Bird and Rock Parrot				
Landscape context score	1.04	Vegetation Condition Score	46.55	Conservation significance score	1.10
Unit biodiversity Score	52.74	Area (ha)	15.88	Total biodiversity Score	937.34

Vegetation Association 4	*Eucalyptus angulosa* (Ridge Fruited Mallee) +/- *Eucalyptus rugosa* (Coastal White Mallee) Low Mixed Mallee				
					
General description	Vegetation Association 4 was present in the eastern extent of the Survey Area where soils were a calcareous silty loam. The soil surface was highly stable and formed a thick crust with high levels of biocrust and Moss species. *Melaleuca* species were a common species in this Association compared to those on lighter soils with *Eucalyptus diversifolia* (Coastal White Mallee). Inter-patches were dominated by Association 6 (*Callitris* sp. limestone). In areas where the community was protected from high coastal winds the strata were taller, with an average of 3 m compared to 2 m near the coast.				
Threatened species or community	Provides habitat for Western Whip Bird				
Landscape context score	1.04	Vegetation Condition Score	49.19	Conservation significance score	1.10
Unit biodiversity Score	55.48	Area (ha)	1.04	Total biodiversity Score	59.76

Vegetation Association 5	*Leucopogon parviflorus* (Coastal Bearded Heath) Low Very Open Shrubland over exotic annual grasses.				
					
General description	Vegetation association 5 was a disturbed regenerating association with pioneer species such as *Adriana quadripartita* (Coast Bitter Bush) present that were otherwise absent from the intact sections of the Project site. Numerous environmental weed species were present throughout the area and grass species were overwhelmingly annual exotic species such as *Bromus* spp. (Brome), *Vulpia* sp. (Fescue) and *Avena* spp. (Wild Oat). Overall, the condition was very poor, and regeneration of local species was patchy.				
Threatened species or community	No threatened flora or fauna recorded within this association. Potentially provides habitat for Diamond firetail Finch, Painted Button Quail and Purple-gaped Honeyeater.				
Landscape context score	1.04	Vegetation Condition Score	26.8	Conservation significance score	1.1
Unit biodiversity Score	30.66	Area (ha)	4.89	Total biodiversity Score	149.9

Vegetation Association 6	*Callitris* sp. 'Limestone' (Native Pine) Low Shrubland.				
					
General description	Vegetation association 6 was dominated by *Callitris* sp. 'Limestone' mixed with other sclerophyllous shrubs. It occurred exclusively with Association 4 on calcareous silty loam soils. Condition of these communities was good with the only perennial exotic species observed being *Limonium companyonis* (Sea Lavender) which increased in density with proximity to the coast.				
Threatened species or community	Provides habitat for Southern Emu-wren, Western Whip bird, Rock Parrot				
Landscape context score	1.04	Vegetation Condition Score	51.6	Conservation significance score	1.1
Unit biodiversity Score	58.35	Area (ha)	0.54	Total biodiversity Score	38.18

Site map showing areas of proposed impact

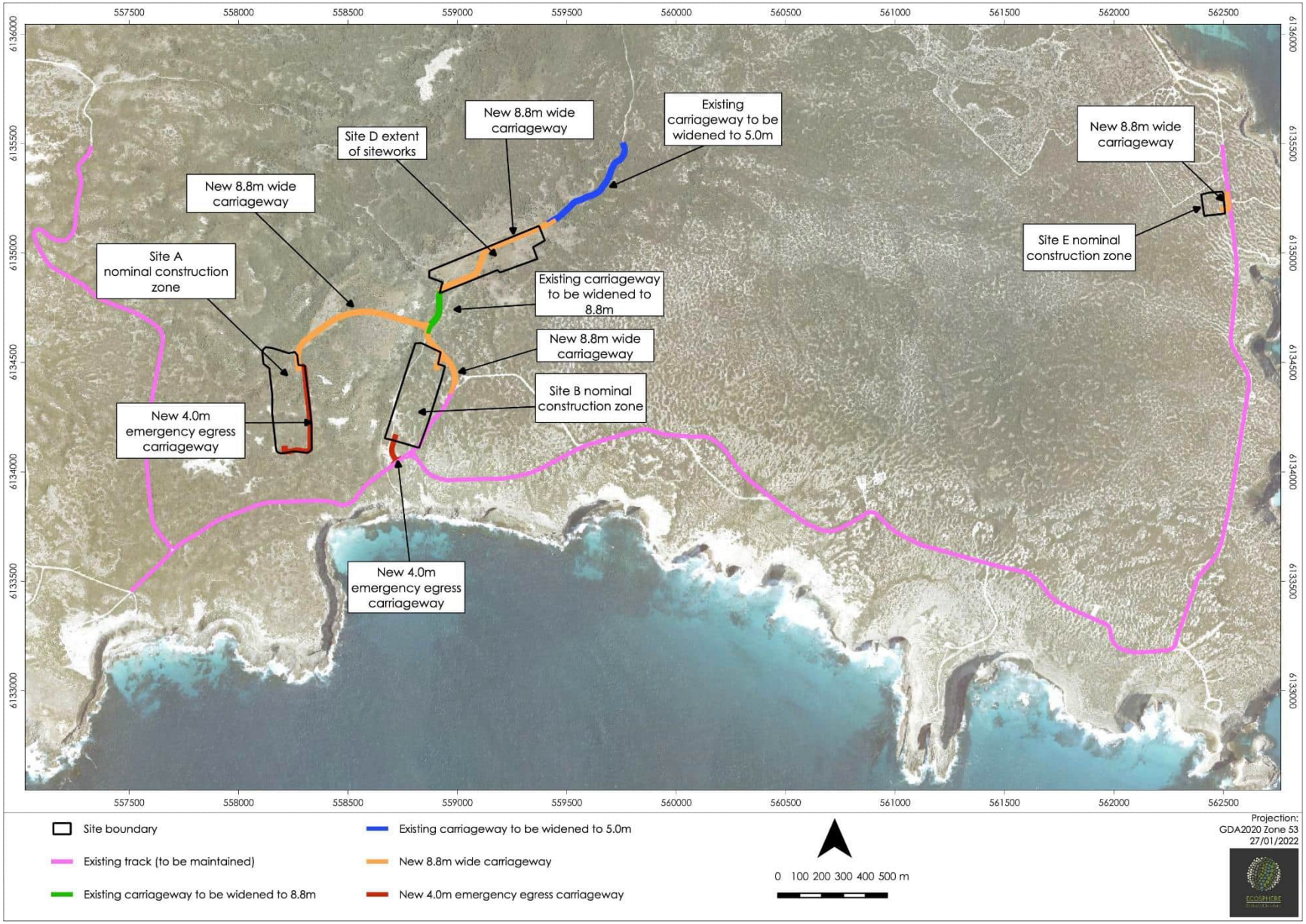


Figure 1. Map 1 of 8, Sites and road upgrade overview.

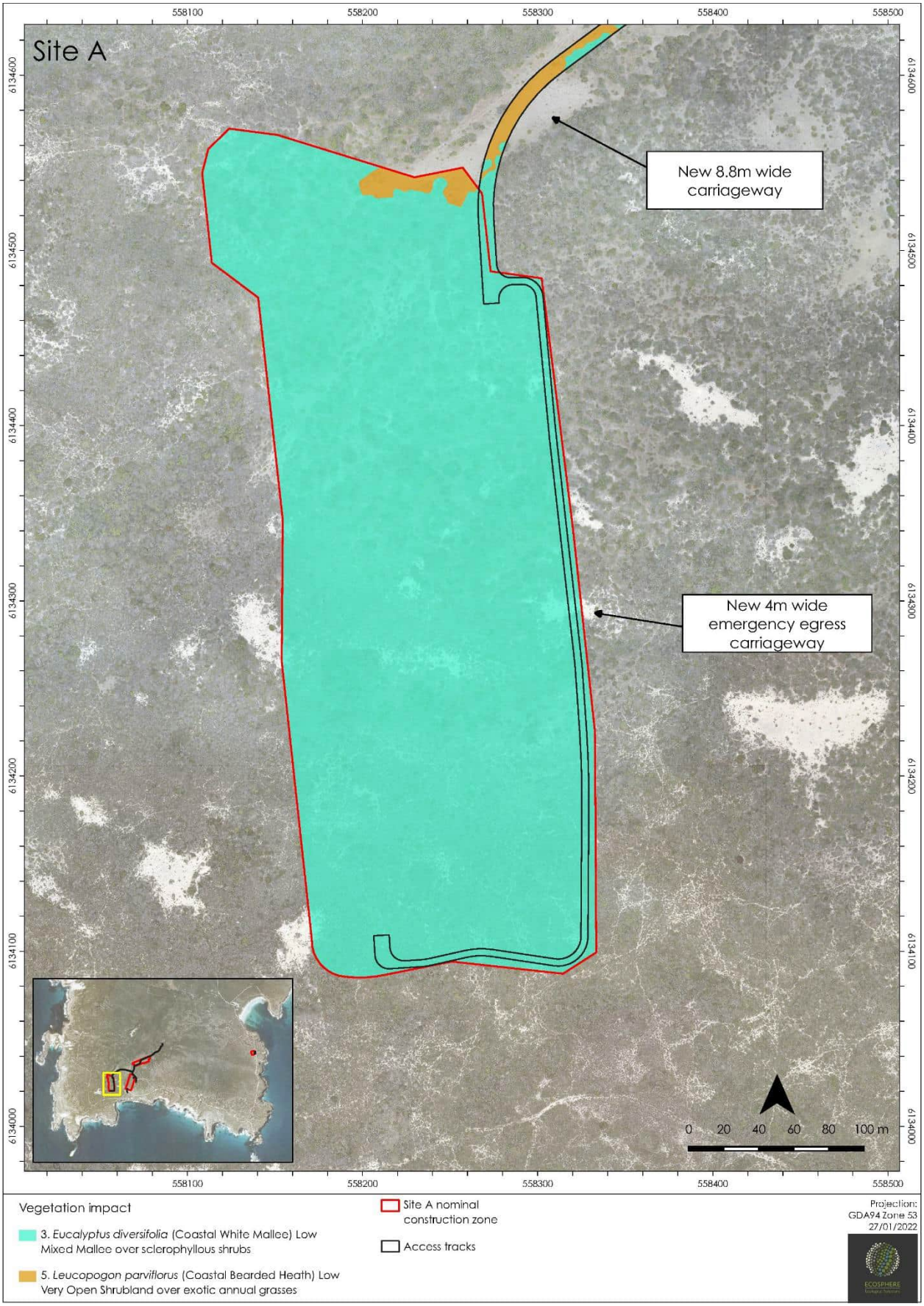


Figure 2. Map 2 of 8 Launch Site A.

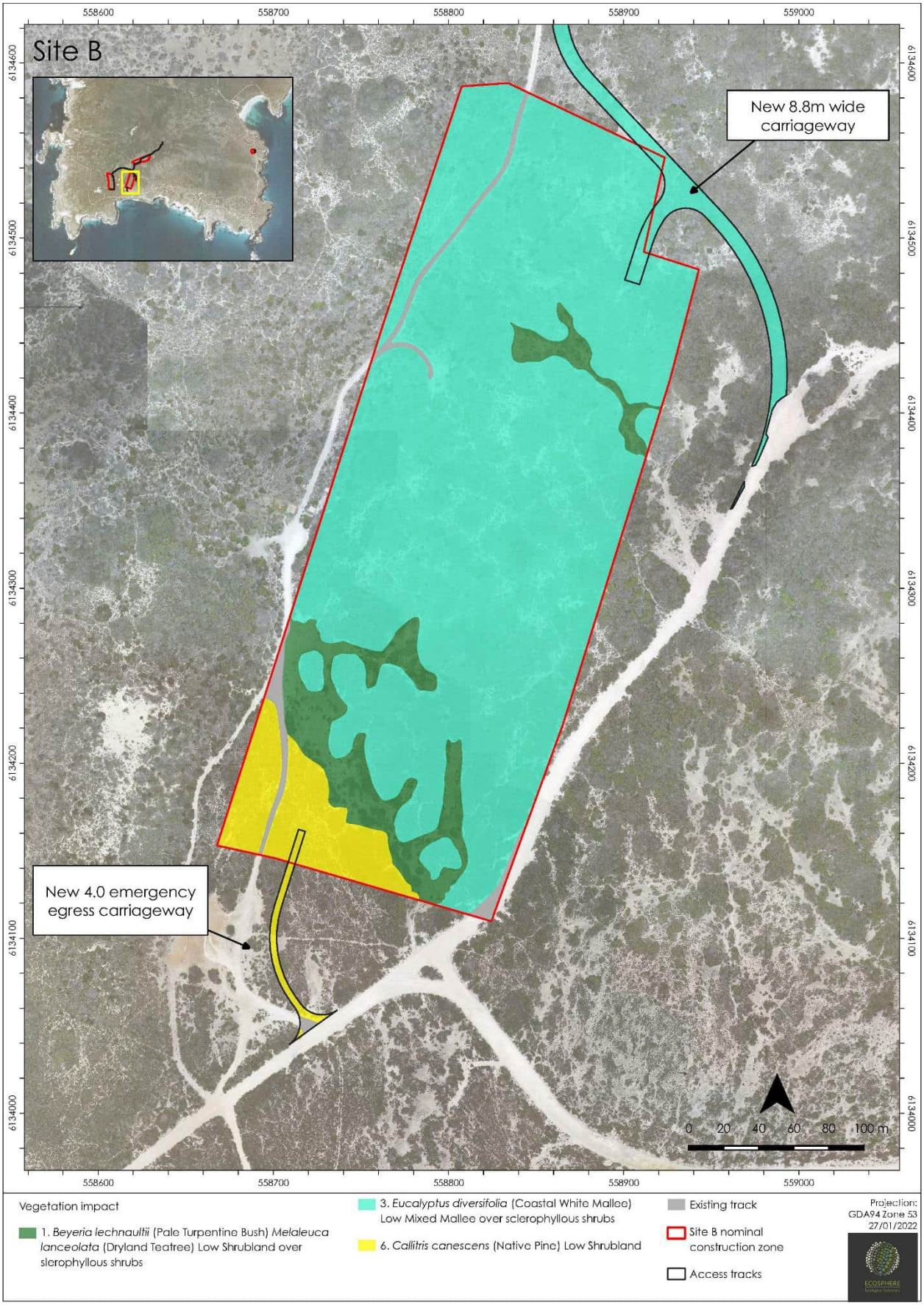


Figure 3. Map 3 of 8, Launch Site B

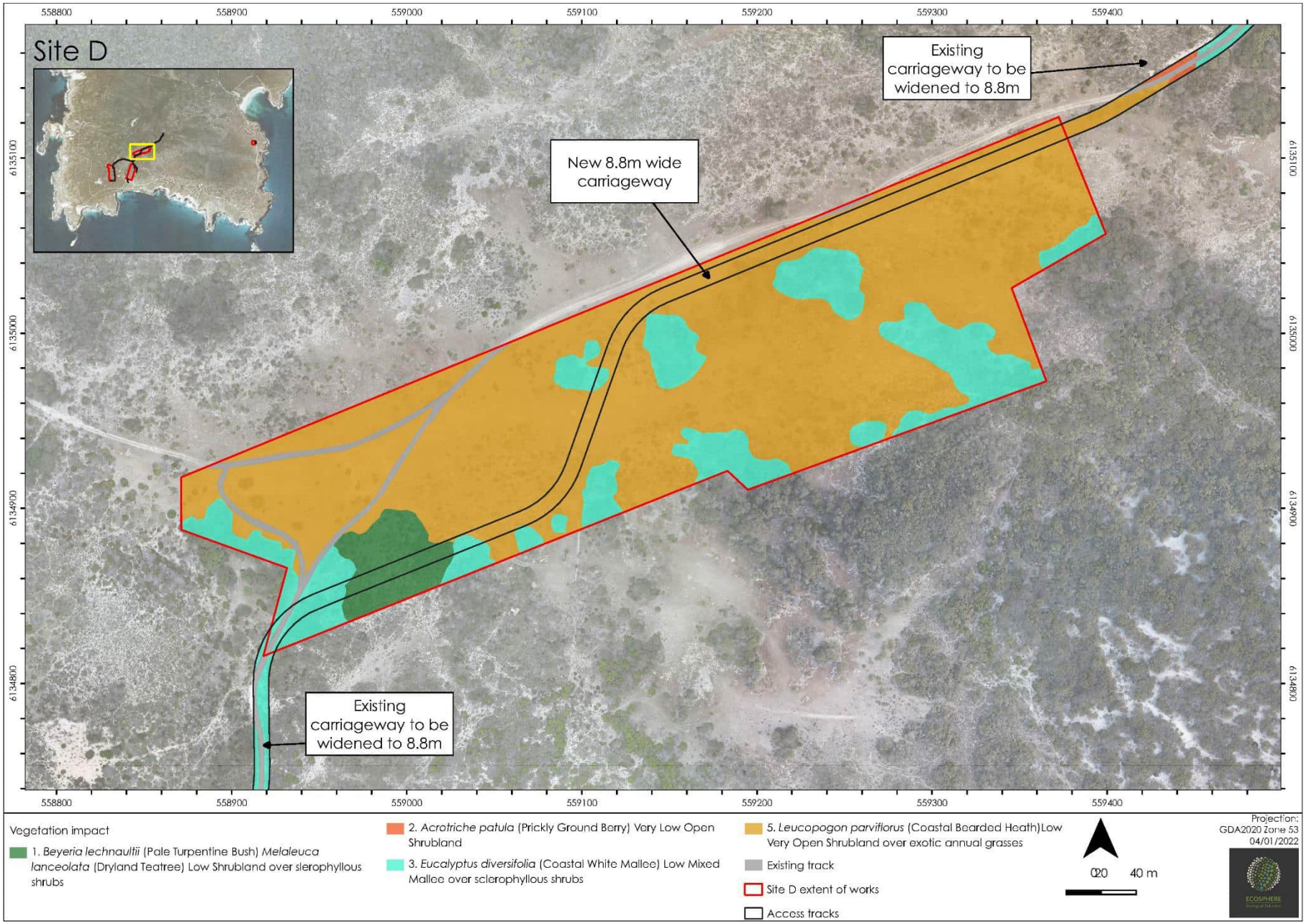


Figure 4. Map 4 of 8, Workshop.

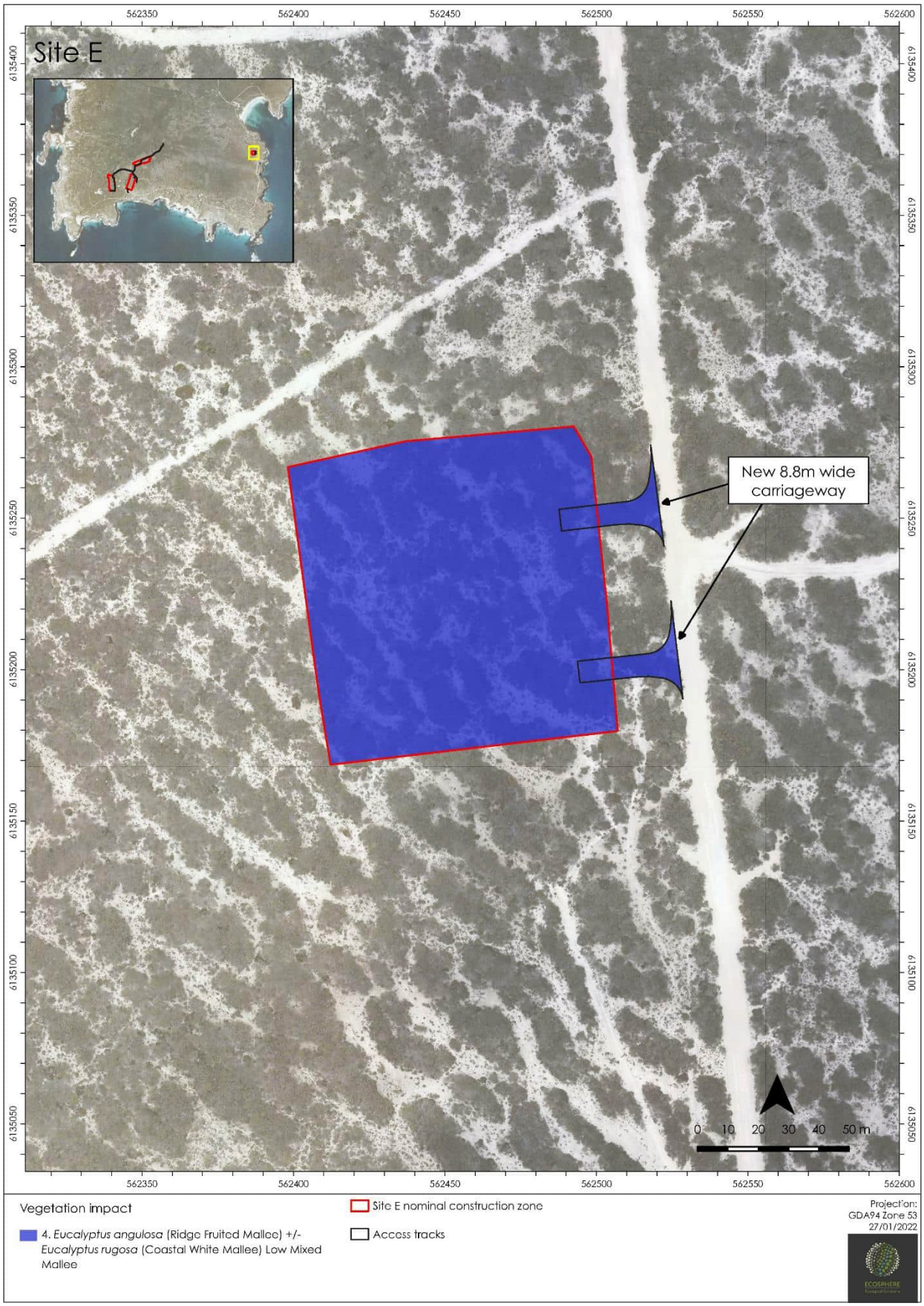


Figure 5. Map 5 of 8 Range Control.

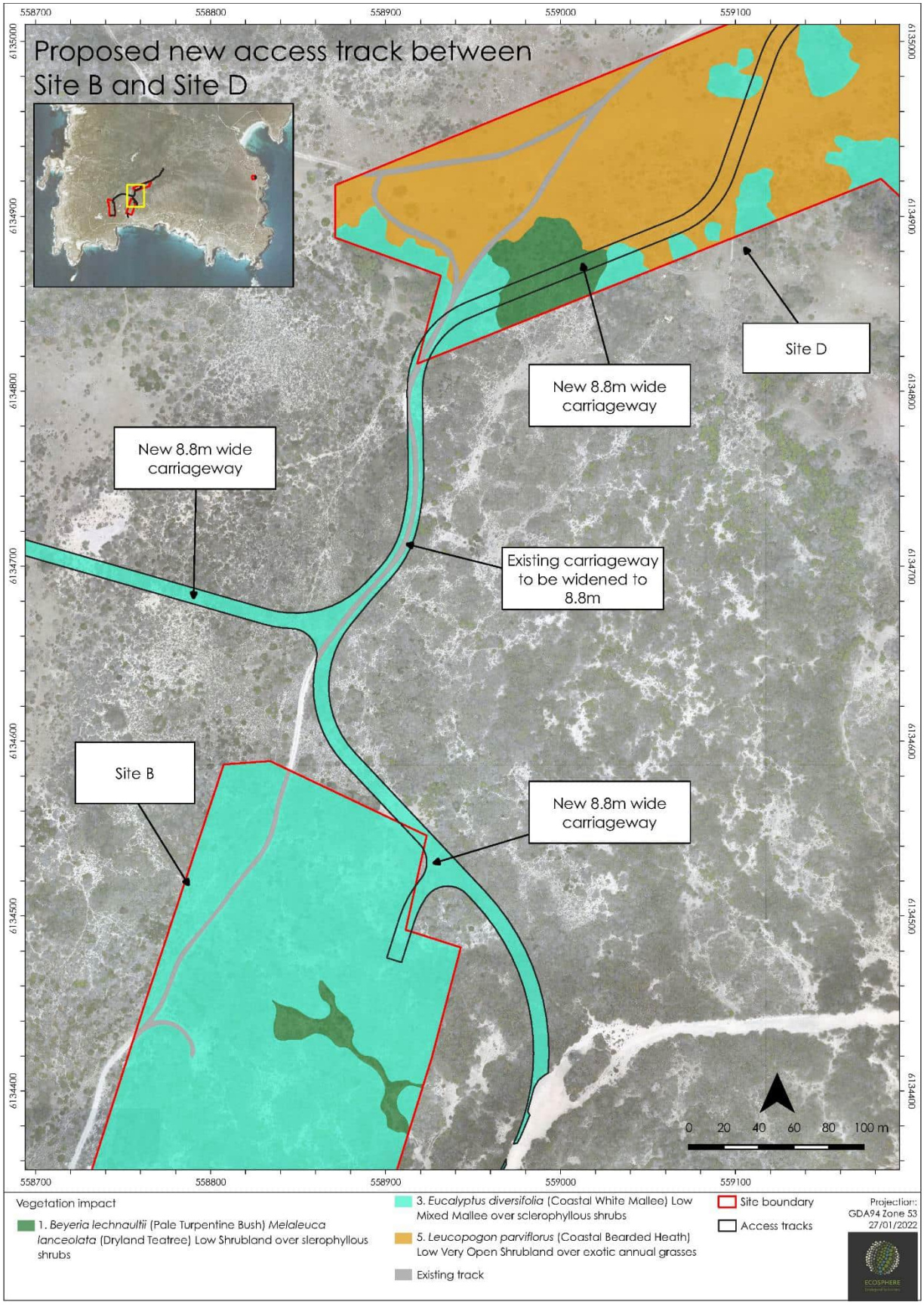


Figure 6. Map 6 of 8, Launch Site B to workshop access.

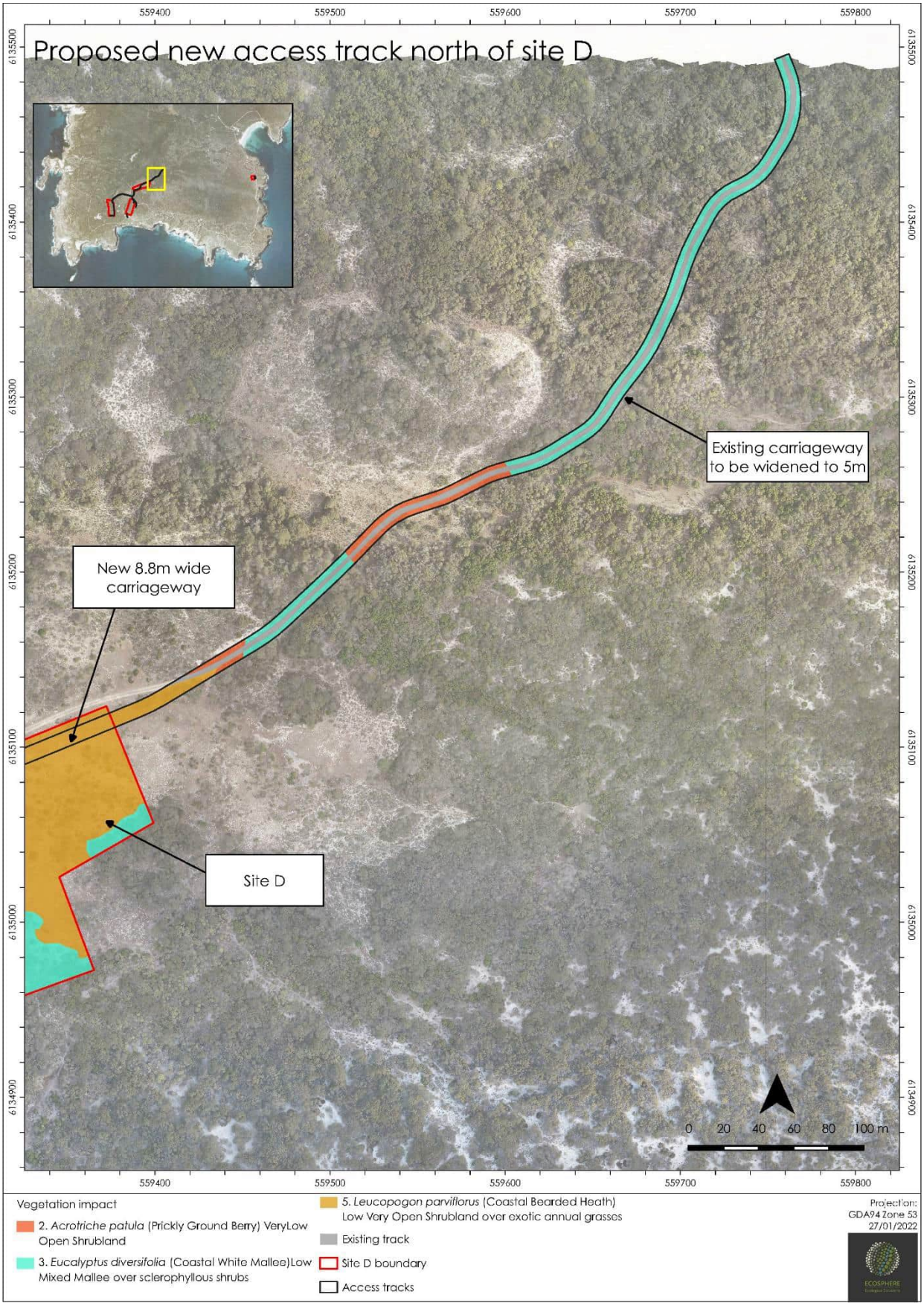


Figure 7. Map 7 of 8. Workshop access road upgrade.

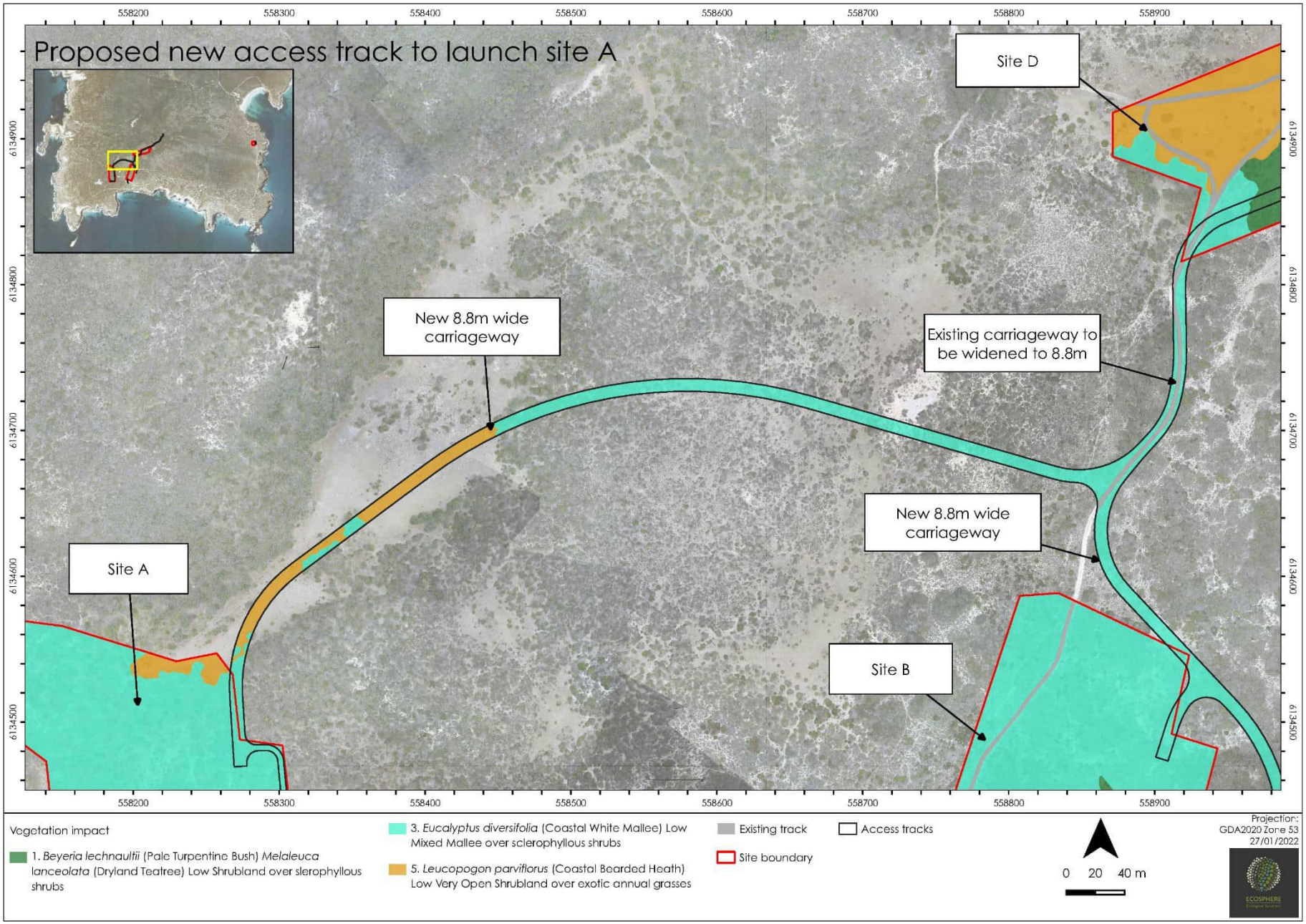


Figure 8. Map 8 of 8. Launch Site A access road construction layout.

Photo log

Cliff edge vegetation outside of project areas provide the highest diversity locations.

Looking southeast over Launch Site A proposed location

Looking east over proposed Launch Site B location.

Launch Site A access road alignment direction

Launch Site A access road association 5 cover

Range Control vegetation structure.

4.2 Threatened Species assessment

Threatened Flora

The desktop study identified 11 conservation significant flora species that may occur in the Survey Area. This included six species listed as threatened under the EPBC Act, and five species listed under the *National Parks and Wildlife Act 1972* Act. An assessment of likelihood was completed prior to conducting the field survey. This assessment determined:

- two species were likely to occur
- four had a moderate likelihood of occurrence
- five species were unlikely to occur.
- Species likely to, or possibly occurring, are outlined in Table 2.

Table 2. Desktop flora assessment results.

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys- Likelihood
		EPBC Act	NPW Act			
Acacia alcockii	Alcock's Wattle	-	R	Normally grows in sand over limestone in Mallee communities, sometimes with *Melaleuca* spp. Numerous records close to coastal fringe within Port Lincoln NP and Cathedral Rocks however not recorded during targeted flora survey in BDBSA location.	Likely	Possible
Acacia pinguifolia	Fat-leaved Wattle	E		Loam soils, all known EP populations occur within rail reserves and corridors. Highly unlikely within this habitat.	Unlikely	Unlikely
Caladenia tensa	Greencomb Spider-orchid	E		Taxonomic confusion has led to records of *Caladenia tensa* (Inland Green-comb Spider-orchid) occurring on the Eyre Peninsula. However, it is unlikely that C. tensa occurs on Eyre Peninsula, and records of its presence were of the *Caladenia interanea* (Inland Spider-orchid). Despite this, the nearest record at Tulka, occurs on Limestone plain with calcareous outcropping and sparse calcareous cobble Clay loam. *Allocasuarina verticillata, Melaleuca lanceolata* Low Open Forest (Atlas Living Australia, 2020). Targeted orchid surveys within Project area returned common species such as Microtis and Acianthus in high abundance however proximity to open coast and long-term grazing may have impacted area.	Unlikely	Unlikely
Eucalyptus gillenii	Mallee Red Gum	-	R	Was known from only Mount Wooltarlinna and Birksgate Range in far north -west of the state. Unknown whether local records are planted specimens.	Unlikely	Unlikely
Hibbertia cinerea		-	R	Decumbent habit with cane-like branches that scramble into other vegetation. Can be up to 2m high. Was recorded in 1986.Located in same area as some other doubtful records where follow up surveys were unable to locate individuals	Likely	Unlikely
Pleuropappus phyllocalymmeus	Silver Candles	V		The species occurs on the margins of coastal saline lakes and depressions and low-lying stream channels and watercourses.(DotE 2013b). No habitat matching description was present within project areas been well drained sandy soils and limestone. Remains unlikely	Unlikely	Unlikely
Poa fax		-	R	Known from dune mallee and gypsum plains and near-coastal sands (Vic flora 2020). Possible however targeted surveys did not record any tussocks, species is distinctive so would be likely to be observed if present.	Possible	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys- Likelihood
		EPBC Act	NPW Act			
Prostanthera calycina	West Coast Mintbush	V	V	Occurs in association with *Eucalyptus diversifolia* Mallee. Records in nearby heritage agreements. Intensive targeted search for this species returned no individuals. Recorded *Prostanthera serpyllifolia* along coast fringe in similar preferred habitat. Definitely not recorded within project footprints.	Likely	Unlikely
Ptilotus beckerianus	Ironstone Mulla Mulla	V		Associated with orange duplex soils and ironstone nearest records >50km north of Project Area. Associated with *Melaleuca uncinata* (Broombush). Previous personal knowledge of this species has seen it confined to gravelly soils around Wanilla on southern Eyre Peninsula. Very different habitat to that found within project area.	Unlikely	Unlikely
Thelymitra epipactoides	Metallic Sun-orchid	E		Occurs on fertile red loams ideally suited to cropping, hence the high levels of fragmentation, with most remnant populations occurring within road reserves and other easements such as rail, power and water corridors. It is likely the historical disturbance from grazing has all but destroyed any real chance of this species occurring within area.	Unlikely	Unlikely
Xanthorrhoea semiplana subsp. *tateana*		-	R	Widespread throughout southern Eyre Peninsula, most often in association with Mallee / Banksia, Hysterobaeckea on inland consolidated white sand dunes and low rises. Species observed in road reserve close to Fishery Beach. Record near Groper Bay associated with some other doubtful records and observation description does not match site location. No Yaccas present within coastal fringe of HA nor within project areas. No Yaccas recorded within HA at all however may be present in northern sections as present on Fisheries Beach Road reserve.	Unlikely	Unlikely

EPBC Act: CE Critically endangered, E Endangered, V Vulnerable, Mi Migratory, Ma Marine NPW Act: E Endangered, V Vulnerable, R Rare

Threatened Ecological Communities

No Threatened Ecological Communities (TEC) are known to occur, and none are considered likely to occur within the Survey Area. The closes community is the Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Woodland, listed as Endangered under the EPBC Act. This community occurs approximately 30 km north of the Survey Area

Threatened Fauna

The desktop study identified 112 conservation significant fauna species that may occur in the area. This included 71 bird species, 36 fish species, 23 mammal species, and three reptile species. Of these:

- Nine species are listed as Threatened under the EPBC Act
- 25 species are listed as Threatened and Migratory and/or Marine under the EPBC Act
- 67 species are listed as Migratory and/or Marine under the EPBC Act
- 11 species are listed as protected under the NPW Act.

Seventeen species are known or considered likely to occur (Table 7) based on habitat preference and previous surveys. These are all bird species. Another five species have a moderate likelihood, 14 have a low likelihood, and 27 species are unlikely to occur.

Marine species, including whales, fish, turtles and dolphins, were not assessed. This desktop study was used as an opportunity to identify these species that will require consideration in the future.

Marine species comprise 45 of the 112 conservation significant fauna species.

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Birds						
Actitis hypoleucos	Common Sandpiper	Mi	R	Edges of saltwater to fresh waterbodies and wetlands, including estuaries, lakes, drainage lines, tidal watercourses, and mudflats; occasionally beaches and rocky headlands; spring-summer non-breeding migrant.	Unlikely	Unlikely
Apus pacificus	Fork-tailed Swift	Mi, Ma	-	In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas, and cities. They mostly occur over dry or open habitats, including riparian woodland and Tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes. The sometimes occur above rainforests, wet sclerophyll forest or open forest or plantations of pines.	Possible	Unlikely
Ardea alba	Great Egret	Ma	-	The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2003). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2007).	Unlikely	Unlikely
Ardea ibis	Cattle Egret	Ma	R	The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. The Cattle Egret is known to follow earth-moving machinery and has been located at rubbish tips. It uses shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation.	Unlikely	Unlikely
Ardenna carneipes	Flesh-footed Shearwater	Mi, Ma	R	The Flesh-footed Shearwater occurs in the subtropics over continental shelves and slopes and occasionally inshore waters. They breed on islands in burrows on sloping ground in coastal forest, scrubland, shrubland or grassland.	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Ardenna grisea	Sooty Shearwater	Mi, Ma	-	The Sooty Shearwater forages in pelagic (open ocean) sub-tropical, sub-Antarctic and Antarctic waters.	Unlikely	Unlikely
Ardenna tenuirostris	Short-tailed Shearwater	Mi, Ma	-	Found in coastal waters. Likely to be present on adjacent offshore islands potentially.	Possible	Unlikely
Ardeotis australis	Australian Bustard	-	V	Ground dweller, common in grasslands, woodland and in agricultural areas (Birdlife, 2020). Not likely to utilise shrubland community or if does would be very unfrequently. The project areas are highly unlikely to constitute critical habitat for this species and there are no records within project areas. This species has a habit of turning up unexpectedly in random locations so is always a possibility anywhere.	Known	Unlikely/ Possible as vagrant.
Botaurus poiciloptilus	Australasian Bittern	E	V	Favours wetlands with tall dense vegetation where it forages in still shallow water at the edge of pools and waterways or from platforms or mats of vegetation over deep water (TSSC, 2019)	Unlikely	Unlikely
Calidris acuminata	Sharp-tailed Sandpiper	Mi	-	Prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewage farms, flooded fields, mudflats, mangroves, rocky shores and beaches.	Unlikely	Unlikely
Calidris alba	Sanderling	Mi, Ma	R	Coastal species, open sandy beaches exposed to open sea-swell and exposed sandbars and spits and shingle banks where they forage in wave-wash zone amongst rotting seaweed. May occur on sheltered sandy shorelines of estuaries, inlets and harbours.	Possible	Unlikely
Calidris canutus	Red Knot	E, Mi, Ma	-	Intertidal mudflats, sandflats and sandy beaches of sheltered coasts. Sometimes seen on terrestrial saline wetlands.	Unlikely	Unlikely
Calidris ferruginea	Curlew Sandpiper	CE, Mi, Ma	-	Coastal estuaries, bays and shallow wetlands, tidal mudflats and sandflats; spring-summer non-breeding migrant.	Unlikely	Unlikely
Calidris melanotos	Pectoral Sandpiper	Mi, Ma	R	Shallow freshwater or brackish wetlands, including swamps, flooded grasslands, sewage ponds, occasionally tidal flats and saltmarshes.	Unlikely	Unlikely
Calidris ruficollis	Red-necked Stint	Mi, Ma	-	Coastal areas, sheltered inlets, intertidal mudflats, protected sandy or coralline shores.	Unlikely	Unlikely
Catharacta skua	Great Skua	Ma	-	Marine species breeds on islands.	Unlikely	Unlikely
Cereopsis novaehollandiae	Cape Barren Goose	-	R	Coastal grasslands and wetlands (Birdlife, 2020). Noted grazing in open paddocks adjacent to Whalers Way. Have taken advantage of grain left in paddocks and roost in Sleaford Mere. Commonly occurring in local area but unlikely to use Whalers as habitat area. No observations over three site visits.	Known	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Charadrius ruficapillus	Red-capped Plover	Ma	-	Coastal species on bare sand or mudflats at margins of saline, brackish or freshwater wetlands (Birdlife, 2020).	Unlikely	Unlikely
Charadrius veredus	Oriental Plover	Mi	-	A non-breeding visitor to Australia, they spend a few weeks in coastal habitats such as estuarine mudflats and sandbanks, on sandy or rocky ocean beaches or nearby reefs, or in near-coastal grasslands, before dispersing further inland. Thereafter they usually inhabit flat, open, semi-arid or arid grasslands, where the grass is short and sparse, and interspersed with hard, bare ground, such as claypans, dry paddocks, playing fields, lawns and cattle camps.	Unlikely	Unlikely
Chrysococcyx osculans	Black-eared Cuckoo	Ma	-	Dry country in mulga and mallee open woodlands and shrublands. Often found in vegetation along creek beds.	Unlikely	Unlikely
Diomedea antipodensis	Antipodean Albatross	V, Mi, Ma	-	Marine, pelagic, and aerial. Nests on New Zealand islands in open patch vegetation among tussock grassland or shrubs on ridges, slopes and plateaus.	Unlikely	Unlikely
Diomedea epomophora	Southern Royal Albatross	V, Mi, Ma	V	Marine, breeds on a few select islands in tussock grassland, plateaus, or ridges (Birdlife, 2020).	Unlikely	Unlikely
Diomedea exulans	Wandering Albatross	V, Mi, Ma	V	Marine, pelagic and aerial. Breeds on islands.	Unlikely	Unlikely
Diomedea sanfordi	Northern Royal Albatross	E, Mi, Ma	E	Marine, pelagic and aerial. Nests on Chatham Islands.	Unlikely	Unlikely
Falco peregrinus	Peregrine Falcon	-	R	A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests (Bamford, 2009). Possibly fly through however project not likely to impact on this species. More likely to encourage this species and provide advantageous benefit if towers used as part of project.	Known	Possible fly through project area
Falco subniger	Black Falcon	-	R	Sparsely spread across inland Australia where it is found along tree-lined watercourses and isolated woodlands. It may move to coastal areas and is known to have regular seasonal movements (Birdlife, 2020). Possibly fly through only, uncommon species unlikely to use whalers as part of critical habitat.	Known	Possible
Gallinago hardwickii	Latham's Snipe	Mi, Ma	R	Wet grasslands and pastures, open and wooded swamps; spring-summer non-breeding migrant.	Unlikely	Unlikely
Haematopus fuliginosus	Sooty Oystercatcher	-	R	Occurs over the Southern Ocean. Non-breeding visitor to Australia. Breeds on Campbell I and Auckland Island (Birdlife, 2020). None	Known	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
				recorded within area including targeted searches at Redbank's where beach was available, probably not extent of habitat required for permanent habitat. Definitely at Fishery Bay and may very infrequently utilise Redbank's Bay.		
Haliaeetus leucogaster	White-bellied Sea-Eagle	Ma	E	Occupies all coastal areas extending inland through main waterways, coastal islands, coastal lakes and along some inland rivers. It forages primarily for fish over large areas of open water. Was recorded flying along cliffs and probably does so frequently. Requires ongoing surveys to determine extent of use of whaler's area and potential impacts relating to rocket launching facility. Requires EPBC referral	Known	Known
Halobaena caerulea	Blue Petrel	V, Ma	-	Breeds offshore stacks near Macquarie Island. It forages in Antarctic and subantarctic waters (TSSC, 2015).	Unlikely	Unlikely
Hydroprogne caspia	Caspian Tern	Mi, Ma	-	Breeding in SA has been recorded along the coast from the Coorong north-west to Ceduna, and inland at Lake Eyre and Lake Goyder. It forages in open wetlands including lakes and rivers. Prefers sheltered shallow water near margins.	Unlikely	Unlikely
Larus pacificus	Pacific Gull	Ma	-	Prefers sandy beaches or sometimes rocky coasts and/or areas that are protected from ocean swells including estuaries, bays and harbours. It has also been seen on farmland and rubbish piles (Birdlife, 2020).	Possible	Unlikely
Leipoa ocellata	Malleefowl	V	V	Mallee woodlands, scrubland, and heathlands, often with sandy substrate. Breed in areas with good leaf litter layer. Occasional forage in open areas, including farmland and clearing amongst mallee.	Unlikely	Unlikely
Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater	-	R	Inhabits mallee heathlands and sometimes mallee with open understorey. Preferred habitat present along with historical records. Other honeyeater species present within project areas in high abundance. No individuals recorded however would utilise area periodically and targeted approach to identifying this species would likely be successful.	Known	Likely
Limosa lapponica	Bar-tailed Godwit	Mi, Ma	R	Coastal habitats including large intertidal sandflats, banks, mudflats, estuaries, inlets and harbours. Forages near edge of water, prefers soft mud. Roosts on sandy beaches, sandbars, spits and near-coastal saltmarsh.	Unlikely	Unlikely
Limosa lapponica baueri	Bar-tailed Godwit	V	-	Non-breeding visitor to Australia where it occurs in coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons, and bays (TSSC, 2016a).	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE	-	Non-breeding visitor to Australia where it occurs in coastal habitats including intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons, and bays (TSSC, 2016b).	Possible	Unlikely
Macronectes giganteus	Southern Giant-Petrel	E, Mi, Ma	V	This species breeds on subantarctic and Antarctic islands in Australian territory.	Unlikely	Unlikely
Macronectes halli	Northern Giant Petrel	V, Mi, Ma	-	Breeds in the sub-Antarctic and visits Australian mainland during winter months. Commonly seen in waters around Fremantle (Western Australia) to Sydney (New South Wales).	Unlikely	Unlikely
Merops ornatus	Rainbow Bee-eater	Ma	-	Spring-summer migrants to Victoria where they occur in many wooded habitats with an annual rainfall of less than 800mm, especially north of the Great Divide, often along vegetated watercourses and cuttings or banks along watercourses. Lack of cuttings and nesting areas for species. Lack of historical records suggests unlikely.	Unlikely	Unlikely
Motacilla cinerea	Grey Wagtail	Mi, Ma	-	The grey wagtail is found around fast-flowing mountain streams, often in forested areas, as well as lowland watercourses such as canals and rivers.	Unlikely	Unlikely
Motacilla flava	Yellow Wagtail	Mi, Ma	-	The yellow wagtail occurs in a variety of damp or wet habitats with low vegetation, from brushy pastures, meadows, hay fields and marshes to damp steppe and grassy tundra.	Unlikely	Unlikely
Neophema elegans	Elegant Parrot	-	R	Inhabits open areas including grasslands, shrublands, mallee, woodlands and thickets, bluebush plains, heathlands, saltmarsh and farmland (Birdlife, 2020). Suitable habitat present. One sighting in 2004.	Known	Likely
Neophema petrophila	Rock Parrot	-	R	Restricted to coastlines and offshore rocky islands, frequenting windswept coastal dunes, mangroves, saline swamps and rocky islets (Birdlife, 2020). Suitable habitat present. Sighted 17 times in 2004 comprising 479 individuals and other surveys have noted high abundance and frequency of this species within coastal fringe and low dune swales. One of the more common species at Whalers Way.	Known	Present
Numenius madagascariensis	Eastern Curlew	CE, Mi, Ma	V	Coastal lakes, estuaries, tidal mudflats and sandflats, mangroves and saltmarshes; occasionally fresh or brackish lakes near coast; mainly spring-summer non-breeding migrant	Unlikely	Unlikely
Pachyptila turtur subantarctica	Fairy Prion (southern)	V	-	Breeds on Macquarie Island and other subantarctic islands.	Unlikely	Unlikely

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Pandion haliaetus	Osprey, Eastern Osprey	Mi, Ma	E	Occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia. Found in coastal areas of open fresh, brackish or saline water for foraging. Four records, five individuals. Lack of data to determine level of habitat utilisation. Requires EPBC referral.	Known	Present
Pezoporus occidentalis	Night Parrot	E	E	Extinct in south-eastern Australia; historical records from arid and semi-arid chenopod shrublands, spinifex (Triodia) on stony rises, flats around salt lakes and flooded claypans. Lack of suitable habitat.	Unlikely	Unlikely
Phalacrocorax fuscescens	Black-faced Cormorant	Ma	-	Coastal waters where they are found in flocks in large bays, deep inlets, rocky headlands and islands.	Possible	Unlikely
Phoebetria fusca	Sooty Albatross	Mi, Ma	E	This species is marine and pelagic and breeds on subtropical and subantarctic islands in the Indian and Atlantic Oceans.	Unlikely	Unlikely
Psophodes leucogaster	Western Whipbird (eastern) (eastern subspecies)	V	E	Occupies mallee and thicket vegetation in coastal and inland areas of southern South Australia (DAWE, 2020b). 80 records and heard with high frequency during targeted surveys. Very difficult to determine how many individuals present due to inconspicuous nature however appear to be relatively abundant within Whalers Way area.	Known	Present
Pterodroma mollis	Soft-plumaged Petrel	Ma		Marine, oceanic species that is a non-breeding visitor to Australia.	Unlikely	Unlikely
Rostratula australis	Australian Painted Snipe	Ma	VU	Inhabits shallow terrestrial freshwater wetlands and inundated or waterlogged grassland or saltmarsh. Exposed bare wet mud with ample canopy cover nearby are preferred.	Unlikely	Unlikely
Stagonoleura guttata	Diamond Firetail	-	V	Open grassy woodland, heath and farmland or grassland with scattered trees (Birdlife, 2020). One record of 10 individuals in BDBSA as well as additional record during baseline assessments.	Known	Present
Sternula nereis nereis	Australian Fairy Tern	V	VU	Nests in southern Australia on sheltered sandy beaches, spits and banks above the high tide line and below vegetation between October and February. Occupies a variety of habitats including offshore, estuarine, or lacustrine islands, wetlands and mainland coastline. Sighted in 2004. Likely to be around.	Likely	Likely
Stipiturus malachurus parimeda	Southern Emu-wren	V	E	This species is confined to the extreme south of the Eyre Peninsula. It occurs in shrubland/heathland, mallee and sedgeland. 74 sightings in 2004 comprising 109 individuals. Targeted surveys identified presence within project area and also along all areas of suitable habitat within 50m of coast edge. See targeted survey assessment report. EPBC referral required	Known	Present

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Thalassarche cauta cauta	Shy Albatross	V, Mi, Ma	VU	Marine species that occurs in subantarctic and subtropical waters. It is a non-breeding visitor to Australia.	Unlikely	Unlikely
Thalassarche cauta steadi	White-capped Albatros	V, Mi, Ma	-	Marine species that occurs in subantarctic and subtropical waters. It is a non-breeding visitor to Australia.	Unlikely	Unlikely
Thalassarche impavida	Campbell Albatross	V, Mi, Ma	VU	Marine sea bird and specialised shelf feeders. They are non-breeding visitors to Australian waters.	Unlikely	Unlikely
Thalassarche melanophris	Black-browed Albatross	V, Mi, Ma	-	Marine sea bird that inhabits Antarctic, subantarctic and temperate waters and occasionally enters the tropics. It forages around breaks of continental and island shelves and across nearby underwater banks.	Unlikely	Unlikely
Thinornis rubricollis rubricollis	Hooded Plover	V, Ma	VU	Mainly occurs on wide beaches backed by dunes with large amounts of seaweed and jetsam, creek mouths and inlet entrances. Suitable habitat present. Sighted 20 times in 2004 comprising 50 individuals. No records within Redbanks Bay where beach has lack of refuge sites with boulders present at base of cliff at high tide mark. Certain to be present at Fisheries Beach however unlikely within proximity to project area.	Likely	Unlikely
Tringa nebularia	Common Greenshank	Mi, Ma	-	Found in a variety of inland wetlands and sheltered coastal habitats. It occurs in sheltered coastal habitats, typically with large mudflats and saltmarsh, mangroves or seagrass.	Likely	Unlikely
Turnix varius	Painted Buttonquail	-	R	Prefer closed canopies with understorey cover in temperate and eastern tropical forests and woodlands (Birdlife, 2020). Also known from scrub and grassy habitat. Suitable habitat present. Sighted three times in 2004 comprising 23 individuals. Likely within mallee habitats within Whalers Way.	Likely	Likely
Zanda (Calyptorhynchus) funerea whiteae	Yellow-tailed Black Cockatoo	-	V	Favours Eucalypt woodland and pine plantations (Birdlife, 2020). Six records sighted in 2004 comprising 14 individuals. Potentially flyover, the project area does not support habitat for this species however they may infrequently fly through area to foraging patches on southern EP.	Likely	Possible
Fish						
Acentronura australe	Southern Pygmy Pipehorse	Ma	-	Not considered	-	Marine
Campichthys galei	Gale's Pipefish	Ma	-	Not considered	-	Marine
Carcharodon carcharias	White Shark	V, Mi, Ma	-	Not considered	-	Marine

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Filicampus tigris	Tiger Pipefish	Ma	-	Not considered	-	Marine
Heraldia nocturna	Upside-down Pipefish	Ma	-	Not considered	-	Marine
Hippocampus abdominalis	Big-belly Seahorse	Ma	-	Not considered	-	Marine
Hippocampus breviceps	Short-head Seahorse	Ma	-	Not considered	-	Marine
Histiogamphelus cristatus	Rhino Pipefish	Ma	-	Not considered	-	Marine
Hypselognathus horridus	Shaggy Pipefish	Ma	-	Not considered	-	Marine
Hypselognathus rostratus	Knifesnout Pipefish	Ma	-	Not considered	-	Marine
Kaupus costatus	Deepbody Pipefish	Ma	-	Not considered	-	Marine
Lamna nasus	Porbeagle	Mi, Ma	-	Not considered	-	Marine
Leptoichthys fistularius	Brushtail Pipefish	Ma	-	Not considered	-	Marine
Lissocampus caudalis	Australian Smooth Pipefish	Ma	-	Not considered	-	Marine
Lissocampus runa	Javelin Pipefish	Ma	-	Not considered	-	Marine
Maroubra perserrata	Sawtooth Pipefish	Ma	-	Not considered	-	Marine
Notiocampus ruber	Red Pipefish	Ma	-	Not considered	-	Marine
Phycodurus eques	Leafy Seadragon	Ma	-	Not considered	-	Marine
Phyllopteryx taeniolatus	Common Seadragon	Ma	-	Not considered	-	Marine
Pugnaso curtirostris	Pugnose Pipefish	Ma	-	Not considered	-	Marine
Solegnathus robustus	Robust Pipehorse	Ma	-	Not considered	-	Marine
Stigmatopora argus	Spotted Pipefish	Ma	-	Not considered	-	Marine
Stigmatopora nigra	Widebody Pipefish	Ma	-	Not considered	-	Marine
Stipecampus cristatus	Ringback Pipefish	Ma	-	Not considered	-	Marine
Urocampus carinirostris	Hairy Pipefish	Ma	-	Not considered	-	Marine
Vanacampus margaritifer	Mother-of-pearl Pipefish	Ma	-	Not considered	-	Marine
Vanacampus phillipi	Port Phillip Pipefish	Ma	-	Not considered	-	Marine
Vanacampus poecilolaemus	Longsnout Pipefish	Ma	-	Not considered	-	Marine
Vanacampus vercoi	Verco's Pipefish	Ma	-	Not considered	-	Marine
Mammals						

Scientific Name	Common Name	Conservation Code		Habitat	Desktop Assessment - Likelihood	Post Field Surveys - Likelihood
		EPBC Act	NPW Act			
Arctocephalus forsteri	Long-nosed Fur-seal	Ma	-	Not considered	-	Marine
Balaena glacialis australis	Southern Right Whale	E, Mi, Ma	V	Not considered	-	Marine
Balaenoptera acutorostrata	Minke Whale	Ma	R	Not considered	-	Marine
Balaenoptera borealis	Sai Whale	V, Mi, Ma	V	Not considered	-	Marine
Balaenoptera edeni	Bryde's Whale	Mi, Ma	R	Not considered	-	Marine
Balaenoptera musculus	Blue Whale	E, Mi, Ma	E	Not considered	-	Marine
Balaenoptera physalus	Fin Whale	V, Mi, Ma	V	Not considered	-	Marine
Caperea marginata	Pygmy Right Whale	Mi, Ma	R	Not considered	-	Marine
Delphinus delphis	Common Dolphin	Ma	-	Not considered	-	Marine
Grampus griseus	Risso's Dolphin	Ma	R	Not considered	-	Marine
Lagenorhynchus obscurus	Dusky Dolphin	Mi, Ma	-	Not considered	-	Marine
Megaptera novaeangliae	Humpback Whale	V, Mi, Ma	V	Not considered	-	Marine
Neophoca cinerea	Australian Sea-lion	V, Ma	V	Not considered	-	Marine
Orcinus orca	Killer Whale	Mi, Ma	-	Not considered	-	Marine
Tursiops aduncus	Indian Ocean Bottlenose Dolphin	Ma	-	Not considered	-	Marine
Tursiops truncatus s. str.	Bottlenose Dolphin	Ma	-	Not considered	-	Marine
Reptiles						
Caretta caretta	Loggerhead Turtle	E, Mi, Ma	E	Non-breeding visitor to SA waters. They live at or near the surface of the ocean and move with currents.	Unlikely	Marine
Chelonia mydas	Green Turtle	V, Mi, Ma	V	A non-breeding visitor to SA waters. They drift on ocean currents and are often found with drift lines and rafts of *Sargassum* sp.	Unlikely	Marine
Dermochelys coriacea	Leatherback Turtle	E, Mi, Ma	V	A non-breeding visitor to most Australian waters. This species is highly pelagic and only comes close to shore during nesting season.	Unlikely	Marine

EPBC Act: CE Critically endangered, E Endangered, V Vulnerable, Mi Migratory, Ma Marine NPW Act: E Endangered, V Vulnerable, R Rare

4.3 Cumulative impact

When exercising a power or making a decision under Division 5 of the Native Vegetation Regulations 2017, the NVC must consider the potential cumulative impact, both direct and indirect, that is reasonably likely to result from a proposed clearance activity.

All vegetation within the project areas has had an additional 5m clearance buffer applied for fire safety. The buildings and infrastructure are all located within 5m of the project boundary meaning the 10m clearance buffer is within the existing fence buffer.

All roads have a 3m buffer applied to each side of the road however this may be utilised as 6m on one side of the road as part of upgrades or alternatively as the buffer is stated. Dependent on the bends in roads and terrain encountered. This is also provided to allow for the addition of power and water easements, the construction method and infrastructure type not finalised at this stage.

Stormwater retention will be allocated within the existing project area boundaries and retained within. No cumulative additional effects have been allowed for nor expected to occur.

4.4 Address the Mitigation Hierarchy

When exercising a power or making a decision under Division 5 of the Native Vegetation Regulations 2017, the NVC must have regard to the mitigation hierarchy. The NVC will also consider, with the aim to minimize, impacts on biological diversity, soil, water and other natural resources, threatened species or ecological communities under the EPBC Act or listed species under the NP&W Act.

a) *Avoidance – outline measures taken to avoid clearance of native vegetation such as making adjustments to the location, design, size or scale of the activity in order to reduce the impact.*
   The Whalers Way area provides a number of benefits to operating an orbital launch complex at this location.

The availability of suitable sites is extremely constrained

- Southern Launch undertook an extensive site selection process
- The process was underpinned by a weighted multi-criteria analysis
- The process ultimately led to the selection of Whalers Way

Critical criteria included:

- Latitude – between -30 and -40 degrees
- Launch Trajectories – support launches from 60 to 180-degree wrt equator
- Coastal Access – site to be on the coast with open ocean due south
- Weather – support year-round launches with no temperature extremes
- Land Size – min 500 Ha to support 2 launch pads and buffer zones
- Critical National Infrastructure – no critical national infrastructure in buffer
- zones or on trajectory
- Population – Need to be capable of exclusion from buffer zones
- Environment – Impact on environmental values

Existing cleared land exists several kilometres to the north of Whalers Way, this land is not suitable for the proposal due to constraints on achieving exclusion zones under national legislative requirements.

Internal site selection was based on criteria including:

- Existing degraded areas
- Existing cleared areas
- Topography
- Blast radius
- Existing road access
- Proximity to coast
- Security requirements

Avoidance of vegetation wherever possible has occurred within the engineering constraints of a highly technical project. Reduction of the footprint as far as practicable to avoid clearing native vegetation with the size of the Project Area reduced in size from 70.58 ha to 23.76 ha from concept design with further refinements reducing the clearance to 20.4 ha.

As a result of the comments received from the SA Government, public submissions provided, and further analysis undertaken by Southern Launch's ecology and cultural heritage advisors, and alteration to proposed Site A has been made. This launch site will be moved 700 metres to the northeast.

Site A was originally closer to the coast. Assessment of the original site suggested the disturbance to this vegetation would negatively impact upon listed species such as the Western Whip Bird and Southern Emu Wren (Listed Species) found in this area.

A thorough analysis has therefore been undertaken to identify not only a better location from an ecology point of view, but also from a cultural heritage point of view. Several sites were identified and respectfully ruled out. Therefore, the new site selected has been superior from an ecological and cultural heritage standpoint. Physical limitations also exist around the placement of site further to the north in areas of slightly poorer vegetation. Each of the launch sites at Whalers Way are designed to safely support a wide range of launch directions (azimuths) from each launch site. Multiple sites are being designed to ensure concurrent operations can be supported. Risk associated with all launch activities are defined in isopleths (contours) emanating from the launch location and proceeding downrange in the direction (azimuth) the rocket flies into space. The risk isopleth is not a narrow shape but expands laterally as a rocket lifts off and ascends towards space. As the rocket travels downrange, the associated risk decreases as the width of the isopleth increases. Therefore, the areas of highest risk are always around the launch site and the immediate area around the trajectory the rocket flies downrange. The launch risk criteria associated with each site must ensure there is no critical infrastructure, or other launch sites within an arch from approximately 55 degrees through to approximately 125 degrees wrt the equator, for each launch site. To ensure there is no overflight between launch sites, all launch sites should be located as close to the same latitude as possible. This will ensure that the risk from a launch on one launch site does not encroach on the infrastructure on the other, adjacent launch site.

The majority of the existing access track, commonly known as Whalers Way Drive, will be retained in its current condition, with localised grading and re-sheeting, not affecting the existing alignment, and not requiring an expansion of the existing footprint, as required to maintain all weather access.

b) *Minimization – if clearance cannot be avoided, outline measures taken to minimize the extent, duration and intensity of impacts of the clearance on biodiversity to the fullest possible extent.*
The clearance footprints have been minimized to the minimum area possible and located adjacent to existing roads where possible. Existing access roads are being utilised to ensure minimum disturbance and implementing a CEMP and OEMP to manage direct and indirect impacts
    - Some resizing and shapes of infrastructure areas refined to limit impact
    - Areas minimised and located in areas of lower condition
    - Future reductions in footprint are being sought
    - Proposed access tracks have been aligned with existing tracks where possible
    - Limitations due to engineering and nationally threatened fauna species

Each launch site will have a clearance footprint which is larger than the site to accommodate batter slopes and enable suitable external access to the fencing and a nominal ten (10) metre width buffer beyond this. It is on this basis that the clearance envelopes for the site have been calculated. Notwithstanding the calculated clearance envelopes, these are conservative figures as the clearance required for each site will be minimised through the design and construction process, and it is likely that the final clearance envelopes can be reduced from those indicated on the proposal plans, in the EIS and the supporting technical reporting.

c) *Rehabilitation or restoration – outline measures taken to rehabilitate ecosystems that have been degraded, and to restore ecosystems that have been degraded, or destroyed by the impact of clearance that cannot be avoided or further minimized, such as allowing for the re-establishment of the vegetation.*
Southern Launch are enthusiastic about incorporating the restoration and conservation of the Whalers Way area as a critical part of the project. Mitigating impacts is at the forefront of the company ethos. Some measures that are in planning phases include:

- Predator Proof fencing and eradication of predators including cats and foxes from the Whalers Way HA
- Firebreaks incorporated along fences to protect and mitigate one of the primary threats to EPBC listed species present
- Weed control
- Ongoing studies into risks associated with the project which have no precedent such as funding PhD studies in association with state universities.

Rehabilitation of tracks that are remnants of previously visited but closed areas or unnecessary are proposed to be rehabilitated as a stage approach utilising clearance material from clearance areas. The tracks proposed are shown below in Figure 9, and include (east to west); the closed track to the southern tip of Whalers Way; a former track aligned south of the existing main track which has partially self-regenerated; the old track alignment previously used prior to formation of the sinkhole; and the small loop track to Blue Whale Bay which is significantly degraded due to wind erosion and ongoing off road vehicle damage.

Rehabilitation will be planned as ripping of the existing base material where present, spreading of topsoil from other clearance areas which will provide the seedbank, and placement of organic material on top of that to stabilise and prevent erosion until natural regeneration occurs. These rehabilitation areas will act in reducing fragmentation of vegetation within the primary Southern Emu Wren habitat.

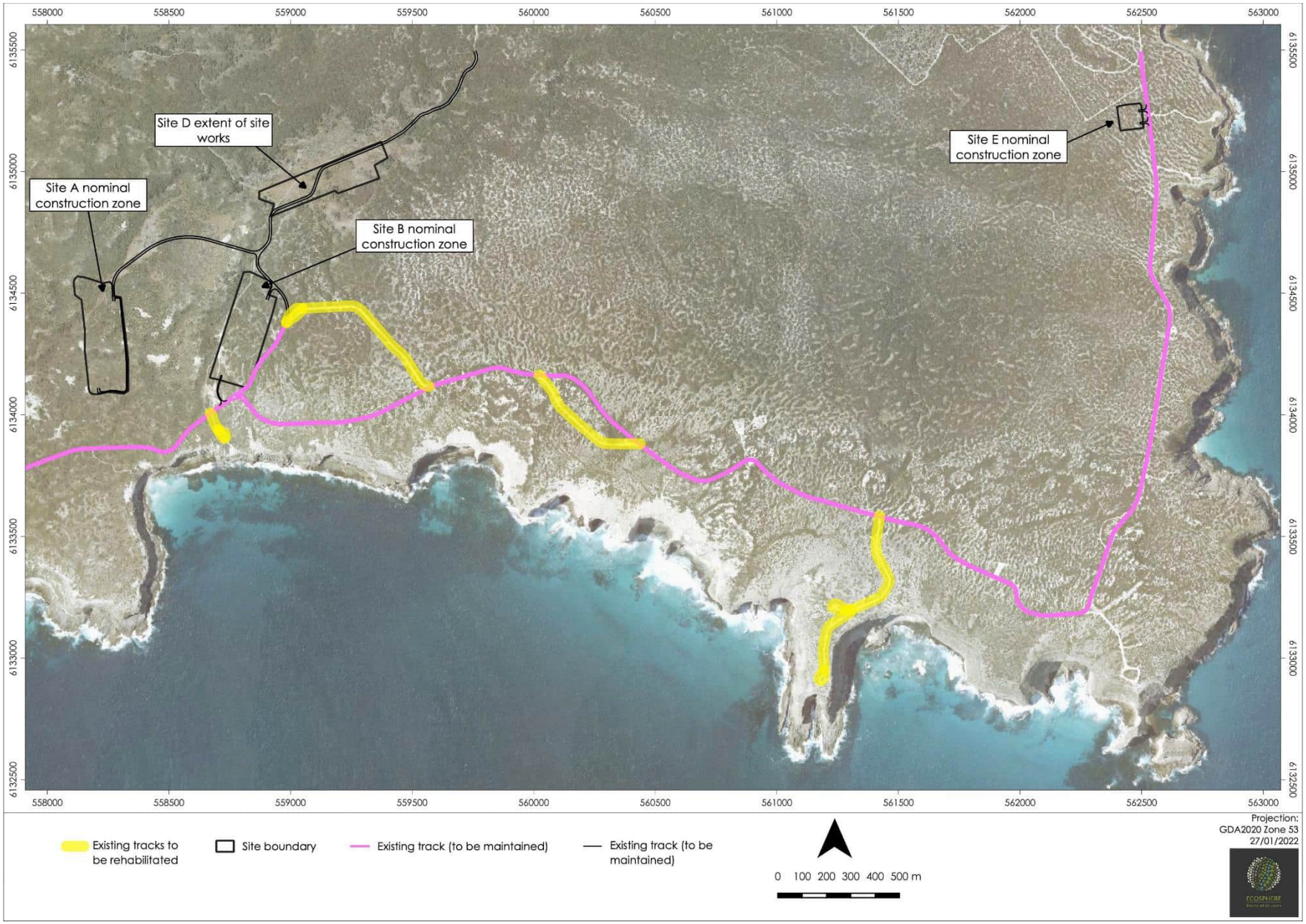


Figure 9. Proposed rehabilitation sites associated with existing tracks within Whalers Way.

d) *Offset – any adverse impact on native vegetation that cannot be avoided or further minimized should be offset by the achievement of a significant environmental benefit that outweighs that impact.*
Southern Launch will provide a SEB in the form of an inground offset provided by SEB credit providers within the region. This is in association with ongoing negotiations and pending final footprints and offsetting requirements.

4.5 Principles of Clearance (Schedule 1, *Native Vegetation Act 1991*)

The Native Vegetation Council will consider Principles 1(b), 1(c) and 1(d) when assigning a level of Risk under Regulation 16 of the Native Vegetation Regulations. The Native Vegetation Council will consider all the principles of clearance of the Act as relevant, when considering an application referred under the *Planning, Development and Infrastructure Act 2016*.

Principle of clearance	Considerations
Principle 1a - it comprises a high level of diversity of plant species	<u>Relevant information</u> The number of plant species recorded (native and introduced) for each vegetation association The plant diversity scores for 10 of the 26 sites assessed within Whalers Way were >20 points meaning they were seriously at variance with this principle. The remaining 16 sites were between 10 and 20 points being at variance with this principle.
	<u>Assessment against the principles</u> Seriously at Variance: • Launch Site A • Launch Site B, associations 3 and 6 • Launch Site B to infrastructure area access associations 1 and 5 • Infrastructure Site D, association 1 • Infrastructure access associations 1 and 7 At Variance: • All remaining sites.
	<u>Moderating factors that may be considered by the NVC</u> None
Principle 1b - significance as a habitat for wildlife	<u>Relevant information</u> The Whalers Way area is under a current Heritage Agreement and constitutes an intact vegetation community. The area has numerous landforms and vegetation associations present and forms a link in a chain of a number or reserves and national parks in the southern Eyre Peninsula. The area has records for over 120 fauna species within 10km of the project site. The site directly provides critical habitat for two nationally threatened terrestrial species and at least 12 terrestrial species at state level. The following nationally threatened species are known to use the Project area for some or all their habitat requirements: • Southern Emu Wren • Western Whip Bird A further nine species listed as migratory/marine at federal level or of state conservation significance are known to, likely to or will possibly utilise the habitat present within the project areas.

	All areas subsequently resulted in a threatened fauna score of 0.1.
	Assessment against the principles The threatened fauna score for associations within the project site scored greater than 0.05 points making clearance of vegetation within all project area seriously at variance with this principle.
	Moderating factors that may be considered by the NVC There are no moderating factors relating to the presence of Southern Emu Wren and Western Whip bird. Some species such as Rock Parrot may be considered locally common only.
Principle 1c - plants of a rare, vulnerable or endangered species	Relevant information No threatened flora species were recorded within the Project site areas directly or in other sites surrounding the project areas. There are historical records for a number of species including: • *Xanthorrhoea semiplana* ssp. *tatei* • *Eucalyptus gillenii* • *Hibbertia crinita* • *Acacia alcockii* These records are all in similar locations and not recorded within the project area when checked for accuracy. There is some doubt about the integrity of many of these records given the descriptions of record locations do not match the actual location and the specific habitat is not suitable for these species. Other species without records but more likely to be present based on habitat preferences such as *Prostanthera calycina* were also not recorded despite targeted searches within the project areas and within areas of preferred habitat.
	Assessment against the principles The clearance is not at variance with this principle.
	Moderating factors that may be considered by the NVC N/A
Principle 1d - the vegetation comprises the whole or part of a plant community that is Rare, Vulnerable or endangered:	The low shrubland and Mallee communities within Whalers Way are not recognized as threatened at national or state level. The proposed clearance is not at variance with this principle. Threatened Community Score - 1
	Assessment against the principles The clearance is not at variance with this principle.
	Moderating factors that may be considered by the NVC N/A
Principle 1e - it is significant as a remnant of vegetation in an area which has been	Relevant information The Talia sub region has 56% remnancy of which 32% is protected in formal reserves. The Mungerowie Association has 78% remnancy of which 25% is formally protected. The remnants within whalers Way are highly valuable in providing connectivity between the Port Lincoln National Park and the Coffin Bay National Park.

extensively cleared.	Total Biodiversity Score – 1241.39
	Assessment against the principles Clearance of vegetation within the Project areas with a biodiversity score of greater than 500 and over 30% remnancy is at variance within this principle.
	Moderating factors that may be considered by the NVC No moderating factors are considered for this principle.
Principle 1f - it is growing in, or in association with, a wetland environment.	Relevant information N/A
	Assessment against the principles The clearance is not at variance with this principle.
	Moderating factors that may be considered by the NVC N/A
Principle 1g - it contributes significantly to the amenity of the area in which it is growing or is situated.	Relevant information The vegetation does contribute significantly to the amenity of the area. the types of soil present in the area means that the vegetation plays a highly significant role in stabilising an otherwise fragile environment. Careful management of stormwater will be required.
	The clearance is not at variance with this principle.
	Moderating factors that may be considered by the NVC N/A

Principles of Clearance (h-m) will be considered by comments provided by the local NRM Board or relevant Minister. The Data Report should contain information on these principles where relevant and where sufficient information or expertise is available.

4.6 Risk Assessment

Determine the level of risk associated with the application

Total clearance	No. of trees	N/A
	Area (ha)	23.403
	Total biodiversity Score	1241.399
Seriously at variance with principle 1(b), 1(c) or 1 (d)		Seriously at variance with principle 1a and 1b. At variance with 1e
Risk assessment outcome		Level 4

4.7 NVC Guidelines

Provide any other information that demonstrates that the clearance complies with any relevant NVC guidelines related to the activity.

5. Clearance summary

Clearance Area(s) Summary table

Block	Site	Native species diversity score	Threatened Ecological community Score	Threatened plant score	Threatened fauna score	UBS	Area (ha)	Total Biodiversity score	Loss factor	Loadings	Reductions	SEB Points required	SEB payment	Admin Fee
Launch Site A	3	22	1	0	0.1	66.23	7.652	506.79	1	1		1064.26	$741,756.80	$40,796.62
Launch Site A	5	12	1	0	0.1	30.66	0.080	2.45	1	1		5.15	$3,590.00	$197.45
Launch Site A access track	3	22	1	0	0.1	66.23	0.466	30.86	1	1		64.81	$45,172.33	$2,484.48
Launch Site A access track	5	12	1	0	0.1	30.66	0.179	5.49	1	1		11.53	$8,032.62	$441.79
Launch Site B	1	16	1	0	0.1	51.65	0.684	35.33	1	1		74.19	$51,708.06	$2,843.94
Launch Site B	3	24	1	0	0.1	53.43	5.996	320.37	1	1		672.77	$468,898.26	$25,789.40
Launch Site B	6	24	1	0	0.1	70.84	0.495	35.07	1	1		73.64	$51,323.42	$2,822.79
Launch site B emergency egress	6	24	1	0	0.1	70.84	0.044	3.12	1	1		6.55	$4,562.08	$250.91
Launch Site B to infrastructure Site D track	3	12	1	0	0.1	55.71	0.404	22.51	1	1		47.26	$32,941.73	$1,811.79
Infrastructure Site D	1	22	1	0	0.1	62.72	0.265	16.62	1	1		34.90	$24,326.73	$1,337.97
Infrastructure Site D	3	12	1	0	0.1	38.97	1.158	45.13	1	1		94.77	$66,049.69	$3,632.73
Infrastructure Site D	5	12	1	0	0.1	30.66	4.582	140.48	1	1		295.02	$205,617.02	$11,308.94
Site D Northern Access	2	18	1	0	0.1	55.89	0.076	4.25	1	1		8.92	$6,216.98	$341.93
Site D Northern Access	3	12	1	0	0.1	50.23	0.233	11.70	1	1		24.58	$17,129.75	$942.14
Site D Northern Access	5	12	1	0	0.1	30.66	0.048	1.47	1	1		3.09	$2,154.00	$118.47
Range control Pad (E)	4	20	1	0	0.1	57.41	0.999	57.35	1	1		120.44	$83,943.07	$4,616.87
Range control access (E)	4	20	1	0	0.1	57.41	0.042	2.41	1	1		5.06	$3,529.14	$194.10
						Total	23.403	1241.39				2606.94	$1,816,951.66	$99,932.34

	Total Biodiversity score	Total SEB points required	SEB Payment	Admin Fee	Total Payment
Application	1241.40	2606.94	$1,816,951.66	$99,932.34	$1,916,884.01

Totals summary table

IBRA Association percent vegetation remnancy (%)	87
IBRA Subregion percent vegetation remnancy (%)	56
Is the vegetation associated with a Wetland	No
Economies of Scale Factor	0.5
Rainfall (mm)	536

6. Significant Environmental Benefit

A Significant Environmental Benefit (SEB) is required for approval to clear under Division 5 of the *Native Vegetation Regulations 2017*. The NVC must be satisfied that as a result of the loss of vegetation from the clearance that an SEB will result in a positive impact on the environment that is over and above the negative impact of the clearance.

ACHIEVING AN SEB

Indicate how the SEB will be achieved by ticking the appropriate box and providing the associated information:

☐ Establish a new SEB Area on land owned by the proponent.

☐ Use SEB Credit that the proponent has established. Provide the SEB Credit Ref. No. _____

☐ Apply to have SEB Credit assigned from another person or body. The application form needs to be submitted with this Data Report.

☐ Apply to have an SEB to be delivered by a Third Party. The application form needs to be submitted with this Data Report.

☒ Pay into the Native Vegetation Fund.

PAYMENT SEB

If a proponent proposes to achieve the SEB by paying into the Native Vegetation Fund, summary information must be provided on the amount required to be paid and the manner of payment:

The SEB requirement as a payment into the NV Fund is $1,916,884.01

7. Appendices

Appendix 1. Fauna species list from EP biological survey (DEW 2004) with species updates from 2020 surveys.

CLASS	Species	Common	AUS	SA	Most Recent sighting
AVES	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater			15/12/2004
	Acanthiza apicalis	Inland Thornbill			15/12/2004
	Accipiter cirrocephalus cirrocephalus	Collared Sparrowhawk			13/12/2004
	Accipiter fasciatus fasciatus	Brown Goshawk			15/12/2004
	Anthochaera carunculata woodwardi	Red Wattlebird			15/12/2004
	Anthus australis	Australian Pipit			15/12/2004
	Aquila audax	Wedge-tailed Eagle			13/12/2004
	Artamus cyanopterus	Dusky Woodswallow			14/10/2020
	Barnardius zonarius	Australian Ringneck			15/12/2004
	Cacomantis flabelliformis	Fan-tailed Cuckoo			14/10/2020
	Calamanthus campestris campestris	Rufous Fieldwren			15/12/2004
	Chalcites lucidus	Shining Bronze Cuckoo			15/12/2004
	Chroicocephalus novaehollandiae	Silver Gull			14/10/2020
	Circus approximans	Swamp Harrier			15/12/2004
	Colluricincla harmonica	Grey Shrikethrush			15/12/2004
	Corvus coronoides	Australian Raven			14/10/2020
	Cracticus torquatus	Grey Butcherbird			14/10/2020
	Dromaius novaehollandiae	Emu			15/10/2020
	Drymodes brunneopygia	Southern Scrub Robin			15/12/2004
	Eolophus roseicapilla	Galah			14/10/2020
	Eopsaltria griseogularis	Western Yellow Robin			15/12/2004
	Falco cenchroides	Nankeen Kestrel			14/10/2020
	Falco peregrinus	Peregrine Falcon		R	15/12/2004
	Gliciphila melanops	Tawny-crowned Honeyeater			14/10/2020
	Gymnorhina tibicen	Australian Magpie			15/12/2004
	Haliaeetus leucogaster	White-bellied Sea Eagle		E	13/12/2004
	Hirundo neoxena	Welcome Swallow			15/12/2004
	Hydroprogne caspia	Caspian Tern			15/12/2004
	Larus pacificus	Pacific Gull			15/12/2004
	Lichenostomus cratitius occidentalis	Purple-gaped Honeyeater		R	15/12/2004
	Malurus cyaneus leggei	Superb Fairywren			14/10/2020
	Malurus pulcherrimus	Blue-breasted Fairywren			15/12/2004
	Melithreptus brevirostris	Brown-headed Honeyeater			14/10/2020
	Morus serrator	Australasian Gannet			13/07/2020
	Neophema elegans	Elegant Parrot		R	15/12/2004
	Neophema petrophila	Rock Parrot		R	14/10/2020
	Neophema sp.	Neophema parrots			15/12/2004

CLASS	Species	Common	AUS	SA	Most Recent sighting
	Pachycephala pectoralis	Australian Golden Whistler			12/07/2020
	Pandion haliaetus cristatus	Eastern Osprey		E	10/07/2020
	Pardalotus punctatus xanthopyge	Yellow-rumped Pardalote			15/12/2004
	Pardalotus striatus	Striated Pardalote			15/12/2004
	Phaps elegans	Brush Bronzewing			15/10/2020
	Phylidonyris novaehollandiae	New Holland Honeyeater			15/10/2020
	Pomatostomus superciliosus	White-browed Babbler			15/10/2020
	Psophodes leucogaster	Mallee (White-bellied) Whipbird	VU	E	15/10/2020
	Rhipidura albiscapa	Grey Fantail			15/12/2004
	Sericornis frontalis mellori	White-browed Scrubwren			15/10/2020
	Stagenopleura gutatta	Diamond Firetail		R	12/07/2020
	Sternula nereis	Fairy Tern	VU	E	15/12/2004
	Stipiturus malachurus parimeda	Southern Emuwren	VU	E	14/08/2020
	Strepera versicolor intermedia	Brown Currawong			15/12/2004
	Sturnus vulgaris	Common Starling			15/10/2020
	Thalasseus bergii	Greater Crested Tern			13/12/2004
	Thinornis cucullatus cucullatus	Hooded Plover	VU	V	15/12/2004
	Tribonyx ventralis	Black-tailed Nativehen			12/12/2004
	Turdus merula	Common Blackbird			15/12/2004
	Turnix varius	Painted Buttonquail		R	15/12/2004
	Zosterops lateralis	Silvereye			15/10/2020
MAMMALIA	*Felis catus*	Domestic Cat (Feral Cat)			15/12/2004
	Macropus fuliginosus	Western Grey Kangaroo			14/10/2020
	Macropus sp.				14/12/2004
	Mus musculus	House Mouse			16/12/2004
	Oryctolagus cuniculus	Rabbit (European Rabbit)			14/12/2004
	Phascolarctos cinereus	Koala			14/10/2020
	Rattus fuscipes	Bush Rat			16/12/2004
	Vulpes vulpes	Fox (Red Fox)			14/12/2004
REPTILIA	*Christinus marmoratus*	Marbled Gecko			14/12/2004
	Ctenophorus chapmani	Eastern Heath Dragon			14/10/2020
	Delma australis	Marble-faced Delma			16/12/2004
	Drysdalia mastersii	Master's Snake			14/12/2004
	Hemiergis peronii	Four-toed Earless Skink			14/12/2004
	Lampropholis delicata	Delicate Skink			16/12/2004
	Lerista bougainvillii	Bougainville's Skink			14/12/2004
	Lerista dorsalis	Southern Four-toed Slider			16/12/2004
	Liopholis multiscutata	Bull Skink			16/12/2004
	Menetia greyii	Dwarf Skink			12/12/2004
	Morethia obscura	Mallee Snake-eye			15/12/2004
	Notechis scutatus	Tiger Snake	ssp		15/10/2020
	Pseudonaja affinis	Dugite			15/12/2004
	Pseudonaja inframacula	Peninsula Brown Snake			15/10/2020

CLASS	Species	Common	AUS	SA	Most Recent sighting
	Pseudonaja sp.				16/12/2004
	Pygopus lepidopodus	Common Scaly-foot			14/12/2004
	Tiliqua occipitalis	Western Bluetongue			15/10/2020
	Tiliqua rugosa	Sleepy Lizard			14/10/2020
	Tympanocryptis lineata	Lined Earless Dragon			14/10/2020

E DIVERSITY MARINE ECOLOGY

Whalers Way Orbital Launch Complex Updated Marine Ecological Assessment

Report to Southern Launch

Prepared by J Diversity Pty Ltd

Rev 1, 3 August 2022

Cover photo: long-nosed fur seal *Arctocephalus forsteri* near Red Banks, Whalers Way. Photo: J. Brook, November 2017.

Disclaimer

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Executive Summary

The trajectory of rockets launched from the Whalers Way Orbital Launch Complex (WWOLC) is over the Southern Ocean, within an arc between bearings 145° and 265°, with the potential marine impact zone (PMIZ) extending for 1000 km. Two thirds of launches are expected to have Polar or Sun Synchronous trajectories, corresponding to bearings of approximately 185° and 195°, respectively.

The South Australian waters component of the PMIZ overlaps the south-eastern corner of the Thorny Passage Marine Park, which includes a Habitat Protection Zone containing Liguanea Island, about 5–8 km south of the WWOLC. Most of the important values of the park within the PMIZ are concentrated on this island, including:

- A breeding colony of the threatened Australian sea lion (ASL) *Neophoca cinerea.* Liguanea Island is the fifth-largest of 11 breeding colonies within the 'Spencer Gulf' metapopulation, with estimated pup counts of 25–43, corresponding to an estimated total Liguanea Island population size of 100–165. Liguanea Island accounts for about 3% and 1% of the Spencer Gulf and Australian pup production of ASL, respectively. The interval between its breeding seasons is 17–18 months.
- A breeding colony of the long-nosed fur seal (LNFS) *Arctocephalus forsteri.* The pup population of LNFS on Liguanea Island has been estimated at about 1,800, corresponding to a total Liguanea Island population of about 8,700. Liguanea Island accounts for about 9% of the LNFS pup production in South Australia. Breeding occurs between December and March.
- A breeding colony of Short-tailed Shearwater (Mutton Bird) *Ardenna tenuirostris*, listed as Migratory under the EPBC Act 1999. The breeding colony spans about a quarter of the island's area, with more than 10,000 burrows, accounting for about 1% of South Australia's breeding population. Breeding occurs in late November, and fledglings leave the colony in late April (migrating to north of Japan).
- A breeding population of Crested Tern *Thalasseus bergii*, listed as Migratory under the EPBC Act 1999, with 'several thousand' birds (of an estimated South Australian population of 13,000–25,000) recorded.

Sleaford Bay, approximately 10 km east of the WWOLC, has been identified as a site where small, but increasing, numbers of southern right whale *Eubalaena australis* regularly aggregate briefly, and there are museum records from waters adjacent to the WWOLC.

Collision impacts

No impacts on Liguanea Island are expected from debris during successful launches, because the first stage of orbital rockets would not fall to earth within 500 km, and suborbital rockets (for which the booster would fall to earth within range of 3–8 km) would not be launched with a trajectory over Liguanea Island. Debris from failed launches with Polar and Sun Synchronous trajectories has the potential to impact Liguanea Island, but the risk is remote. Flight safety risk analysis using processes set out by the Federal Aviation Authority and Flight Safety Code shows that:

- An air burst, which results in the launch vehicle breaking up into a number of pieces and landing over a large area, would have an average frequency of LNFS and ASL casualties of one every 3,375 and 194,470 launches, respectively, for small rockets. For mini or micro

rockets, expected to collectively account for 95% of launches, the frequency would be 30 or 100 times lower, respectively.

- A ground burst would occur every 3 million launches, with an average frequency of LNFS and ASL casualties of one every 7,700 and 445,000 launches, respectively, for small rockets and almost half as often for mini or micro rockets.

An air burst over Liguanea Island would be a very rare event that could result in mortalities but there would be negligible impact at subpopulation level. Ground bursts on Liguanea Island would be a rarer event than an air burst (provided a flight termination system is used) but could impact more individuals. Although this may result in temporary reductions in ASL pup production, no long-term impact is expected at subpopulation level.

For the entire PMIZ, four sharks, four turtles, 17 marine mammals, 42 marine birds and six shorebirds have been identified as known to occur or possibly occurring. The likelihood of debris colliding with individuals of these species is considered to be remote, and would not occur when animals are submerged. Within the Southern Ocean, including the waters of the Thorny Passage Marine Park surrounding Liguanea Island, there may be occasional debris strike impacts on individual animals on the sea surface but no impact at population level is expected.

Noise impacts

Noise from launches would temporarily alter the quiet setting of the natural environment for one to two minutes during launches. Sound transmission from air into water is limited, with most noise reflected off the sea surface unless the angle of incidence is less than 13° from the vertical. For a typical, near-vertical rocket trajectory, this would mean that the rocket would be at about 2 km altitude before significant noise were able to transmit into the marine environment. Sound attenuation through air and across the air/sea barrier would reduce noise to levels well below the thresholds for hearing damage for marine mammals, and no higher than noise that can frequently arise from wind and waves. Behavioural impacts would be unlikely except within 750 metres of the shoreline for the largest few rockets, and would be short-term.

Airborne noise would be below hearing loss thresholds within ASL or LNFS breeding colonies on Liguanea Island and haul-out sites at Cape Wiles or elsewhere along the Whalers Way coastline. Impacts on pinniped behaviour are the primary concern with regard to rocket launches. For the largest few rockets launched from the WWOLC, there may be some behavioural impacts on seals on Liguanea Island or the Whalers Way coastline, including movement on land or into the water. Trampling injuries are considered unlikely due to the low density of seals and the robustness of pups after their first month, and seals entering the water are expected to return within two hours.

Approvals have been routinely granted for behavioural impacts on pinnipeds at the Kodiak Launch Complex (KLC) in Alaska and Vandenberg Air Force Base (VAFB) in California, including movement both on land and into the water, but the latter has occurred only rarely with seals hauling out again within minutes to two hours of each launch. Seal populations near the VAFB have increased at an annual rate of 12.6 per cent over a decade despite 5–7 space vehicle launches per year.

Airborne noise is not expected to impact whales because their ears remain submerged when surfaced, except for rare occasions when breaching.

Rocket noise is not expected to impact the hearing of birds on Liguanea Island, including Short-tailed Shearwater, Crested Tern or Cape Barren Geese. There may be behavioural impacts on seabirds on

Liguanea Island but these are expected to me minor and short-term in nature. Masking of acoustic signals is not expected to have any significant impact on bird communication due to the infrequency and short duration of the rocket noise.

Other debris impacts

Other debris impacts, including ingestion by marine fauna, crushing or smothering of biota, emission of toxic contaminants, noise from debris striking the sea surface and provision of habitat would be highly localised, the area impacted would be insignificant in comparison to the extent of the receiving environment and population level effects would be negligible.

Monitoring, management and mitigation

Monitoring of seal behaviour and noise on Liguanea Island and underwater noise in the nearshore area near the launch sites will be undertaken before, during and after launches on several occasions, including test launches.

Mitigation measures designed to reduce noise impacts on terrestrial species during rocket take-off, e.g. earth bunds and site structures for acoustic screening, may also benefit seals and seabirds on Liguanea Island. Other mitigation measures specific to marine fauna include:

- avoiding trajectories over Liguanea Island for suborbital launches
- searches for whale presence, by appropriate methods, within areas of possible impact for launches where there is some risk to whales, with the launch delayed if whales are found in the relevant areas
- using a flight termination system, which would substantially reduce the risk of a ground burst on Liguanea Island
- consideration, for some launches, of avoiding critical periods (e.g. breeding times) for species.

A review of risks to the marine environment from debris (once fallen) would be undertaken after the first three years of operation.

The conclusions of this assessment are consistent with the findings of a risk assessment undertaken for comparable rocket launches in New Zealand.

1 Preface

This report updates the original marine assessment provided as Appendix S of the EIS for the Whalers Way Orbital Launch Complex (WWOLC) proposed by Southern Launch Space Pty Ltd (Southern Launch).

The main changes are in relation to southern right whales, with additional information about their presence in the area, and a shift in focus to assessment of underwater rather than airborne noise impacts based on further consultation with noise experts and additional noise modelling. There have also been minor updates to the assessment of noise impacts on pinnipeds and birds as the result of additional noise modelling.

The potential marine impact zone is narrower as a result of being more accurately mapped[1].

Other changes include additional information about:

- sharks near Liguanea Island
- commercially important invertebrate species
- Australian sea lion breeding behaviour
- seal haul-out sites

2 Introduction

Southern Launch are proposing to construct the WWOLC to support the launch of domestic and international launch vehicles to service a growing demand for Polar and sun synchronous orbit (SSO) satellite insertion.

Although the infrastructure, including two launch sites, will be entirely on land, the trajectory of rockets will be over the Southern Ocean. The Polar and SSO trajectories correspond to bearings of approximately 185° and 195°, respectively, and are expected to collectively account for about two thirds of launches. Trajectories for other launches could be within an arc between bearings 145° and 265°. The potential marine impact zone (PMIZ) for orbital rockets, within which debris may fall, extends for 1000 km (Figure 1).

[1] Previous mapping of the PMIZ used the Map Grid of Australia, a projection which preserves area but can distort angles, by which the lateral boundaries were defined.

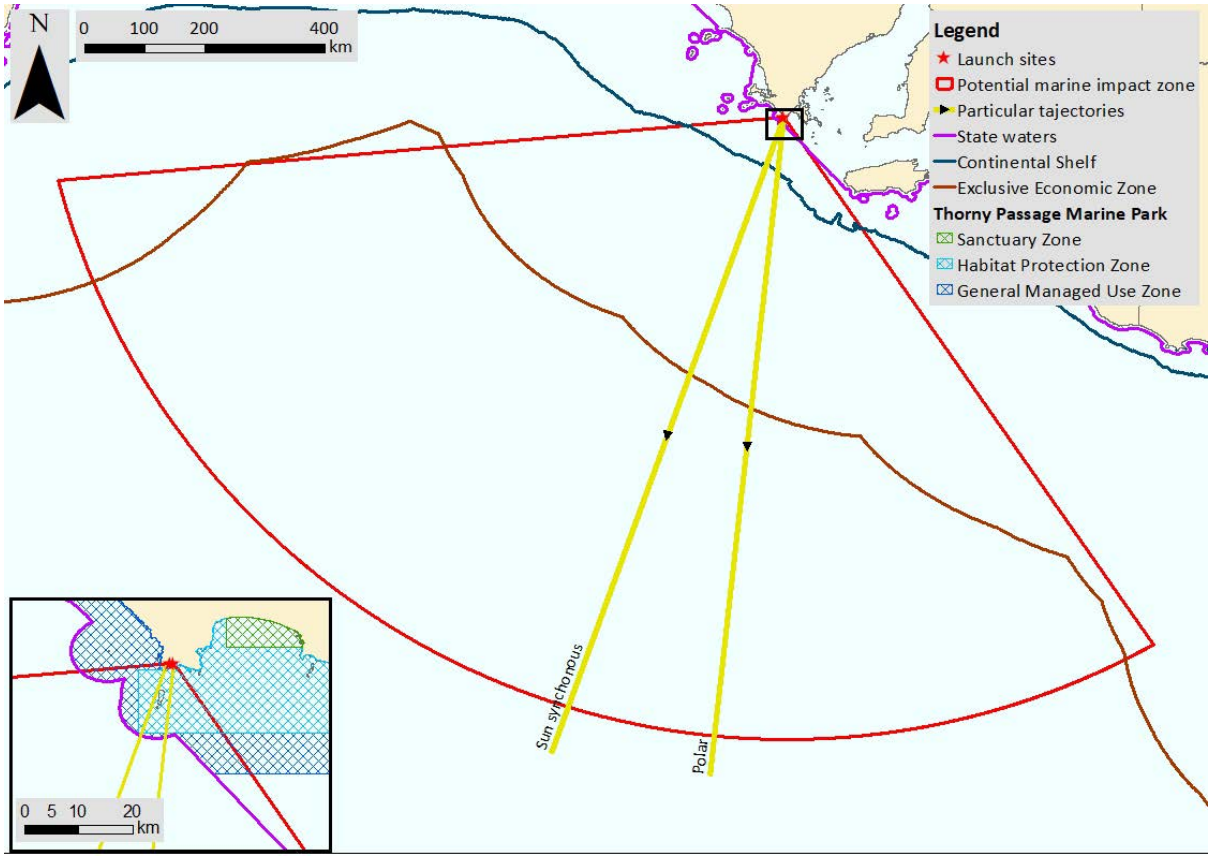

Figure 1. Potential marine impact zone associated with rocket launches from the WWOLC, showing Polar and Sun Synchronous trajectories.

A relatively small proportion of the PMIZ lies within South Australian waters, and all of that area is also within the Thorny Passage Marine Park (TPMP) (Figure 2). The activities of the Project must therefore be consistent with the objects of the *Marine Parks Act 2007*, and the provisions of the TPMP Management Plan (DEWNR 2012). A key feature of the PMIZ/TPMP overlap area is Liguanea Island, which is part of Lincoln National Park.

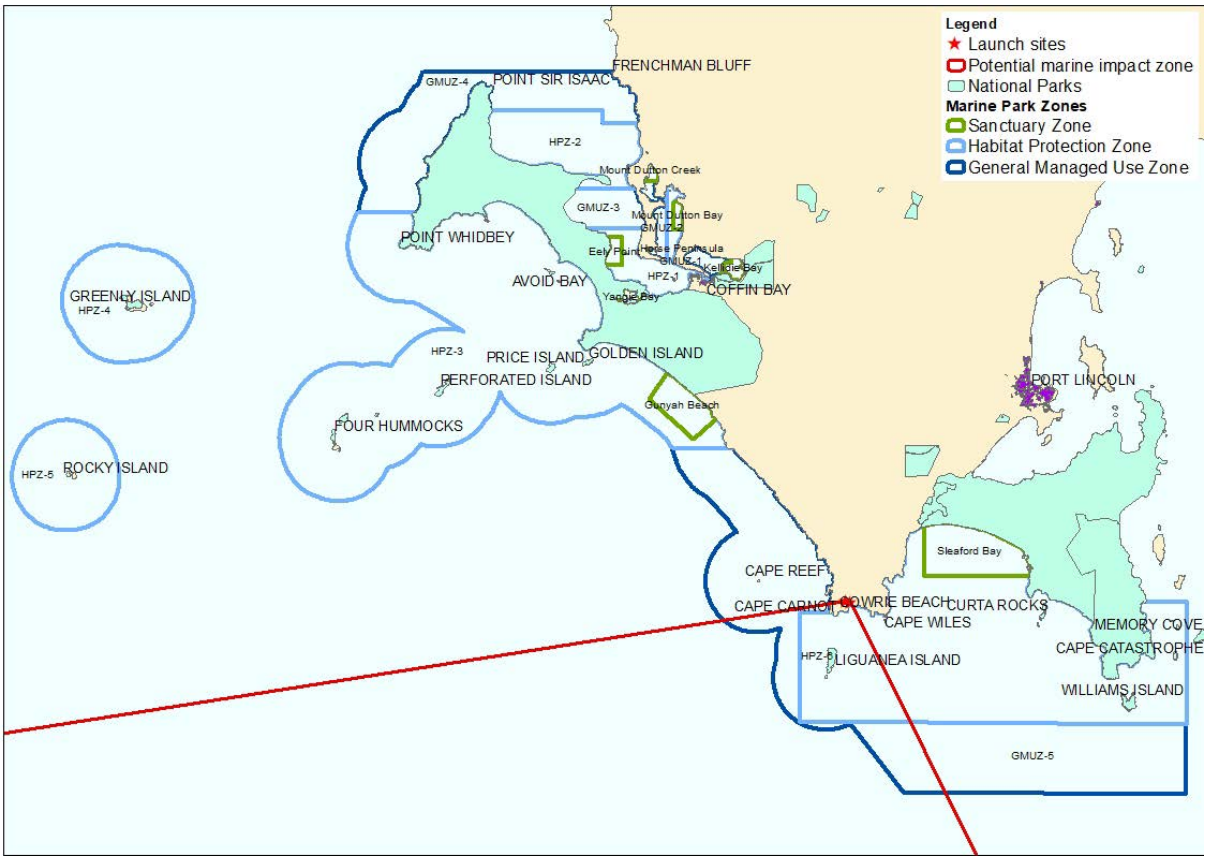

Figure 2. Location of the Potential Marine Impact Zone in relation to the Thorny Passage Marine Park and Coffin Bay and Lincoln National Parks.

This document contributes to responses to a number of the assessment guidelines for the project (Table 1).

Table 1. Contributions of this document to responses to the project assessment guidelines.

Guideline	Response
1.1 Identify the existing terrestrial and marine environments and species that are known and likely to occur on the subject site and surrounds. Detail the conservation values for the Thorny Passage Marine Park, Jussieu Peninsula to Coffin Bay Peninsula Biodiversity Area and Lincoln National Park (including species listed in the SA *National Parks and Wildlife Act 1972*).	• Potential marine impact zone defined in Section 1 to facilitate identification of relevant surrounds • Shoreline and benthic habitats near mainland and Liguanea Island described in Sections 2.2 and 2.3. Habitats beyond state waters have been broadly classified in Section 3. • Conservation values of the TPMP identified in Section 2 include breeding colonies of Australian sea lion (listed as Vulnerable under the *National Parks and Wildlife Act 1972* (NPW Act 1972) (Section 2.6.1), long-nosed fur seal (Section 2.6.2), Short-tailed Shearwater (Section 2.7.1) and Crested Tern (Section 2.7.2). Other species listed under the NPW Act 1972 are cetaceans including southern right whale (Section 2.6.3), humpback whale and blue whale (Section 2.6.4), and seabirds including Cape Barren Goose, Sooty Oystercatcher and Fairy Tern (Section 2.7.3). Mobile macroinvertebrates and fishes have also been described in Sections 2.4 and 2.5.
1.2 Detail the potential impacts on terrestrial and marine habitat for each potential launching site and associated impact area, including runoff from storm and wastewater into the marine environment due to the increase in impervious surfaces, impacts from noise and vibration during launches and impacts of the exhaust from rockets. Both terrestrial and marine ecosystems must be considered for all operational activities. Provide adequate mitigation and management measures for each area in turn.	• Potential impacts on the marine environment largely restricted to fauna on land or sea surface (Section 4.1) • Primary potential impacts detailed include strikes by debris (Section 4.2) and noise disturbance of seals and seabirds (Section 4.3). • Impacts of debris on marine habitat also considered (Section 4.4) • Management and mitigation measures include avoiding trajectories over Liguanea Island for suborbital launches (Sections 4.2.1 and 4.5), use of a flight termination system and consideration of avoiding (for some launches) critical periods (e.g. breeding times) for species (Section 4.5).
1.3 Identify the potential trajectory of launched vehicles and likely location, extent, composition and amount of debris and spent componentry anticipated to impact on the surrounding area, including the adjoining Marine Park. Propose operational management strategies to limit the impacts on the quantified conservation values.	• Potential trajectories have been described in Section 1. • Location, extent and amount of debris are incorporated within the seal strike risk assessment undertaken by Southern Launch (Appendix 1), summarised in Section 4.2.1. • Composition of debris is identified in Section 4.4.

Guideline	Response
3.1 Describe the location, extent, condition and significance of native terrestrial and marine fauna populations, including individual species and communities in the surrounding area, including on land, cliffs and in adjoining waters, including Liguanea Island.	• See response to Guideline 1.1
3.2 Describe the nature and extent of the impacts likely to affect native terrestrial and marine fauna species and populations during both construction and operation. Describe the ability of communities and individual species to recover, especially threatened or significant species (including those listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and *National Parks and Wildlife Act 1972*). Specifically consider the impact of marine debris.	• See response to Guideline 1.2, including the impact of marine debris (Sections 4.2 and 4.4). • Species listed under the EPBC Act 1999 include Australian sea lion (Section 2.6.1), southern right whale, blue whale, humpback whale (Sections 2.6.3 & 3), Short-tailed Shearwater (Section 2.7.1) and Crested Tern (Section 2.7.2).
3.5 Identify the potential impact of noise and vibrations on terrestrial, coastal and marine native fauna, and the mitigation and monitoring strategies during both construction and maintenance.	• Potential impact of noise on marine native fauna is addressed in Section 4.3. It is limited to birds and pinnipeds, as the noise associated with rocket launches would not effectively transfer across the water surface. • Management and mitigation measures are addressed in Section 4.5 and include mitigation measures in response to Guideline 1.2 above. • Mitigation measures listed by AECOM (2022a) to reduce noise impacts on terrestrial species during rocket take-off, e.g. earth bunds and site structures for acoustic screening, may also benefit seals and seabirds on Liguanea Island. • Monitoring of seal behaviour and noise on Liguanea Island before, during and after launches will be undertaken on several occasions, including test launches (Section 4.5).
3.6 Detail appropriate buffer distances that would be required between proposed development (including coastal access points) and threatened terrestrial and marine species, including feeding areas, nesting sites and roosting sites.	• The launch sites were assessed as fixed sites, with noise and debris impact modelling showing acceptable impact or risk to threatened marine species (on Liguanea Island).
3.7 Outline measures to avoid, minimise, mitigate and monitor the effects on native fauna, including any compensatory activities.	• Refer to responses to Guidelines 1.2 and 3.5.

3 Ecological values of the Thorny Passage Marine Park

3.1 Introduction

The Thorny Passage Marine Park (TPMP) covers 2,472 km^2 and is located in the Eyre Bioregion, which extends from Cape Bauer near Streaky Bay into southern Spencer Gulf and along the south coast of Kangaroo Island. The TPMP includes the waters off lower Eyre Peninsula, extending from Frenchman Bluff to Memory Cove with discrete offshore sections overlaying Rocky and Greenly Islands (Figure 2).

The potential marine impact zone (PMIZ) for the WWOLC overlaps an area towards the south-east of the Park, including parts of GMUZ-5 and the western end of HPZ-6, which contains Cape Carnot and Liguanea Island (Figure 2). Many of the key features of the Park are situated outside the PMIZ, and are therefore excluded from this assessment, including all other islands, Coffin Bay (with four Sanctuary Zones), the marine waters offshore from Coffin Bay National Park, Sanctuary Zones at Gunyah Beach and Sleaford Bay, the marine waters surrounding the Memory Cove Wilderness Area and the main body of Lincoln National Park, noting that Liguanea Island itself is a discrete component of that Park (Figure 2).

3.2 Shoreline habitats

The western and eastern coasts and part of the southern coast (Cape Wiles and between Cowrie Beach and Groper Bay) of the Whalers Way site are comprised of ramping (5–30° slope) bedrock platforms of granite at the base of calcarenite cliffs of height 40, 130 and 80 m, respectively, except just south of Red Banks (north-west of the WWOLC) where the granite platforms are backed by sand dunes (DEW 2021a, Figure 3). Cowrie Beach is a sheltered, fine to medium sand beach situated just east of Cape Carnot at the base of 50 m high cliffs, and there are coarse sand beaches near the south-east corner of Whalers Way, backed by cliffs of 100–130 m height which extend across the remaining shoreline of the south coast (Figure 3). Unlike the mainland, the shoreline habitats of Liguanea Island have not been formally described (DEW 2021a), but are comprised of granite platforms and cliffs (Robinson et al. 1996, Google Earth inspections, site inspections)

3.3 Benthic habitats

The majority (80%) of the subtidal habitats in the TPMP have not been mapped (Bryars et al. 2016). Broad scale (1:100,000) mapping using satellite imagery showed that the western and southern coasts of Whalers Way were surrounded by granite reef for 200–700 m offshore on the western and southern coasts, with sand beyond the reef on the western coast, and unmapped area on the southern coast (DEW 2021b, Edyvane 1999, Figure 3). Dive surveys by Shepherd et al. (2005) at Red Banks encountered both granite and calcareous reef, dominated by large brown canopy-forming macroalgae including common kelp *Ecklonia radiata* and species from the order Fucales including *Acrocarpia paniculata, Cystophora siliquosa, C. subfarcinata* and *C. moniliformis*. This is consistent with descriptions of shallow reef macroalgal canopy communities in the Whidbey biounit, noting that the understorey is dominated by the robust red macroalga *Osmundaria prolifera* and articulated coralline macroalga *Haliptilon roseum* (Edyvane 1999).

Granite reef has also been mapped adjacent to the western and south-eastern shore of Liguanea Island, and around the mainly-submerged rock south of the island (Figure 3).

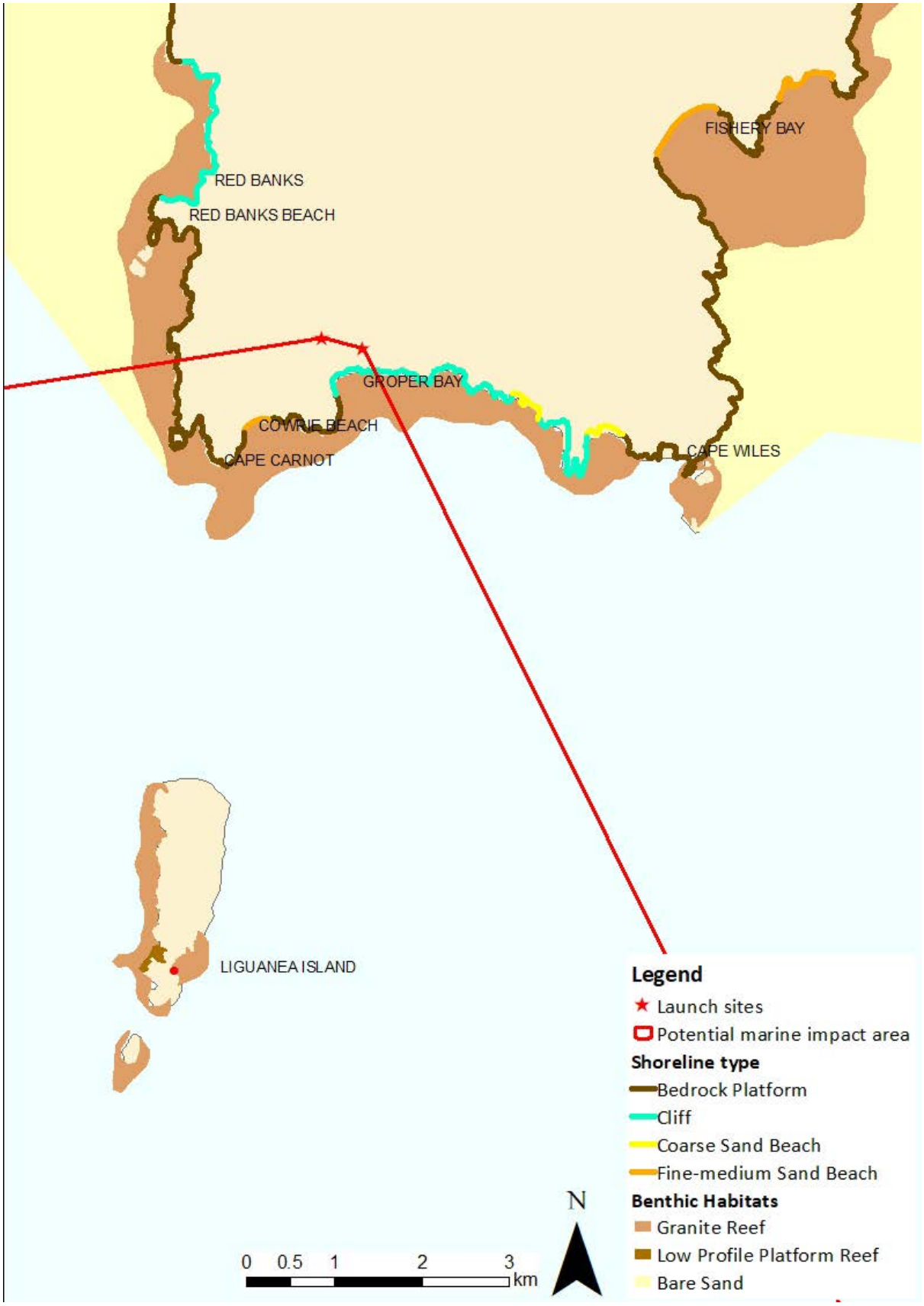

Figure 3. Shoreline and benthic habitats of Whalers Way and Liguanea Island.
Source: DEW 2021a, b.

The red macroalga *Erythrotrichia ligulata,* recorded one kilometre south-west of Cape Carnot, has been classified as *Vulnerable* by Cheshire et al. (2000) due to the few records (three) in southern Australia.

The benthic habitat below the intertidal bedrock platforms on the eastern coastline of the Whalers Way site has been mapped as sand (DEW 2021b, Edyvane 1999). No seagrass has been mapped, but it has been observed immediately adjacent to the intertidal habitats around Whalers Way (DEW 2021a).

3.4 Invertebrates

Annual stock assessments are undertaken of commercially important species including greenlip abalone *Haliotis laevigata* and blacklip abalone *H. rubra* (Stobart & Mayfield 2021) and southern rock lobster *Jasus edwardsii* (Linnane et al. 2021). The PMIZ overlaps the "Fishery Bay" spatial assessment unit, which extends from north of Shoal Point eastwards to Cape Tournefort, within the Western Zone Abalone Fishery. This area has accounted for approximately 2–4% and 1% of annual greenlip and blacklip abalone catches, respectively, in the fishery. The PMIZ within the TPMP overlaps marine fishing areas (MFAs) 28 and 38 of the Northern Rock Lobster Fishery. Annual catches within MFA 28, which extends from Reef Point eastwards to near Cap Turenne, decreased from 74 t I 2014 (24% of the fishery) to 39 t (15% of the fishery) in 2019 (Linnane et al. 2021). MFA 38 is one of 40 MFAs that collectively accounted for 5% of the annual catch in 2020 (Linnane et al. 2021, and accounted for 1.5% of the Northern Zone Rock Lobster catch during 1993–2011 (Ward et al. 2012).

No surveys of broader invertebrate communities are known from within the PMIZ, but a number of surveys of mobile invertebrates have been undertaken by the University of Tasmania and DEW at coastal and nearshore island sites of southern Eyre Peninsula, both to the east and west of the WWOLC (Reef Life Survey 2021). The dominant organisms recorded were the feather star *Cenolia trichoptera,* purple urchin *Heliocidaris erythrogramma,* long-spined urchin *Centrostephanus tenuispinus,* the sea stars *Meridiastra gunnii, M. calcar, Petricia vernicina* and the gastropods *Turbo undulatus, Dicathais orbita* and greenlip and blacklip abalone.

Bryars (2003) identified the reef habitat along southern Eyre Peninsula and Liguanea Island as being suitable for various life stages of southern rock lobster *Jasus edwardsii*, southern calamary *Sepioteuthis australis*, giant cuttlefish *Sepia apama*, Maori octopus *Octopus maorum*, greenlip abalone, blacklip abalone and purple urchin.

The eyelet top shell *Cantharidella ocellina*, identified by Baker & Clarkson (2014) as being of potential conservation concern in South Australia, has been recorded at Cape Wiles (its type locality) and a murex species *Monstrotyphis bivaricata* has been recorded south-west of Cape Carnot (and 64 km south of Cape Wiles).

3.5 Fishes and sharks

Surveys of reef fish undertaken near Red Banks in 2004 by Shepherd et al. (2005) recorded 18 species across five transects with varying levels of wave exposure each covering 500 m^2. The most abundant species were sea sweep *Scorpis aequipinnis*, zebra fish *Girella zebra* and bluethroat wrasse *Notolabrus tetricus* (Shepherd, unpublished data). Western blue groper *Achoerodus gouldii,* which is protected in the South Australian gulfs (east of Cape Carnot), was recorded on all transects, generally as sub-adults but with some juveniles and an adult.

Bryars (2003) identified the reef habitat along southern Eyre Peninsula and Liguanea Island as being suitable for various life stages of King George whiting, snapper *Chysophrys auratus*, Western Australian salmon *Arripis truttacea*, Australian herring *Arripis georgiana*, yelloweye mullet *Aldrichetta forsteri*, trevally *Pseudocaranx* sp., yellowtail kingfish *Seriola lalandi,* snook *Sphyraena novaehollandiae*, sea sweep, silver drummer *Kyphosus sydneyanus,* western blue groper, gummy shark *Mustelus antarcticus*, whaler sharks *Carcharhinus* spp., leatherjackets Monacanthidae spp. and wrasse Labridae spp. (including bluethroat wrasse). Species of recreational and commercial fishing interest recorded during the surveys by Shepherd et al. (2005) included bluethroat wrasse, sea sweep, King George whiting *Sillaginodes punctata* and southern sea garfish *Hyporhamphus melanochir* (Shepherd, unpublished data).

Southern Eyre Peninsula is a biologically important area (for foraging) for the white shark *Carcharadon carcharias* (DSEWPC 2013). Liguanea Island has been identified as a white shark aggregation area, with migration between there and the well-known aggregation at the Neptune Islands (Robbins et al. 2015).

3.6 Marine mammals

Liguanea Island supports breeding populations of Australian sea lion and long-nosed fur seal, and a number of cetaceans have been recorded in the waters of the TPMP.

3.6.1 Australian sea lion

The Australian sea lion (ASL) *Neophoca cinerea* is currently listed as Vulnerable under the South Australian *National Parks and Wildlife Act 1972* (NPW Act 1972) and Endangered under the EPBC Act 1999. It is endemic to Australia, with 58 regular breeding colonies and 151 haul-out sites identified in South Australia and Western Australia. The breeding sites are generally on offshore islands, and have an average pup production of 40 pups, with only five sites producing more than 100 pups per breeding season and most sites producing fewer than 30 pups (DEE 2018). Thirteen distinct ASL metapopulations or regions have been identified based on geographic distance analysis among colonies as a proxy for genetic differences (Pitcher 2018).

The ASL is late-maturing (about 6 years) and makes a high investment of maternal care into relatively few pups. Pupping occurs over 4–5 months (Goldsworthy 2020) with an interval between pupping seasons of 17–18 months (the only pinniped to have a non-annual breeding cycle), with breeding occurring at any time of year and occurring at different times in different breeding colonies. Females breed only at the sites at which they were born (DEE 2018). Females nurse their pups until 1–3 months before giving birth again, or up to three years if they don't pup or new pup dies (DEE 2018). The breeding window for females opens about one week after giving birth, and lasts for about one day[2] (Higgins 1990). Males tend to stay within their territories prior to this breeding window and fight for and defend their access to females (Higgins 1990, DEE 2018).

ASL forage the seafloor of the continental shelf for a variety of prey including fish, sharks, cephalopods, lobster and penguins. Juveniles, adult females and adult males have been recorded foraging 118 km, 190 km and 340 km from their colony, respectively, but behaviour varies both within and between-colonies. Adult females alternate between foraging trips to sea and nursing

[2] Various references have erroneously cited Higgins 1990, stating that the breeding window is for seven days from pup birth.

onshore. Pups explore adult foraging habitat at least eight months prior to weaning. ASL forage at all times of day and dive continuously while at sea, although individual dives rarely exceed eight minutes in duration (DEE 2018).

On Liguanea Island, estimated pup counts were 30 in 1990[3] (Gales et al. 1994), 43 in 2004 (Shaughnessy et al. 2005), 25 in 2015 (Goldsworthy et al. 2015) and 27 in 2019 (Goldsworthy 2020). Liguanea Island is the fifth-largest of 11 breeding colonies within the 'Spencer Gulf' metapopulation, representing about 3.3% of that metapopulation and about 0.9% of total pup production (Goldsworthy 2020). ASL breed mainly on the southern peninsula of the island, although pups have been seen on the east coast, and haul-out around the entire coastline, as well as on top of the island (Professor S. Goldsworthy, SARDI, 31 August 2020). A total population for the island can be estimated from pup numbers using a multiplier of approximately four (Goldsworthy et al. 2015), i.e. 165 and 100 ASLs in 2004 and 2015, respectively.

Cape Wiles is a known haul-out site for long nosed fur seal (see Section 3.6.2). Hamer et al. (2013) found that foraging by ASL north of the island was at the western side of Whalers Way rather than near Cape Wiles. Nevertheless, it is possible that ASL use Cape Wiles as a haul-out site.

The decline in pup numbers between 2004 and 2015 reflects a statewide decline which has been partly attributed to bycatch in a gillnet fishery. Bycatch mitigation and management measures were put in place 10–12 years ago, and the decline of pup numbers has been arrested, particularly on the western coastline of Eyre Peninsula (Goldsworthy et al. 2022).

3.6.2 Long nosed fur seal

The Long nosed fur seal (LNFS) *Arctocephalus forsteri* is not listed as threatened under the South Australian NPW Act 1972 or the EPBC Act 1999, but is listed as 'Marine' under the latter act. Fur seal populations in southern Australia were heavily exploited by colonial sealers in the early 1800s, resulting in major reductions in range and abundance, but are now recovering exponentially, assisted by protection of breeding habitat (Shaughnessy et al. 2014).

LNFS breeds in New Zealand and its subantarctic islands, and southern Australia from New South Wales to Western Australia, mostly (83%) from 29 breeding sites in South Australia, of which 97% are from colonies between Kangaroo Island and the southern tip of Eyre Peninsula (Shaughnessy et al. 2014).

LNFS breeds annually from late November to mid-January, generally over a month (Goldsworthy & Shaughnessy 1994). Most females breed for the first time at age five years (range 4–8 years), and males hold territories for the first time at nine years (McKenzie et al. 2007).

Adult females forage over the continental shelf during the early breeding season (December-March), after which they increasingly forage in oceanic waters. Adult males mainly forage over the shelf and slope waters, although they sometimes forage in oceanic waters. Sub-adult males favour the shelf in winter (Goldsworthy et al. 2019).

[3] Note that Robinson et al. (1996) cite Gales et al. (1994), reporting 23 pups and 30 adults, whereas these numbers correspond to number of pups recorded and the estimated number of pups. Robinson et al. (1996) also refer to counts of 16 pups and 96 adults in 1990, but the primary source of this information is not specified. Standardised (comparable) surveys of ASL did not occur at Liguanea Island until 2004 (Goldsworthy 2020).

The number of LNFS pups on Liguanea Island in February 2014 was estimated at 1832, across four sub-colonies separated by three distinctive features: two chasms and a group of white rocks (Shaughnessy et al. 2014, Figure 4). The total for Liguanea Island represented 9% of the LNFS pup production in South Australia. A total population for the island of 8720 can be estimated from pup numbers using a multiplier of 4.76 (Shaughnessy et al. 2015).

Although not formally documented (DEW 2021c, Goldsworthy & Page 2009, Shaughnessy et al. 2014), Cape Wiles is known as a haul-out site for LNFS (McFarlane 2016). There is also anecdotal evidence that LNFS haul out near Red Banks, west of the WWOLC.

Although the overall population of LNFS has increased in South Australia, the populations of some colonies, including Liguanea Island, appear to have stabilized (Shaughnessy et al. 2014).

Figure 4. Landmarks on Liguanea Island separating four sub-colonies

3.6.3 Southern right whale

The southern right whale (SRW) *Eubalaena australis* is currently listed as Vulnerable under the South Australian *National Parks and Wildlife Act 1972* (NPW Act 1972) and Endangered (and Migratory) under the EPBC Act 1999. It is distributed in the southern hemisphere within latitudes of 20–60°, occupying breeding and calving areas in nearshore continental waters during late April to early November, and offshore feeding areas over the warmer months.

Southern right whales are thought to live for at least 50 years, Females mature at 5–6 years and generally have one calf every three years, with a gestation period thought to be about 12 months. Most SRWs return to breed at their birthing location (DAWE 2022).

Within South Australia, recognised aggregation areas for breeding and calving include Head of Bight, visited by up to 40% of the Australian population of SRW (Burnell 2001), Fowlers Bay and Encounter Bay. Sleaford Bay has been identified as a site where small, but increasing, numbers of mostly non-calving SRW regularly aggregate briefly (DSEWPaC 2012), but sightings in recent years suggest that it may be increasingly used by calving females.

There are SA Museum records of SRW from (ALA 2022):

- Whalers Way, on six occasions during 1983–2002, of up to 8 individuals within 500 m (several within 30 m) of the shoreline
- Fishery Bay, for nine of the years during 1984–2010
- Sleaford Bay, for 12 of the years during 1984–2010

There have also been sightings in Sleaford Bay reported through the South Australian Whale Centre sightings database (SAWC 2022), mostly from 1997 and recent years, including reports of up to three cow/calf pairs during 2018–2021 (at least one of which was reported in multiple years).

3.6.4 Other cetaceans

There are a number of ALA records of other whale species in the TPMP:

- blue whale *Balaenoptera musculus*, a pair 9 km south-east of the WWOLC in February 2007
- humpback whale *Megaptera novaeangliae*, from autumn 2001 (individual) and 2003 (pair), in both cases 20 km south-east of the WWOLC
- killer whale *Orcinus orca*, undated record 8 km south-west of the WWOLC
- southern bottle-nosed whale *Hyperoodon planifrons,* from February 1994, 1.5 km south of the WWOLC.

There is a single ALA record of 200 dolphins from 10 km south of the WWOLC in December 2003. However, an aerial survey was used to estimate dolphin populations in central South Australia, including the shelf waters offshore from Eyre Peninsula (Figure 5). The estimated population size (95% confidence interval) of short-beaked common dolphin *Delphinus delphis* from this area was 2,800–10,600 in summer and 13,000–20,000 in winter (Moller et al. 2012). Densities have not been calculated for this study, but a similar study in the eastern Great Australian Bight (just north-west of the Moller study) had estimates of 20,000 – 22,000 individuals at a density of 0.67 – 0.73 dolphins/km^2 (Goldsworthy et al. 2017).

The estimated population size of bottlenose dolphin *Tursiops* sp. was 7–228 (95% confidence interval) in summer and zero in winter (Bilgmann et al. 2019).

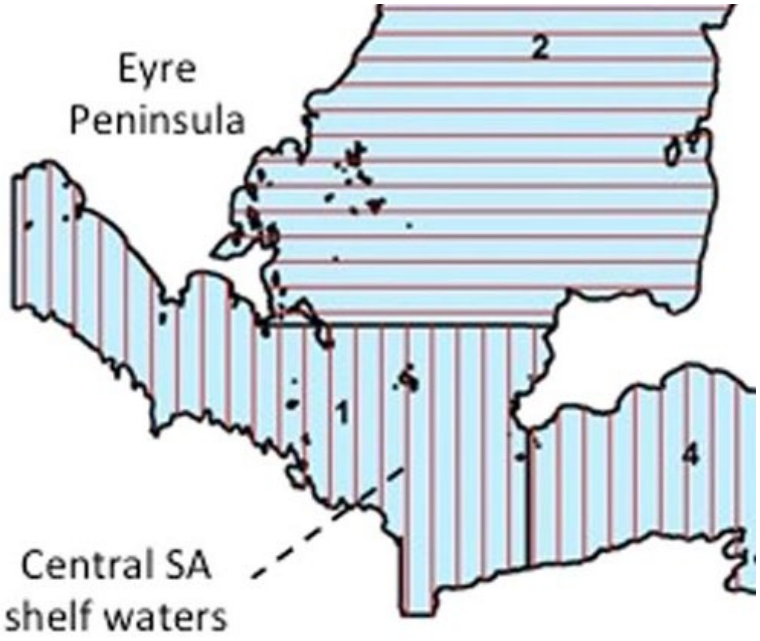

Figure 5. Dolphin aerial survey areas. Source: Bilgmann et al. 2019.

3.7 Seabirds

Liguanea Island supports breeding populations of short-tailed shearwater and crested tern, both migratory species. A number of other seabirds have been recorded on Liguanea Island elsewhere in the TPMP.

3.7.1 Short-tailed shearwater

The short-tailed shearwater (STS) or mutton bird *Ardenna tenuirostris* is currently listed as Migratory under the EPBC Act 1999. The STS breeds in summer on Tasmania and off the coast of southern Australia, migrating to north of Japan for winter in May before returning in October, travelling in dense flocks (Copley 1996, Einoder 2009, Robinson et al. 1996). There are more than 10 million breeding pairs in southern Australia (Skira 1991), including one million in South Australia (Copley 1996) across at least 33 colonies (Robinson et al. 1996), including 14 in the TPMP (Bryars et al. 2016). STS live up to 20 years and begin breeding at about 7 years of age. The male and female have a high interannual fidelity to each other and their previous burrows (which are dug to up 2 m in length), and both participate in incubation of their single egg during a breeding period that is highly synchronised through the range of the species, occurring in late November (McLeay 2014). Fledglings leave the colony in late April, with an estimated mortality rate of at least 50% (Copley 1996).

STS adopt a range of foraging strategies, with short trips on the continental shelf up to 100 km from their colony, often to specific areas, and longer trips of about 1000–7000 km (for up to 32 days), including to subantarctic and Antarctic waters (Einoder 2009).

The breeding colony on Liguanea Island spans 45 ha, which is about a quarter of the island's area (Figure 6). The total number of burrows has been estimated at 10,665 (corresponding to a population of 20,330), based on an average burrow density of a number of other South Australian colonies that have been surveyed (Robinson et al. 1996).

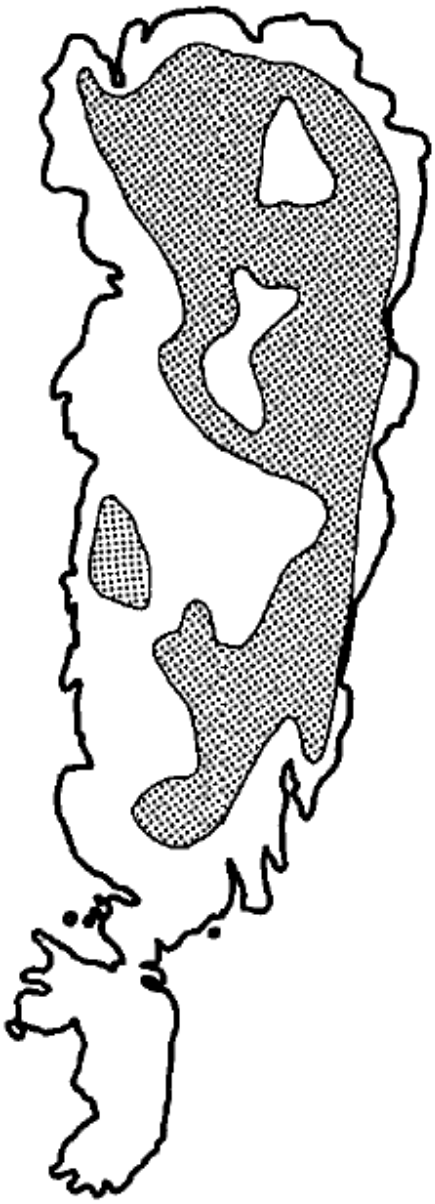

Figure 6. Distribution of breeding colonies of short-tailed Shearwater *Ardenna tenuirostris* on Liguanea Island. Source: Robinson et al. 1996.

3.7.2 Crested Tern

The Crested Tern *Thalasseus bergii* is listed as Migratory under the EPBC Act 1999. There is a breeding population of 'many thousand' birds on Liguanea Island (Goldsworthy & Page 2010), of an estimated South Australian population of 13,000–25,000 (Copley 1996). Breeding in South Australia typically occurs in October (McLeay et al. 2017).

3.7.3 Other seabirds

For most seabird species in the Great Australian Bight, there are few data on species distributions, and little or no quantitative data on their abundances (Goldsworthy et al. 2017). Available information includes:

- Cape Barren Goose *Cereopsis novaehollandiae* (Rare under the NPW Act 1972) breeds on Liguanea Island during winter (Robinson et al. 1996).
- Silver Gull *Chroicocephalus novaehollandiae* and Pacific Gull *Larus pacificus* are common along the coast of Liguanea Island, and Sooty Oystercatcher *Haematopus fuliginosus* (Rare under the NPW Act 1972) and White-faced Heron *Egretta novaehollandiae* also use the intertidal rocks, particularly on the east coast (Robinson et al. 1996).
- Other seabirds with ALA records from Liguanea Island include Fairy Tern *Sternula nereis* (Endangered under the NPW Act 1972 and Vulnerable under the EPBC Act 1999), Little Penguin *Eudyptula minor* and Pied Cormorant *Phalacrocorax varius*.
- Assessment of the Southern Osprey *Pandion haliaetus* and White-bellied Sea Eagle *Haliaeetus leucogaster*, both of which are listed as Endangered under the NPW Act 1972, and the former listed as Migratory under the EPBC Act 1999, has been undertaken by AECOM (2022a).

4 Ecological values of the Southern Ocean

Seabed assemblages of southern Australia have been mapped by examining changes in demersal species composition along environmental gradients. Two assemblages have been identified within the PMIZ, which correspond geographically to the continental shelf and continental slope (Figure 7). The remainder of the PMIZ is over the abyssal plain.

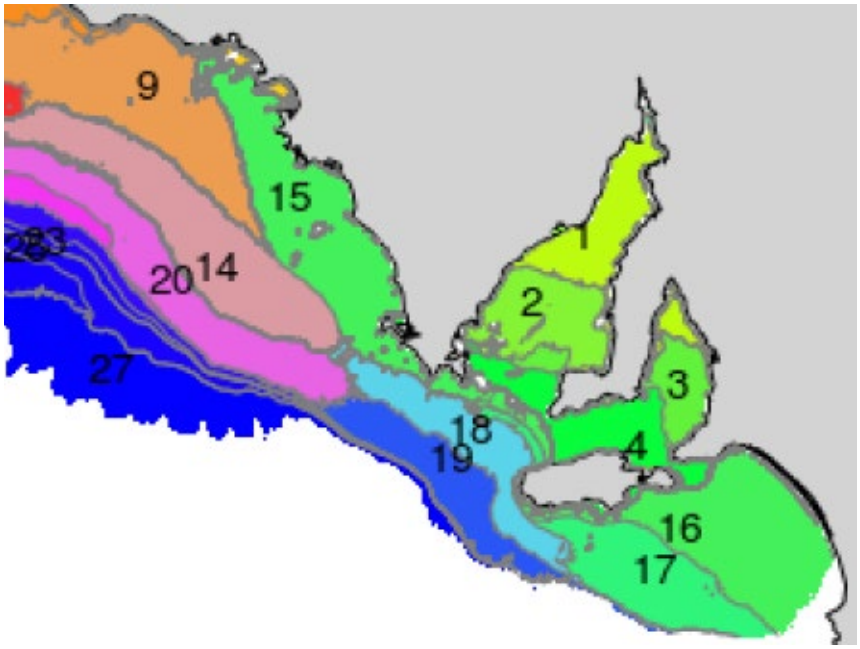

Figure 7. Map of offshore assemblage patterns in southern Australia. Source: Pitcher et al. 2018.

Commonwealth Marine Parks overlapping the PMIZ include (Figure 8):

- South-west Marine Parks Network (Director of National Parks 2018):
  - Great Australian Bight Marine Park
  - Western Eyre Marine Park
  - Western Kangaroo Island Marine Park
  - Southern Kangaroo Island Marine Park
- South-east Marine Parks Network (Director of National Parks 2013):
  - Murray Marine Reserve

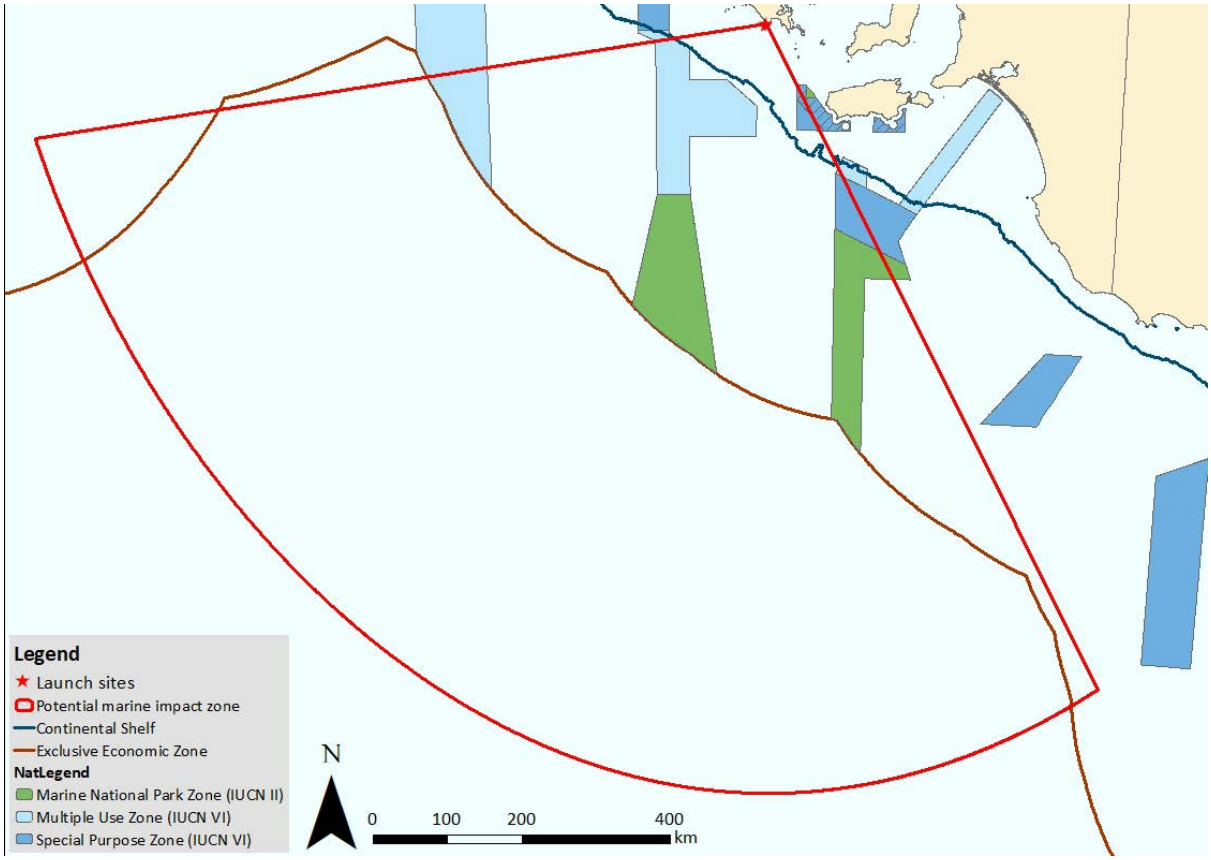

Figure 8. Commonwealth Marine Parks. Source: DAWE (2018).

A number of megafauna and bird species recorded in or considered possible to occur within the PMIZ, including those listed in Section 3, are provided in Table 2. A number of sources have been used to identify these species, including:

- Atlas of Living Australia (ALA) records, which include records from the South Australian Museum, other museums, BirdData and credible citizen science databases including iNaturalist, from particular studies (e.g. IFAW & MCRL 2013), and a seabird atlas (Reid et al. 2002).
- EPBC Act 1999 Protected Matters Search Tool (PMST) (DAWE 2021a)
- The Great Australian Bight Research Program (Baghurst undated)
- *South-west Marine Region: Ecosystems and Key Species* report (McClatchie et al. 2006).

Table 2. Summary of megafauna and bird species that may be present within the PMIZ

Notes: EPBC = *Environment Protection and Biodiversity Conservation Act 1999*; MNES = Matters of National Environmental Significance; SA Status = status under the South Australian *National Parks and Wildlife Act 1972*; PMST = Protected Matters Search Tool. Information about distribution sourced from Atlas of Living Australia (ALA) database or Australian Government's Species Profile and Threats (SPRAT) database (DAWE 2021b) unless otherwise indicated.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Sharks					
Carcharodon carcharias	White shark	Vulnerable, Migratory		Foraging, feeding, or related behaviour known to occur within area	Wide ranging species, with most frequent observations around seal breeding colonies. One ALA record from 500 km south of the WWOLC.
Lamna nasus	Porbeagle, Mackerel shark	Migratory		Species or species habitat likely to occur within area	Oceanic range with occasional temporary visits to coastal waters. No ALA records within search area.
Rhincodon typus	Whale shark	Vulnerable, Migratory		Species or species habitat may occur within area	Occurs in 124 countries. In Australia, it is most commonly seen in waters off northern Western Australia, Northern Territory and Queensland, and only occasionally in South Australia. No ALA records within search area.
Isurus oxyrinchus	Shortfin mako	Migratory		Species or species habitat likely to occur within area	Worldwide in tropical and warm-temperate oceanic waters in depths to at least 500 m, mostly in water temperatures above 16°C. Recorded in Australia from all states except the Northern Territory - usually in offshore waters (Bray 2021a). Individual sharks are wide ranging across southern Australia (Rogers et al. 2016). There are 13 ALA records (from fisheries data) from along the edge of the continental shelf during 2000–2002 and an additional record from the edge of the shelf in 2015.

Scientific name	**Common name**	**MNES Category**	**SA Status**	**PMST results**	**Knowledge of distribution with respect to the search area**
Marine turtles					
Caretta caretta	Loggerhead turtle	Endangered, Migratory	Endangered	Species or species habitat likely to occur within area	Key breeding and foraging habitats are in tropical Australia. No ALA records within search area.
Chelonia mydas	Green turtle	Vulnerable, Migratory	Vulnerable	Species or species habitat known to occur within area	Key breeding and foraging habitat is in tropical Australia. No ALA records within search area.
Dermochelys coriacea	Leatherback turtle	Endangered, Migratory	Vulnerable	Species or species habitat known to occur within area	Pelagic feeder with no known breeding habitat in Australia. No ALA records within search area.
Lepidochelys olivacea	Olive Ridley turtle	Endangered, Migratory		Not reported	Normally inhabits northern Australia. One ALA record from 650 km south-east of the WWOLC.
Marine mammals					
Arctocephalus gazella	Antarctic fur seal	N/A (Listed Marine)		Not reported	Widely distributed in Antarctic waters, breeding and hauling out on numerous islands (FAO 2021). One ALA record (Australian Antarctic Data Centre) from 950 km south of the WWOLC in January 1982.
Balaenoptera bonaerensis	Antarctic minke whale	Migratory	Rare (as *Balaenoptera acutorostrata*)	Species or species habitat likely to occur within area	Found near Antarctica throughout summer. Recorded from all Australian states but not Northern Territory. No ALA records of this species but there are two ALA records of the northern Minke whale *B. acutorostrata* from about 90 km south-west of the WWOLC from aerial surveys in December 2003 and March 1979, which are likely to be *B. bonaerensis.*
Balaenoptera borealis	Sei whale	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Migrate from Antarctic feedings areas to breeding areas in tropical waters, and are infrequently recorded in Australian waters. No ALA records within study area.
Balaenoptera edeni	Bryde's Whale	Migratory		Species or species habitat may occur within area	Wide ranging across temperate and tropical Australia, with no specific breeding or feeding habitats known in Australia. No ALA records within study area.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Balaenoptera musculus	Blue Whale	Endangered, Migratory	Endangered	Foraging, feeding or related behaviour known to occur within area	Migrate between polar and tropical waters and have a number of aggregations worldwide, but are globally rare. Nearest blue whale aggregation area is Robe in south-eastern South Australia. Outside aggregation areas coast is used only for migration and opportunistic feeding. There are 244 records (including about 100 of the subspecies *B. musculus brevicaudata*) in the search area from aerial surveys in December 2003, associated with seismic surveys, extending in a north-westerly/south-easterly direction, 70–100 km offshore from the WWOLC (Morrice et al. 2004). There are a further 11 sightings from an aerial survey in December 2005.
Balaenoptera physalus	Fin whale	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Migrate between polar and tropical waters. Most Australian records are from strandings in temperate waters. There are records for South Australia but no ALA records within the search area.
Caperea marginata	Pygmy Right Whale	Migratory	Rare	Species or species habitat likely to occur within area	Wide ranging across temperate Australia, with some concentration at the entrance to the South Australian gulfs. No ALA records within the search area.
Delphinus delphis	Short beaked common dolphin	N/A (Cetacean)		Species or species habitat may occur within area	Recorded in offshore waters off all Australian states and territories (although rarely in northern Australian waters). Seventeen ALA records from a survey 70 km south of the WWOLC in April 2011. See Section 3.6.3 for details of the population on continental shelf south of the WWOLC.
Eubalaena australis	Southern Right Whale	Endangered, Migratory	Vulnerable	Breeding known to occur within area	The areas of most importance for calving are at Head of Bight, Fowlers Bay and Encounter Bay, all outside the PMIZ. Sleaford Bay has been identified as a site where small, but increasing, numbers of mostly non-calving SRW regularly aggregate briefly, but sightings in recent years suggest that it may be increasingly used by calving females (see Section 3.6.3). Further offshore there are three SA Museum records from May 1993, May 2005 and August 2005 at distances of 45, 90 and 107 km south of the WWOLC, respectively, and two SA Museum records from June 1995 and October 1996 from 360 and 480 km south-south-west of the WWOLC, respectively.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Globicephala melas	Long-finned pilot whale	N/A (Cetacean)		Not reported	Found throughout southern hemisphere. Widely recorded in waters off southern Australia. Two SA Museum records from March 1995 and 1998 at 150 km south-west and 930 km south-east of the WWOLC. Note that there are an additional 14 records of undistinguished pilot whales (same genus) from December to May, during 1979–2009, within an area 180 km south to 550 km west of the WWOLC.
Hyperoodon planifrons	Southern bottlenose whale	N/A (Cetacean)		Not reported	Found in mid- to high latitudes around southern hemisphere, including offshore areas of southern Australia. Five ALA records (SA Museum or Australian Antarctic Data Centre) from February 1996 and 1980, from 160–190 km south or 100–120 km south-west of the WWOLC.
Lagenorhynchus obscurus	Dusky Dolphin	Migratory		Species or species habitat likely to occur within area	Occur throughout southern hemisphere, but considered uncommon in Australia with only 13 reports since 1828, including two in the early 1980s, all in temperate waters. No ALA records within the search area.
Lissodelphis peronii	Southern right whale dolphin	N/A (Cetacean)		Not reported	Found in mid- to high latitudes around southern hemisphere, including southern continental Australia. One SA Museum record from August 1998 from 350 km south-east of the WWOLC.
Megaptera novaeangliae	Humpback Whale	Migratory	Vulnerable	Species or species habitat likely to occur within area	Global distribution is fragmented. In Australia, migration occurs between Antarctic feeding grounds and calving areas in northern Western Australia and Queensland. Five ALA records from 1990–2006 during January to June, 20–230 km south-west to south-south-east from the WWOLC, including two records within the TPMP.
Neophoca cinerea	Australian Sea Lion	Endangered	Vulnerable	Species or species habitat known to occur within area	Temperate water species ranging from western Victoria to Western Australia. Nearest breeding area is Liguanea Island (see Section 3.6.1). There are more than 800 ALA records from sea lions tracked foraging on the continental shelf.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Orcinus orca	Killer whale	Migratory		Species or species habitat likely to occur within area	Occur in all oceans, including all Australian states (possibly in fragmented populations), with concentrations in Tasmania and frequent sightings in South Australia and Victoria. There are 46 ALA records along the edge of the continental shelf, mainly from a 2010–2016 study of interactions of the species with a longline fishery (Tixier et al. 2018), and an additional five SA Museum records from 1985–1992 from further offshore or inshore, including one 3 km west of Liguanea Island.
Physeter macrocephalus	Sperm whale	Migratory	Rare	Foraging, feeding or related behaviour known to occur within area	Occurs in deep waters in all oceans including all Australian states (possibly in fragmented populations), with concentrations near the continental shelf edge, including south-west of Kangaroo Island. There are 37 ALA records within the search area (SA Museum or Australian Antarctic Data Centre, many associated with aerial surveys for tuna spotting or near seismic activity) from 1979–2013, between December and July, beyond but within 50 km of the continental shelf.
Marine birds					
Ardenna carneipes	Flesh-footed shearwater	Migratory	Rare	Foraging, feeding or related behaviour likely to occur within area	A trans-equatorial migrant, and a locally common visitor to waters of the continental shelf and continental slope off southern Australia. There are 35 records from 100–1000 km, south-west to south-east of the WWOLC.
Ardenna grisea	Sooty shearwater	Migratory		Species or species habitat may occur within area	Breeds in southern hemisphere in summer, including islands off New South Wales and Tasmania and is a moderately common migrant and visitor to South Australia. During winter most birds move to the North Pacific Ocean. Seven ALA records from 400–1000 km south-west to south of the WWOLC.
Ardenna tenuirostris	Short-tailed shearwater	Migratory		Not reported	Breeds in summer on Tasmania and off the coast of southern Australia, migrating to north of Japan for winter. There are 62 ALA records from 100–1000 km south-west to south-east of the WWOLC, and two near Liguanea Island. The estimated breeding population on Liguanea Island is greater than 10,000 (see Section 3.7.1).
Cereopsis novaehollandiae	Cape Barren Goose	N/A (Listed Marine)	Rare	Not reported	Resident in south-eastern Australia (to Eyre Peninsula) and south-western Australia. Nearest important areas are Kangaroo Island and the Sir Joseph Banks Group in Spencer Gulf (BirdLife Australia 2021a). One ALA record from Liguanea Island and one other from 100 km south-east of the WWOLC.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Chroicocephalus novaehollandiae	Silver Gull	N/A (Listed Marine)		Not reported	Common throughout Australia and is also found in New Zealand and New Caledonia. Found at virtually any watered habitat but seldom venture far out to sea (Birdlife Australia 2021b). One ALA record from 30 km south-west of the WWOLC
Diomedea antipodensis	Antipodean albatross	Vulnerable, Migratory		Foraging, feeding or related behaviour likely to occur within area	Endemic to, and breeds in, New Zealand but forages widely in the Southern Ocean. No ALA records within search area.
Diomedea dabbenena	Tristan albatross	Endangered, Migratory		Species or species habitat likely to occur within area	Occurs in a single population which breeds on Atlantic Ocean islands and disperses to Africa, South America and south-western Australia during non-breeding periods. No ALA records within search area.
Diomedea epomophora	Southern royal albatross	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Moderately common in offshore areas of southern Australia (Iron Road 2014). Eleven ALA records from more than 500 km offshore in a south-westerly to south-easterly direction.
Diomedea exulans	Wandering Albatross	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Breeds on Macquarie Island and feeds in Southern Ocean. There are 87 ALA records south to west from Kangaroo Island.
Diomedea sanfordi	Northern Royal Albatross	Endangered, Migratory	Endangered	Foraging, feeding or related behaviour likely to occur within area	Breeds in New Zealand. Ranges widely over the Southern Ocean, feeding regularly in Tasmanian and South Australian waters. Five ALA records from 100 or 700 km south of Kangaroo Island.
Egretta novaehollandiae	White-faced Heron	N/A		Not reported	Found wherever there is water throughout the mainland and Tasmania, and most coastal islands (Australian Museum 2021a). One ALA record from 700 km south-east of the WWOLC.
Eudyptula minor	Little penguin	N/A (Listed Marine)		Not reported	Distributed in coastal waters around the southern mainland and Tasmania (Australian Museum 2021b). One ALA record from Liguanea Island.
Haematopus fuliginosus	Sooty oystercatcher		Rare	Not reported	Resident around the Australian coastline, with nearest important area at Coffin Bay (BirdLife Australia 2021c). Two ALA records from Cape Carnot and one from Liguanea Island.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Haliaeetus leucogaster	White-bellied sea eagle	N/A (Listed Marine)	Endangered	Not reported	Refer AECOM (2022a).
Halobaena caerulea	Blue Petrel	Vulnerable		Species or species habitat may occur within area	Breeds in sub-Antarctic territory, with some records from south-eastern Australia. Eleven ALA records from at least 300km south to south-west from Kangaroo Island.
Hydroprogne caspia	Caspian Tern	Migratory		Foraging, feeding or related behaviour known to occur within area	Global distribution. Migratory species but has widespread resident populations in Australia. One ALA record from 30 km west of Kangaroo Island.
Larus pacificus	Pacific gull	N/A (Listed Marine)		Foraging, feeding or related behaviour known to occur within area	Endemic to southern Australia. Prefers areas that are protected from ocean swells (BirdLife Australia 2020d). One ALA record from 30 km west of Kangaroo Island.
Macronectes giganteus	Southern Giant Petrel, Southern-Giant Petrel	Endangered, Migratory	Vulnerable	Species or species habitat likely to occur within area	Widespread throughout the Southern Ocean and breed on six subantarctic and Antarctic islands in Australian territory. Ten ALA records from at least 300 km south of Kangaroo Island.
Macronectes halli	Northern Giant Petrel	Vulnerable, Migratory		Species or species habitat may occur within area	Breeds on sub-Antarctic islands. Visits south-eastern Australia, with nearest record being from western Eyre Peninsula in 2003. There are 14 ALA records 150–750 km from Kangaroo Island in a westerly to south-easterly direction.
Pachyptila belcheri	Slender-billed Prion	N/A (Listed Marine)		Not reported	Southern hemisphere distribution, breeding on the southern Indian Ocean islands (BirdLife International 2021a). Eight ALA records at least 300 km south of Kangaroo Island.
Pachyptila turtur subantarctica	Fairy Prion (southern)	Vulnerable		Species or species habitat may occur within area	Breeds on subantarctic islands but wide-ranging along southern Australian coastline. There are 29 ALA records 150–1000 km from Kangaroo Island in a westerly to south-easterly direction.
Pandion cristatus (listed as *P. haliaetus*)	Southern Osprey	Migratory	Endangered	Species or species habitat may occur within area	Refer AECOM (2022a).

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Phalacrocorax fuscescens	Black-faced Cormorant	N/A (Listed Marine)		Species or species habitat likely to occur within area	Found along southern Australian coasts, common in Bass Strait and in Spencer Gulf, South Australia (BirdLife Australia 2021e). One ALA record from about 30 km south-west of the WWOLC.
Phalacrocorax varius	Pied Cormorant	N/A		Not reported	Found throughout mainland Australia but most common to the south and along the south-western coastline (BirdLife Australia 2021f). No ALA records within study area.
Phoebetria fusca	Sooty Albatross	Vulnerable, Migratory	Endangered	Species or species habitat likely to occur within area	Breeds on islands in the southern Indian and Atlantic Oceans, sometimes observed foraging on southern Australian coasts. There are 33 ALA records from 300–1000 km south-west to south-east of the WWOLC.
Phoebetria palpebrata	Light-mantled Sooty Albatross	Migratory	Vulnerable	Not reported	Widespread circumpolar distribution. Breeds on Antarctic and subantarctic islands and occurs over southern Australian waters. There are 25 ALA records (Birdata and Museum New Zealand), mostly from 450–950 m south of the WWOLC.
Pterodroma leucoptera leucoptera	Gould's Petrel	Endangered		Species or species habitat may occur within area	Breeds on islands in New South Wales, uses south-eastern Australian waters and there have been records from further west. Four ALA records from 250–650 km south of the WWOLC.
Pterodroma macroptera	Great-winged Petrel	N/A (Listed Marine)		Foraging, feeding or related behaviour known to occur within area	There are 86 ALA (including 62 Bird Life records) from 100–1000 km south-west to south-east of the WWOLC.
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable		Foraging, feeding or related behaviour likely to occur within area	Breeds on southern Tasmanian islands. Inhabits sub-Antarctic oceanic areas and visits southern Australian seas, mainly to the west. Three ALA records within 550–600 km south-west to south-east of the WWOLC.
Stercorarius skua	*Great skua*	N/A (Listed Marine)		Species or species habitat may occur within area	No ALA records in search area.
Sternula nereis nereis	Australian Fairy Tern	Vulnerable	Endangered	Foraging, feeding or related behaviour likely to occur within area	Widespread through temperate Australian coasts. One ALA record from Liguanea Island.

Scientific name	Common name	MNES Category	SA Status	PMST results	Knowledge of distribution with respect to the search area
Thalassarche bulleri	Buller's Albatross	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	A New Zealand resident but are regular visitors to Australian waters between New South Wales and South Australia. One ALA record from 300 km south of the WWOLC.
Thalassarche bulleri platei	Northern Buller's albatross	Vulnerable	Vulnerable (as *Diomedia bulleri*)	Foraging, feeding or related behaviour likely to occur within area	Breeds in New Zealand. Most birds seem to disperse outside Australasian seas during the non-breeding season. Some birds forage near the eastern Australian mainland. No ALA records in search area.
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable, Migratory	Endangered	Foraging, feeding or related behaviour may occur within area	Breeds in South Africa and on French Antarctic islands. Forages mostly in the southern Indian Ocean including Western Australia Thirteen ALA records from 100–600 km south-west to south-east of the WWOLC.
Thalassarche cauta	Shy Albatross	Endangered, Migratory	Vulnerable (as *Thalassarche cauta cauta*)	Foraging, feeding or related behaviour likely to occur within area	Breeds in Tasmania, but uses southern Australian coastline. Thirty ALA records from 80–1000 km south-west to south-east of the WWOLC.
Thalassarche chlororhynchos	Atlantic yellow-nosed albatross	Migratory	Endangered	Not reported	Resident of the South Atlantic Ocean (BirdLife International 2021b). There are 35 ALA records (mainly BirdLife Australia) from 100–300 km south-west of the WWOLC.
Thalassarche chrysostoma	Grey-headed albatross	Endangered, Migratory	Vulnerable	Species of species habitat may occur within area	Circum-global southern hemisphere distribution, breeding on subantarctic islands including Macquarie Island. Most Australian records from Tasmania. There are 83 ALA records from 200–1000 km south-west to south-east from the WWOLC.
Thalassarche impavida	Campbell Albatross	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Does not breed in Australia but forages in south-eastern Australian waters, and may visit southern Australian shelf waters. Five ALA records from 150–650 km south to south-east of the WWOLC.
Thalassarche melanophris	Black-browed Albatross	Vulnerable, Migratory		Foraging, feeding or related behaviour likely to occur within area	Breeds on subantarctic islands but is distributed throughout Southern Ocean. There are 122 ALA records from 70–1000 km south-west to south-east from the WWOLC.

Scientific name	**Common name**	**MNES Category**	**SA Status**	**PMST results**	**Knowledge of distribution with respect to the search area**
Thalassarche salvini	Salvin's Albatross	Vulnerable, Migratory	Vulnerable	Foraging, feeding or related behaviour likely to occur within area	Breeds in New Zealand and the southern Indian Ocean. Forages over most of the southern Pacific Ocean, including Australia. One ALA record from 300 km south of the WWOLC.
Thalassarche steadi	White-capped Albatross	Vulnerable, Migratory		Foraging, feeding or related behaviour likely to occur within area	Breeds in New Zealand but considered common across southern Australia. There are 75 ALA records mainly from 200–350 km south-west of the WWOLC.
Thalasseus bergii	Crested Tern	Migratory		Not reported	Breed on islands and coastlines of Africa, Asia, Australia and western Pacific Ocean in spring and summer, dispersing to sea at other times. One ALA record from near Red Banks within the WWOLC, one from Liguanea Island and 18 records from 80–330 km south-west to south-east of the WWOLC.
Shorebirds					
Actitis hypoleucos	Common Sandpiper	Migratory		Species or species habitat may occur within area	Breeds in Europe and Asia. Areas of national importance for the species are primarily in the north of Australia. Known to use coastal habitats, including sandy beaches and rocks. No ALA records within search area.
Calidris acuminata	Sharp-tailed Sandpiper	Migratory		Species or species habitat may occur within area	Range includes large areas of the Australian coastline and inland areas. No ALA records within search area.
Calidris canutus	Red knot	Endangered, Migratory	Endangered (as *Calidris canutus rogersi*)	Species or species habitat may occur within area	Range includes large areas of the Australian coastline. No ALA records within search area.
Calidris ferruginea	Curlew sandpiper	Critically Endangered, Migratory	Endangered	Species or species habitat may occur within area	Range includes large areas of the Australian coastline and inland areas. No ALA records within search area.
Calidris melanotos	Pectoral sandpiper	Migratory	Rare	Species or species habitat may occur within area	Broad distribution across Australia but in South Australia is generally found to the east of Spencer Gulf. No ALA records within search area.

Scientific name	**Common name**	**MNES Category**	**SA Status**	**PMST results**	**Knowledge of distribution with respect to the search area**
Numenius madagascariensis	Eastern curlew	Critically Endangered, Migratory	Endangered	Species or species habitat may occur within area	Range includes large areas of the Australian coastline and inland areas. No ALA records within search area.

5 Impact Assessment

5.1 Introduction

The following impacts on the marine environment within the TPMP and the broader PMIZ are assessed:

- Operational impacts:
  - Debris collision with fauna on land or the sea surface (Section 5.2)
  - Other debris impacts, including ingestion by marine fauna, crushing or smothering of biota, emission of toxic contaminants and provision of habitat (Section 5.3).
  - Noise, including acoustic trauma and behavioural impacts (Section 5.4)
- Construction noise

Details of the various rocket stages and their expected return to earth are provided in Table 3 for sub–orbital vehicles and Table 4 for orbital vehicles. Whilst the dimensions and weights of launch vehicles vary from vehicle to vehicle they can generally be classified according to their payload capacity, namely micro (< 150 kg), mini (150–500 kg) and small (500–2000[4] kg). It is expected that only two of 36 rockets launched annually would be of the small class, with more than half being near the lower end, i.e. an order of magnitude smaller, and the rest being about a third of the payload size range.

The operational impacts listed above include all those considered during a generic ecological risk assessment of debris jettisoned during successful launches in New Zealand of *Electron* space vehicles of similar scale to the 'mini' class proposed for the WWOLC (NIWA 2017). All of the issues assessed by NIWA (2017) were classified as low risk, having varying degrees of likelihood but negligible or minor consequences. Minor consequence was defined as measurable but localised change with 1–5% impact on populations and recovery within weeks. NIWA (2017) considered that the risk profile of the issues assessed may change after multiple launches if there were significant spatial overlap of their debris fields. The impacts associated with rocket launches were not considered to make a significant difference to the overall cumulative impact of other stressors including commercial fishing and climate change (NIWA 2017).

Table 3. Size of suborbital vehicles proposed for launch from the WWOLC. Note that dry mass = without fuel, wet mass = with fuel (whether solid or liquid), n/a = not applicable. Source: compiled from information provided by Southern Launch.

Attribute	Entire vehicle	Stage 1	Stage 2
Length (m)	2.8–8	2–6	0.08–2
Diameter (m)		0.3–0.8	0.05–0.7
Dry mass (kg)	5–480	3–400	2–80
Wet mass (kg)	22–2800	20–2600	2–200
Payload mass (kg)	<1–50		
Return to earth range (km)	n/a	3–8	40–150

[4] Note that the largest payload proposed for WWOLC is 1500 kg (Table 4).

Table 4. Size of orbital vehicles proposed for launch from the WWOLC. Note that dry mass = without fuel, wet mass = with fuel (whether solid or liquid), n/a = not applicable. Source: compiled from information provided by Southern Launch.

Attribute	Entire vehicle	Stage 1	Stage 2	Stage 3	Stage 4	Fairing
Length (m)	12.5–34	8–20	3–6	1.5–6	0–2	5–10
Diameter (m)		0.8–3.5	0.6–3	0.5–2.8	0–2.5	
Dry mass (kg)	1400–13,200	800–8000	400–3000	200–1200	0–1000	50
Wet mass (kg)	9700–120,000	8000–60,000	1200–35,000	500–25,000	0–12,000	n/a
Payload mass (kg)	<50–1500					
Return to earth range (km)		500–900	>900	>900	>900	600–1000

5.2 Collision of debris with fauna

Several scenarios could result in fauna being struck by high speed projectiles associated with a rocket launch (Appendix 1):

- Nominal success: orbit achieved with slight variations in trajectory – some stages fall to earth at distances of 3–8 and 40–150 km for suborbital rockets (Table 3) and >500 km for orbital rockets (Table 4), respectively.
- Failure – air burst: a launch vehicle explodes while in the air. This results in the launch vehicle breaking up into a number of pieces and landing over a large area. This can be the result of a manual detonation of a rocket (using a flight termination system) that is not behaving as expected.
- Failure – ground burst: launch vehicles motors fail shortly after lift-off. The flight termination system fails and the vehicle remains whole as it falls to the ground/water and explodes on impact.

Debris, functioning as a high speed projectile, would not have any significant impact on marine life below the surface because of rapid attenuation of its kinetic energy on entering seawater. Other impacts associated with debris underwater are discussed in Section 5.3.

5.2.1 Liguanea Island

Rockets launched from either launch station with Polar and Sun Synchronous trajectories are the most likely to pass close enough to Liguanea Island to present a risk of debris falling onto the island (Figure 9). Although any point on the island could be considered a sensitive receiver with the possible presence of seabirds or pinnipeds, there are a number of focal areas (all abundances and areas are estimates):

- 165 ASL occupying 15 ha on the southern peninsula of the island
- 9,500 LNFS occupying 20 ha along the east coast of the island
- 10,665 STS burrows occupying 45 ha inland on the island

Flight safety risk analysis using processes set out by the Federal Aviation Authority and Flight Safety Code has been undertaken using established frameworks for estimating the probability of human casualties, applied to seals (Appendix 1). The probabilities are expressed as the average number of

launches expected between seal casualties for scenarios for each of the micro, mini and small size classes.

The modelling is conservative in many respects, including:

- an assumption that the modelled number of seals are all on land, when many would be foraging at sea, particularly outside of the breeding season.
- the use of near worst-case (99.5th percentile) of debris interactions with Liguanea Island, rather than mean, to calculate expected casualties
- an assumption that all debris striking with energy greater than 15 joules would be fatal.

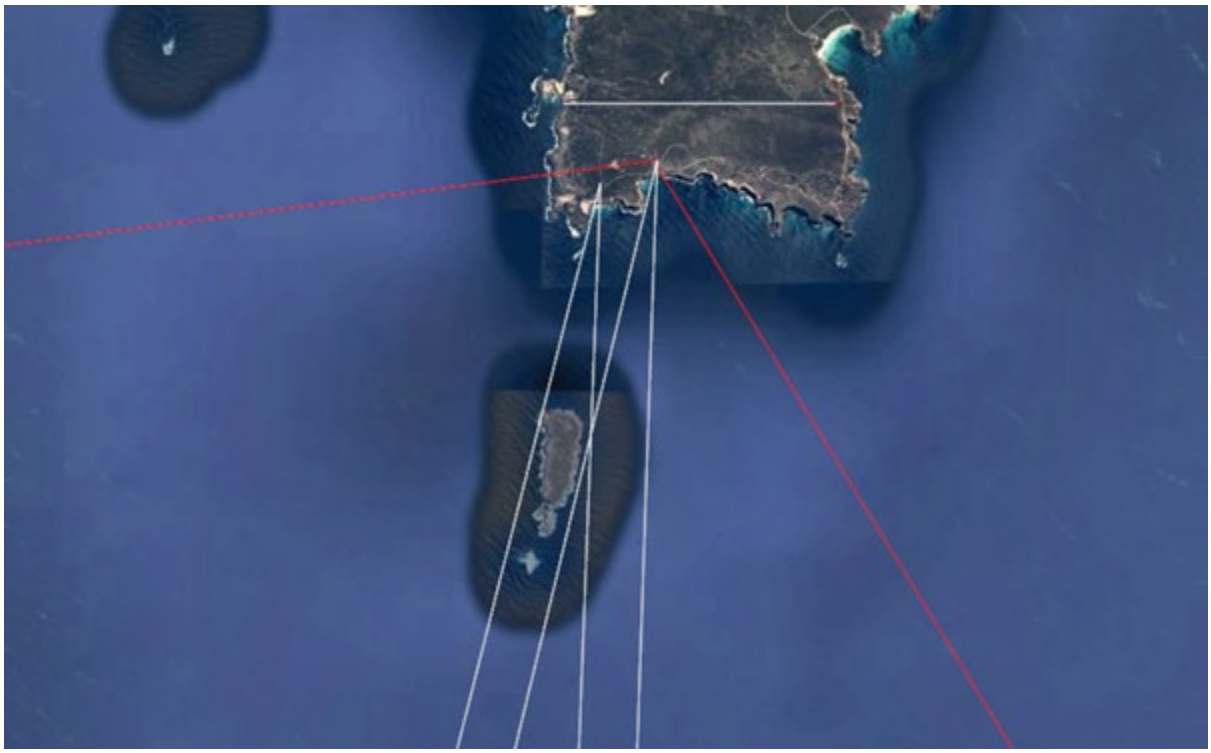

Figure 9. Range of possible bearings for sun synchronous and polar trajectories from each launch site. Source: Southern Launch (see Appendix 1).

Successful launches

No impacts on Liguanea Island are expected from debris arising from successful launches, because the first stage of orbital rockets would not fall to earth within 500 km (Table 4).

A booster from a suborbital rocket is typically 2–3 m long, with a diameter of 400 mm. It is expected to fall to earth within 3–8 km from the launch pad (Table 3). For a polar or sun synchronous orbit over the Liguanea Island, the entire island would be within that range; the northern tip of the island is about 5.4 km from both launch sites A and B, and the length of the island is 2.7 km. However, no impacts are expected from suborbital rockets as they would not be launched with a polar, sun synchronous or any other trajectory that could result in debris falling on Liguanea Island.

Air burst

An air burst would result in a scatter of debris over an area that would increase with distance from the launch. For a debris fragment to collide with fauna on Liguanea Island, it would require not only failure of the rocket, but at such a precise time as would result in fallout over the island, and one or more of the few fragments falling on the island to coincide with the sparsely distributed fauna.

The risk analysis modelling predicted that an air burst would have an average frequency of LNFS and ASL casualties of one every 3375 and 194,470 launches, respectively, for small rockets. For mini or micro rockets, expected to collectively account for 95% of launches (Appendix 1), the frequency would be 30 or 100 times lower, respectively (Table 5). The low number of casualties per air burst for both species suggests that there would be no impact at subpopulation level for either species.

Table 5. Probabilities of seal casualties from air burst events. Source: Southern Launch (Appendix 1)

Vehicle	1 Accident per [X] Launches	LNFS		ASL	
		Casualties per air burst	1 Casualty Per [X] Launches	Casualties per air burst	1 Casualties Per [X] Launches
Small	11,764	3.48	3375	0.0604	194,470
Mini	7407	0.07	105,814	0.0012	6,170,000
Micro	7407	0.02	370,350	0.0004	18,510,000

Ground burst

Rockets can be installed with a flight termination system (FTS) that allows the rocket to be detonated in mid-air in the event of unexpected and undesirable behaviour. Explosion of a rocket on Liguanea Island would require failure of the FTS, in addition to other factors such as launch failure at the precise time that resulted in a collision with Liguanea Island.

The risk analysis modelling predicted that a ground burst would occur about every 4.7 million launches for a small rocket and every 3 million launches for mini or micro rockets, with an average frequency of LNFS and ASL casualties of one every 7700 and 445,000 launches, respectively, for small rockets and almost twice as many launches for mini or micro rockets (Table 6).

Despite the very low frequency of ground bursts on Liguanea Island, the higher number of casualties relative to air bursts warrants further assessment of the potential impact at subpopulation level of a single accident.

For ASL, population viability analysis undertaken by Goldsworthy et al. (2007), in the context of fisheries bycatch, found that 2 additional mortalities of immature females would be required annually to drive an already declining subpopulation of similar size of Liguanea Island (i.e. with 27 pups) to extinction over 34 years, i.e. the removal of 68 immature females (Goldsworthy et al. 2007). Predicted ground burst mortalities from a single incident are about 11 from the largest class of launch vehicles, or 3–4 from smaller vehicles (Table 6). A comparison of the ground-burst and fisheries bycatch scenarios is problematic because of the differing timeframes of the removals and because the ground burst may affect all ages and both sexes, which may have a different overall

effect than removing only immature females. Nevertheless, the data suggest that a ground burst would have a minor to moderate impact on pup production but there would be no long-term subpopulation level impact. More certainty could be gained from further population viability analysis specifically targeting mortality rates predicted for ground bursts.

For LNFS, population viability analysis found that more than 1,000 additional mortalities of immature females would be required annually to drive the Liguanea Island subpopulation to extinction over 32 years, i.e. the removal of 32,000 immature females (Goldsworthy et al. 2007). Predicted ground burst mortalities from a single incident are 613 from the largest class of launch vehicles, or about 200 from smaller vehicles (Table 6). This suggests that there would be no subpopulation level impact on LNFS.

Table 6. Probabilities of seal casualties from ground burst events. Source: Southern Launch (Appendix 1)

Vehicle	1 Accident per [X] Launches	LNFS		ASL	
		Casualties per ground burst	1 Casualty per [X] Launches	Casualties per ground burst	1 Casualty per [X] Launches
Small	4,716,981	613	7,694	10.6	444,998
Mini	2,914,176	226	12,894	3.9	747,224
Micro	2,914,176	199	14,644	3.4	857,110

Conclusion

Debris from successful launches would not impact on Liguanea Island fauna. An air burst over Liguanea Island would be a very rare event that could result in mortalities but there would be negligible impact at subpopulation level. Ground bursts on Liguanea Island would be a rarer event than an air burst but could impact more individuals. Although this may result in reductions in ASL pup production, no long-term impact is expected at subpopulation level.

5.2.2 Southern Ocean

High speed strikes by debris on marine biota below the sea surface are not expected because of rapid attenuation of the kinetic energy of the debris on entering seawater. Impacts of debris settling onto the benthic environment are discussed in Section 5.3.

The probability of an animal (including birds) being struck by debris decreases with downstream distance and lateral distance from the trajectory. Figure 10 shows debris impact probability isopleths for a particular launch scenario (Perigee rocket, sun synchronous trajectory). Inside each isopleth the probability of debris striking a particular location is greater than the value of the isopleth. For the scenario shown, a given location beyond the continental shelf would have less than one in a million chance of debris falling on it.

For the TPMP, there would be no impact from successful orbital launches because the stages would all return to earth more than 500 km offshore (Table 4), but for successful suborbital rockets the spent first stage (3–400 kg mass) may fall into the TPMP (away from Liguanea Island), at least 3 km offshore (Table 3).

An ecological risk assessment of direct strikes of rocket debris on air breathing fauna in New Zealand found that the likelihood of individuals being killed by a direct strike was remote and consequences at the population and community scale were negligible, resulting in a low risk classification (NIWA 2017).

Marine fauna likely to occur at least some time on or above the surface with records from within the PMIZ are discussed in Section 4. These records do not represent a systematic survey of marine fauna across the PMIZ but are opportunistic sightings, related to particular studies, e.g. fishery bycatch or seismic surveys. They provide little information about the density of each species or whether debris from polar, sun synchronous or any other orbit would be more or less likely to encounter marine fauna.

More spatially structured data are available for cetaceans in the outer shelf and upper slope region (50–100 km south of the WWOLC) from an aerial survey associated with the Great Australian Bight Research Program (Gill 2016). Dolphins and pilot whales were the most commonly sighted (including a pod of 500 bottlenose dolphins), but there were insufficient sightings of any species in that study to calculate densities. However, the density of common dolphin *Delphinus delphis* was calculated to be 0.67–0.73 dolphins/km^2 in a region immediately to the north-west (Bilgmann et al. 2014), and this can be adopted as a conservative upper bound for all cetaceans.

Noting that the surveys by Gill (2016) were in summer and autumn, further consideration is given to southern right whales during their migration to and from the calving areas at Head of Bight and Fowlers Bay that they inhabit between May and October. Southern right whales within the PMIZ are likely to be from the south-western Australian population, which extends eastwards from WA at least as far as Encounter Bay (Carroll et al. 2011, Evans et al. 2021)[5]. The south western population of southern right whales is increasing at a rate of about 6 per cent, close to its biologically plausible maximum (Bannister 2018, Charlton 2017, Carroll et al. 2011).

The exact path of whales between summer offshore and winter coastal habitat is not well understood, but they travel west along the southern coastline during winter (Burnell 2001). Sleaford Bay, just east of the WWOLC, has been identified as a brief aggregation area for whales on their way to calving areas at Head of Bight and Fowlers Bay (DSEWPaC 2012).

Maximum counts of SRW were 172 from shore and aerial surveys at Head of Bight (Charlton 2017, Charlton et al. 2014a), and 55 from aerial surveys at Fowlers Bay (Charlton et al. 2014b), i.e. 227 in total, and 206 from a simultaneous aerial survey at both sites (Mackay & Goldsworthy 2015). Not all of these would pass through the PMIZ.

Theoretical and simulation models developed by BMT WBM (2018) found that 260 SRWs migrating through the Great Australian Bight, generally as individuals (DSEWPaC 2012), would collide about once every 300 years with vessels passing at 15 knots every two weeks during the whale migration season. The probability of colliding with falling debris at particular instants would be much less likely.

It is concluded that there may be occasional debris strike impacts on individual animals on the sea surface but no impact at population level.

[5] DSEWPaC (2012), which cites Carroll (2011), refers to Ceduna, South Australia as the boundary between the south-western and south-eastern Australian populations but this is considered to be an error.

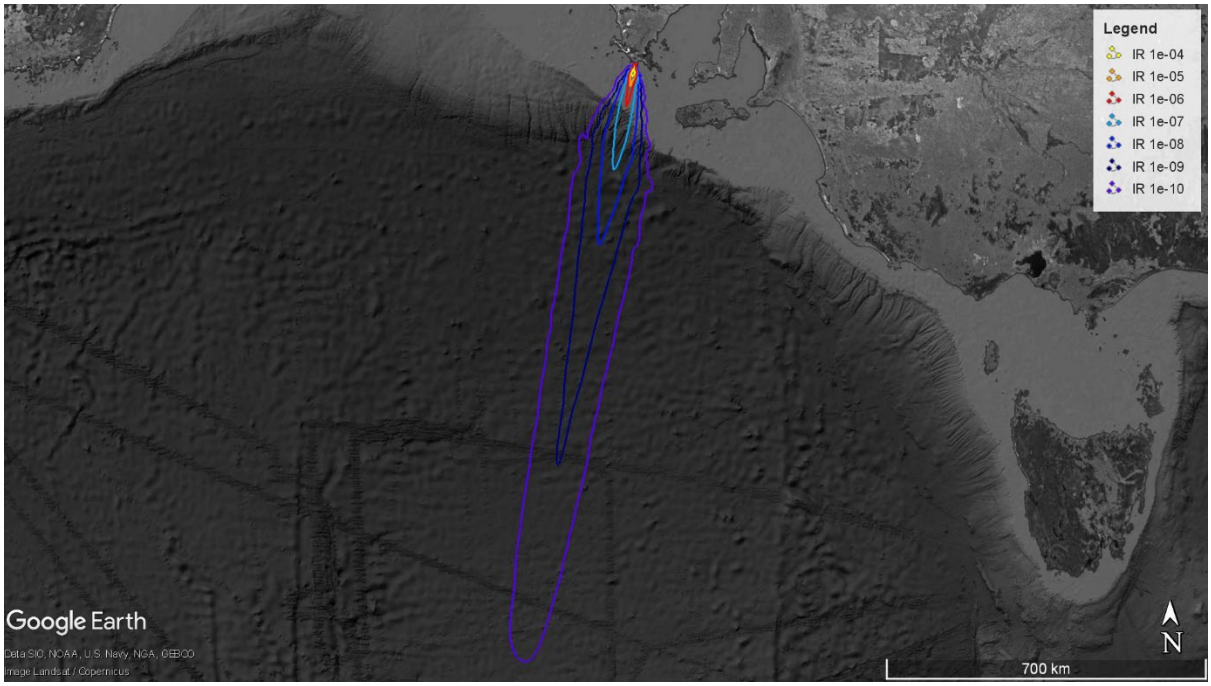

Figure 10. Isopleths showing probability of impact from falling debris associated with a particular rocket launch scenario (Perigree rocket, sun synchronous trajectory). Source: Southern Launch.

5.3 Other debris impacts

The impacts of debris following contact with the sea surface depend on the nature of the rocket components of which the debris is comprised. Southern Launch has provided details of these components (refer Section 22 of the Draft EIS). Key points include:

- all component materials are inert and harmless to the marine environment except lithium (within batteries) and copper (within electrical wiring)
- Fuels would be expended before contact with the sea floor, or would burn, remain inert (rubber-based solid fuel) or vaporise (liquid fuels)
- Most materials would sink, except rubber-based solid fuels (and liquid fuels prior to vaporisation) and some small pressure vessels which have not been punctured
- Casings that have not already broken up during re-entry would generally shatter into thousands of pieces on impact with sea surface, with the possible exception of some thick carbon fibre components.

5.3.1 Toxic contaminants

Copper fragments would sink to the seafloor where their slow dissolution may have long-term local effects on sediment infauna, or be dispersed from areas of hard substrate, adding a very low total mass of copper relative to natural oceanic copper quantities (NIWA 2017).

Lithium ion batteries (about the size of two car batteries in volume) would likely rupture on impact with the sea surface or at depth. Lithium is already elevated in seawater and is not toxic, but would react with seawater and in sufficient quantity could cause alkaline conditions with localised, short-term toxic effects (NIWA 2017).

5.3.2 Crushing or smothering of benthic organisms

Sessile organisms may be impacted by larger items of debris or accumulations of fragments settling on the seafloor, but the descent of such debris is expected to be slow enough for mobile fauna to avoid (NIWA 2017). Fragile biota may be damaged or destroyed, and feeding or respiration may be inhibited. However, the area impacted would be insignificant in comparison to the extent of the receiving environment and population level impact would be negligible.

5.3.3 Ingestion of debris

The breakup of rocket debris during re-entry or on impact with the sea surface would create particles small enough to be ingested by most biota, but will likely sink fast enough to avoid air-breathing fauna. Although ingestion may impact some individuals, population level impact would be negligible.

5.3.4 Habitat changes

The settlement of larger fragments of debris on soft sediment would result in a shift to benthic communities requiring hard surfaces. Floating debris may provide shelter for pelagic organisms and substrate for attachment and dispersion of sessile organisms. In the context of the size of the receiving environment, such changes are considered to have negligible impact at population level.

5.4 Operational noise

Noise from launches would temporarily alter the quiet setting of the natural environment for one to two minutes during launches. The assessment of operational noise impacts on marine fauna in the sections below relies on comparisons of noise modelling predictions against published fauna impact criteria, as well as experience from launch sites elsewhere in the world.

Rocket launch noise levels surrounding the WWOLC were predicted using the RUMBLE 3.0 computer modelling package, used and approved in the United States for predicting noise from rocket launches, including vehicles launched by SpaceX (AECOM 2022b, Resonate 2022).

Rockets modelled included the Vega, New Shepard and Electron. The Vega represents an upper bound vehicle in terms of the noise generated, the New Shephard represents the 95th percentile, i.e. only 5% or about 2 launches per year from the WWOLC would be for vehicles larger (and hence louder) than this, and the Electron represents the 30th percentile. For each rocket the noise levels presented in this assessment represent the worst case from Sites A and B.

Sound transmission from air into water is limited, with most noise reflected off the sea surface unless the angle of incidence is less than 13° from the vertical. For a typical, near-vertical rocket trajectory, this would mean that the rocket would be at about 2 km altitude before significant noise were able to transmit into the marine environment. The noise level from a Vega rocket is predicted to be 20 dB lower due to transmission loss over that distance, and would likely be even lower because rocket thrust would be reduced at that altitude. A further transmission loss of about 42 dB across the air/sea boundary is predicted (Resonate 2022). It must be noted that sound levels in water (and associated criteria) are expressed using a different reference system to sound in air, with values approximately 62 dB higher (Resonate 2022). Coincidentally, this is the same as the total transmission loss of 62 dB from high altitude to underwater (see above).

Criteria relating to impacts of noise on the hearing or behaviour of relevant fauna groups have been collated by Resonate (2022). They are expressed using various noise metrics, all measured in decibels (dB), including:

- Maximum root mean square (RMS) value, also known as L_{max}
- Cumulative sound exposure level (SEL), also known as $L_{EA,}$ representing the sound level of a constant sound that would generate the same acoustical energy in one second as the actual time-varying noise event

Furthermore, these values reflect the combination of noise levels at a range of frequencies, which can be weighted to reflect the hearing sensitivity of different animal groups. For example, 'A-weighted' values reflect the frequency range of human hearing. Weightings (collectively known as 'M-weightings') have also been developed for a number of marine mammal groups, including whales, dolphins, phocid seals (e.g. leopard seal) and eared seals (including ASL and LNFS). In the case of seals, there are weightings for noise both through air and through water (Southall et al 2019, Resonate 2022). For the noise modelling undertaken for the WWOLC, the weightings were applied to a typical rocket noise frequency spectrum to find a constant that could be added to RUMBLE model outputs, which were not available for individual frequencies (AECOM 2022b).

Noise impacts associated with engine testing have not been considered as the noise would be for a shorter duration (15 seconds) and further from the marine environment and at maximum levels of 10–20 dB lower than the launch scenarios (AECOM 2022b).

Noise impacts from sonic booms would be limited to behavioural impacts but are considered unlikely to occur on the coast or on Liguanea Island. Sonic booms would be generated several kilometres offshore during ascent, but are typically directed in front of the rocket and would not be close enough or strong enough, due to the relatively small size of the rockets, to reach the earth's surface (AECOM 2022b).

Noise from debris falling into the ocean has the potential to generate noise though the initial "slap" at the water entry, vibrations of the impacting object, and pulsations of an air cavity created by the impact. In general, high impact energy is required to generate underwater noise levels above typical background noise levels. Rocket debris is likely to have similar impact energy to waves breaking at the coast or on the bow of a ship, and is not expected to generate underwater noise levels above typical background noise levels beyond a distance of a few metres (Resonate 2022). An ecological risk assessment of underwater noise impacts from rocket launches in New Zealand found that the consequences were minor with measurable, localised, short-term effects at a population or community scale negligible for fauna near or on the surface, and negligible for other fauna (NIWA 2017). It is concluded that impacts on marine fauna from noise arising from debris strikes would be infrequent (a maximum of 36 times per year), short-term, minor and localised.

5.4.1 Pinnipeds

Criteria presented by Southall et al. (2019) for noise impacts on eared seals above water suggest that there would be no temporary hearing loss for ASL or LNFS below SEL values of 157 dB (weighted for eared seals). Noise modelling predicted SEL values (also weighted for seals) of less than: 115, 105 and 95 dB on Liguanea Island for the Vega, New Shephard and Electron launch vehicles, respectively; 115, 105 and 100 dB at Cape Wiles for those vehicles, respectively; 120, 110 and 105 dB near Red

Banks; and 130, 120 and 115 dB at the base of the cliffs just south of the launch sites (Figure 11). Therefore the noise generated by rocket launches is not expected to impact on the hearing of seals.

The limited noise propagated underwater from rockets at altitude would also have no impact on pinniped hearing, with the predicted values of underwater noise being significantly less than the thresholds for temporary or permanent hearing loss of 199 dB and 219 dB, respectively (Resonate 2022).

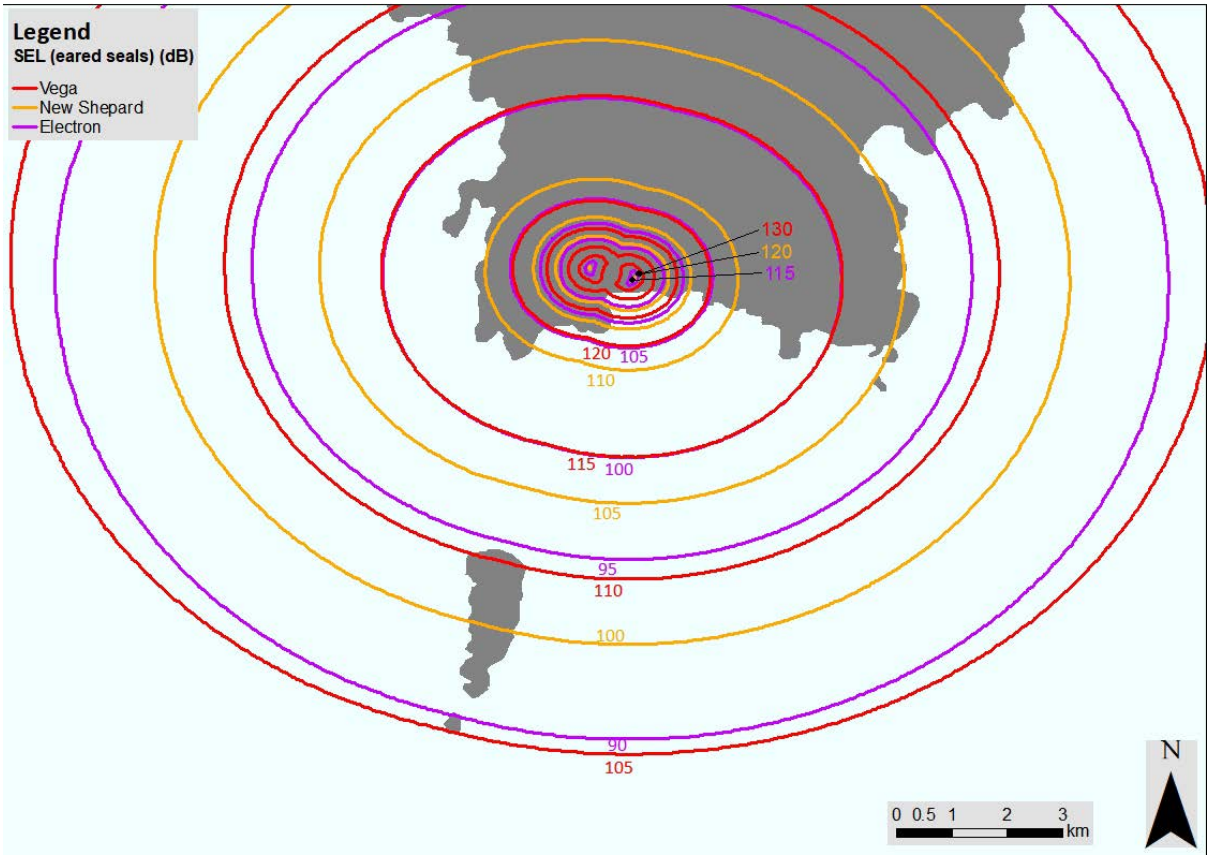

Figure 11.Predicted sound exposure level (adjusted for eared seal hearing) from either Site A or B. Source: Resonate unpublished data.

Impacts on pinniped behaviour are the primary concern with regard to rocket launches (FAA 2016). Wildlife typically exhibit a startle response to sudden loud, uncommon, short-term noise, and pinnipeds may enter the water when frightened and in some circumstances a stampede could cause pups to be trampled or separated from their mothers in the process (Sandegren 1969, Johnson 1979, Pitcher and Calkins 1979, Back et al 2018). Marine mammal reactions to rocket launches are highly variable and may be attributable to the species, age, time of year, air temperature and potential habituation to noise (FAA 2016, Bowles 2000). Animals can be sensitive to sound pressures of a given level one day and not the next (AAC 2017).

It is generally accepted that significant behavioural responses of pinnipeds to noise through air are not expected at L_{max} level below 100 dB, but 90 dB for harbor seal *Phoca vitulina* (USAF 1997, Oliver 2006, Southall et al. 2007, Marzin 2018, Rauch 2019). Therefore some behavioural impacts on

pinnipeds are possible within colonies on Liguanea Island, at least for rockets the size of Vega and New Shepard, with predicted L_{max} values of 105–110 dB and 95–100 dB, respectively (Figure 12). Seals hauled out at Cape Wiles, Red Banks or at the base of cliffs south of the launch sites may also show a response to rocket noise, with L_{max} predictions at the latter location of 130, 125 and 105 dB respectively for the Vega, New Shephard and Electron rockets, respectively (Figure 12). If seals on Liguanea Island were to be sufficiently startled to stampede towards the water, pups are unlikely to be injured by trampling because the narrow habitat does not allow for a sufficiently dense concentration of seals, and after their first month, the pups are quite robust (pers. comm. Professor S. Goldsworthy, SARDI Aquatic Sciences). Approvals have been routinely granted for behavioural impacts on pinnipeds at the Kodiak Launch Complex (KLC) in Alaska and Vandenberg Air Force Base (VAFB) in California (Oliver 2006, Marzin 2018, Rauch 2017, 2019), including movement both on land and into the water, but the latter has occurred only rarely with seals hauling out again within minutes to two hours of each launch (USAF 2018). It should also be noted that harbor seal populations near the VAFB increased at an annual rate of 12.6 per cent over a decade despite 5–7 space vehicle launches per year (Oliver 2006).

Seals are also known to respond to helicopter noise (Bowles 2000, Oliver 2006), which was found to exceed launch noise at Ugak Island in Alaska, near the Kodiak Launch Complex[6] (Oliver 2006). It is noted that helicopters have been used to conduct aerial surveys and/or facilitate ground surveys of ASL on Liguanea Island (Goldsworthy et al. 2015), with no suggestion of adverse impacts.

It is concluded that behavioural impacts on seals on Liguanea Island are possible during the launch of the largest rockets launched from the WWOLC, but are likely to be infrequent and short-term. Seals at haul-out sites on the coastline near the WWOLC may also experience infrequent, short-term impacts from a wider range of rockets.

Noise propagating underwater would be of a similar level to that generated by wind and waves but would exceed the threshold for behavioural impacts on marine mammals (see Section 5.4.2), including seals, within 750 m of the closest shoreline to the launch sites (Resonate 2022). Any behavioural impacts are expected to be localised, infrequent, minor and short-term.

[6] Now known as the Pacific Spaceport Complex Alaska

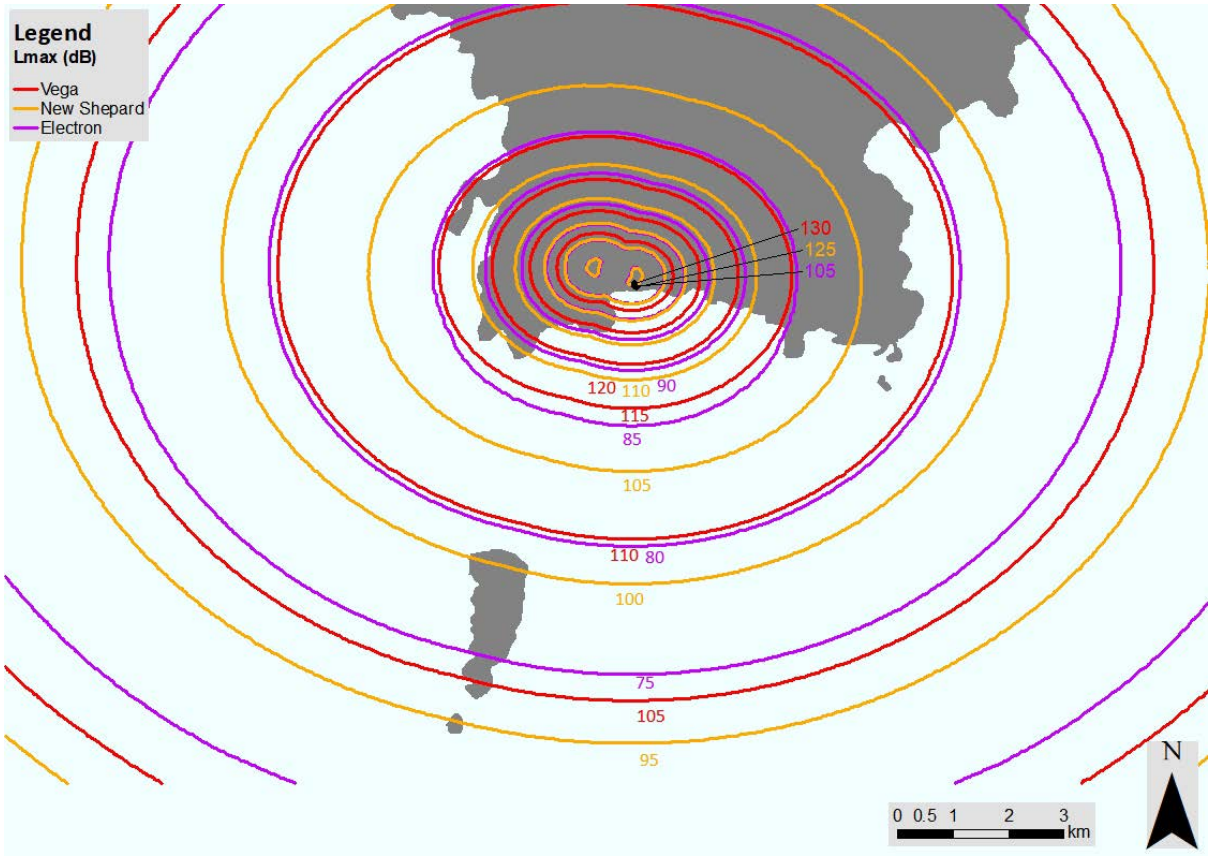

Figure 12. Predicted sound pressure level (root mean square/L_{max}) from either Site A or B. Source: Resonate unpublished data.

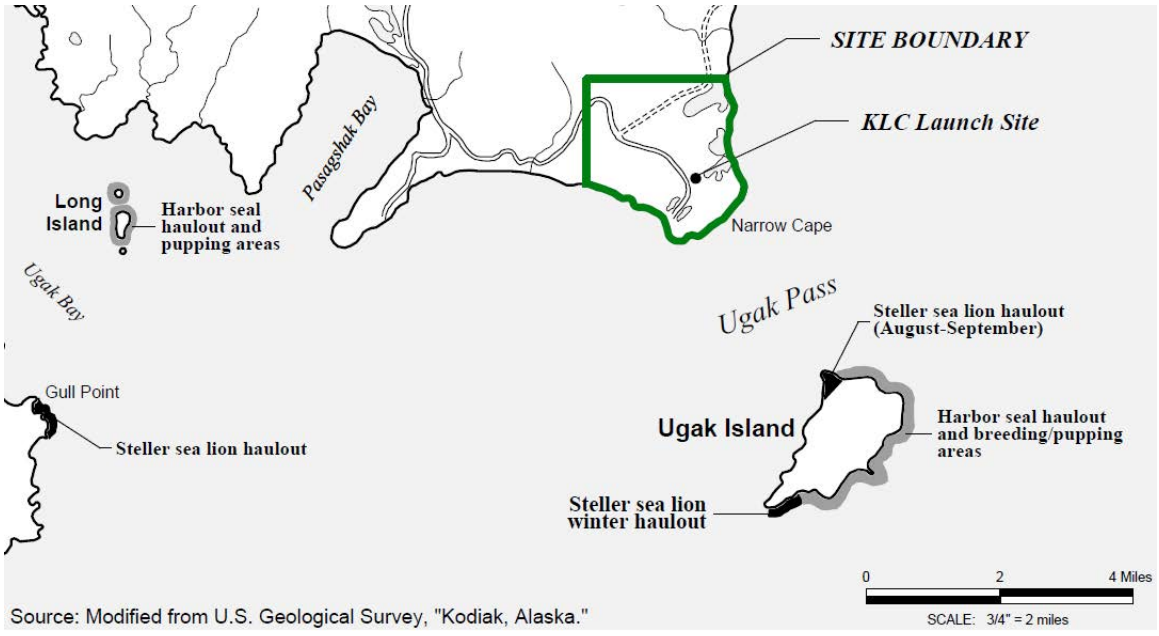

Figure 13. Pinniped colonies near the Kodiak Launch Complex, Alaska. Source: Brown & Root Environmental 1996.

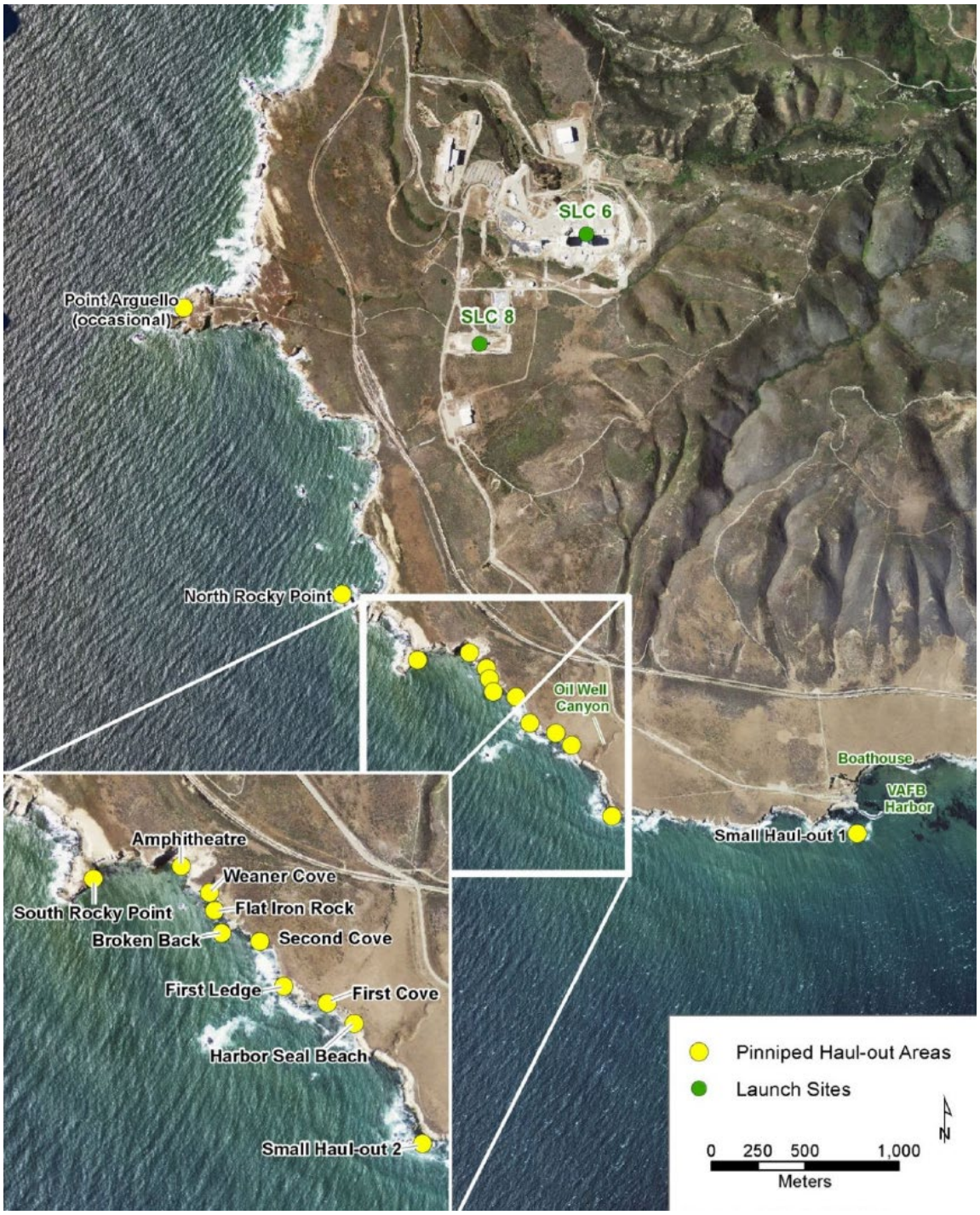

Figure 14. Pinniped haul-out sites near launch sites at the Vandenberg Air Force Base. Source: USAF 2018.

5.4.2 Southern right whale

Whales are more likely to be subjected to noise through water rather than air because their ears remain underwater while on the surface, except for rare occasions when breaching (Resonate 2022).

Underwater sound exposure levels, as heard by whales, are predicted to be less than 135 dB for the Vega rocket. This prediction is conservative because it doesn't take into account reduced thrust from rockets at the altitude required for noise transmission through the water surface, but is nevertheless comfortably below the thresholds for temporary or permanent hearing loss of 179 dB and 199 dB, respectively, for whales in water (Resonate 2022).

Predicted underwater sound pressure levels (L_{max}) may exceed the threshold for behavioural impacts on marine mammals of 120 dB by up to 5 dB for the Vega rocket within 750 m of the closest shoreline to the launch sites, for periods of up to 30 seconds (Resonate 2022). The threshold would not be exceeded by rockets the size of or smaller than a New Shephard (Resonate 2022), which account for 95% of launches proposed for the WWOLC. Behavioural impacts are therefore limited to the largest few rockets, and would be localised, infrequent, minor and short-term. To put such impacts in perspective, ambient underwater noise levels (L_{max}) in a coastal environment can frequently exceed 125 dB due to noise from wind and waves (Resonate 2022).

An assessment of the impact of rocket launch noise on whales near the Kodiak Island in Alaska found that whales would only hear the launch if it flew directly overhead, and it would be unlikely that the noise would be sufficient to affect behaviour or cause injury (FAA 2009).

5.4.3 Birds

Dooling & Popper (2016) found that birds are generally more resistant to hearing loss from noise than humans, and proposed criteria of 140 and 93 dBA[7] for avoiding permanent and temporary hearing loss, respectively. These recommendations were based on studies with continuous noise exposure extending to 72 hours, rather than the two minutes likely to be experienced during a launch. Resonate (2022) calculated equivalent noise levels with a conservative averaging time of 24 hours from the model predictions of A-weighted sound exposure levels.

The equivalent noise levels ($L_{Aeq,24hr}$) on Liguanea Island are predicted to be less than 60 dBA for all rockets modelled (Figure 15), well below the hearing loss thresholds, and therefore no impacts are expected on the hearing of Short-tailed shearwater, Crested Tern, Cape Barren Goose or other seabirds inhabiting Liguanea Island.

There may be behavioural impacts on seabirds on Liguanea Island but these are expected to me minor and short-term in nature. Masking of acoustic signals is not expected to have any significant impact on bird communication due to the infrequency and short duration of the rocket noise.

An assessment of impacts on Fairy Tern *Sternula nereis*, Eastern Osprey *Pandion haliaetus* and White-bellied Sea Eagle *Haliaeetus leucogaster* has been undertaken by AECOM (2022a).

[7] A-weighted (i.e. reflecting human hearing frequency range).

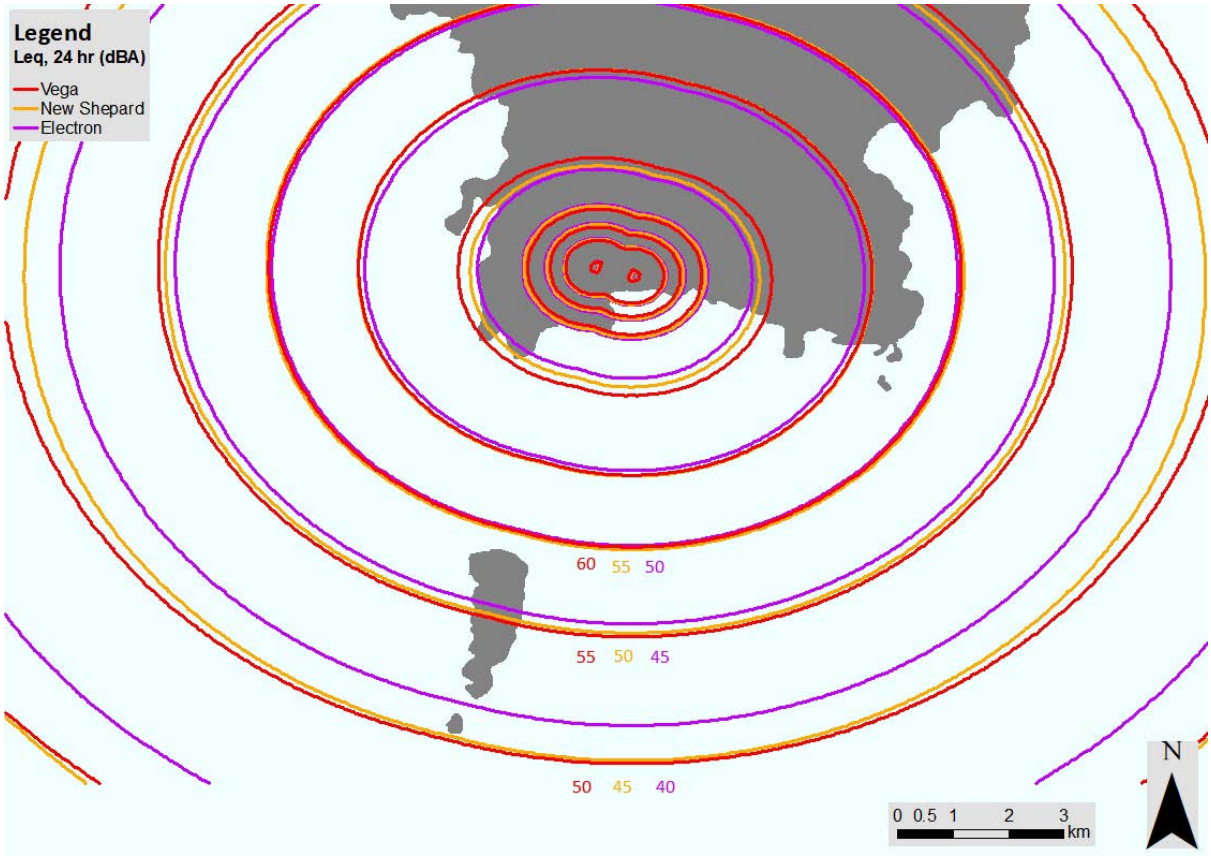

Figure 15. Predicted equivalent noise level (24 hour, A-weighted) contours from either Site A or Site B. Source: Resonate unpublished data.

5.4.4 Other species

Comparisons of the estimated sound propagated underwater against noise impact criteria for sharks, fish and turtles (Resonate 2022) show that there would be no organ damage to these groups as a result of rocket noise. In the absence of quantitative criteria for temporary hearing loss and behaviour change, Resonate (2022) applied the risk assessment approach of Popper et al. (2014), finding a low risk of temporary hearing loss except within tens of metres of the source and a low risk of behavioural impacts except within hundreds of metres of the source (Resonate 2022). Behavioural changes are likely to be a short term result of movement away from the source.

5.5 Construction noise

As close as 25 m from source, sound pressure levels associated with various sources of construction noise are all predicted to be below the thresholds associated with acoustic trauma or behavioural change for birds and marine mammals (AECOM 2022), and underwater species would not be impacted by construction noise (see Section 5.4). Therefore no impacts on marine species are expected from noise associated with construction activities.

5.6 Monitoring, management and mitigation

Monitoring of seal behaviour and noise on Liguanea Island and underwater noise in the nearshore area near the launch sites will be undertaken before, during and after launches on several occasions, including test launches.

Mitigation measures listed by AECOM (2021) to reduce noise impacts on terrestrial species during rocket take-off, e.g. earth bunds and site structures for acoustic screening, may also benefit seals and seabirds on Liguanea Island.

Other mitigation measures specific to marine fauna include:

- avoiding trajectories over Liguanea Island for suborbital launches (Section 5.2.1)
- searches for whale presence, by appropriate methods, within areas of possible impact for launches where there is some risk to whales, with the launch delayed if whales are found in the relevant areas
- using a flight termination system, which would substantially reduce the risk of a ground burst on Liguanea Island
- consideration, for some launches, of avoiding critical periods (e.g. breeding times) for species. Relevant critical periods are provided in Table 7. Note that management of Southern Osprey and White-bellied Sea Eagle have been addressed by AECOM (2021).

A review of risks to the marine environment from debris (once fallen) would be undertaken after the first three years of operation.

Table 7. Critical periods for species potentially impacted by launches.

Month	**Australian sea lion[1]**	**Long-nosed fur seal[2]**	**Southern right whale[3]**	**Short-tailed shearwater[4]**	**Crested tern[5]**	**Cape Barren Goose[6]**
July	Breeding (every third year from 2022)		Migration to calving areas			Breeding
August						
September						
October				Inbound flock	Breeding	
November				Breeding		
December		Breeding (one month)				
January						
February	Breeding (every third year from 2024)					
March						
April						
May			(as above)	Outbound flock		
June						

Sources:

1. Derived from Goldsworthy (2020). Note that times will shift incrementally due to the inter-breeding interval of 17–18 months, which is also subject to variation (DEE 2018).
2. Goldsworthy & Shaughnessy 1994
3. DSEWPaC 2012
4. Copley 1996, Einoder 2009, Robinson et al. 1996, McLeay 2014
5. McLeay et al. 2017
6. Australian Museum 2021c

6 Summary of conclusions

Debris from successful launches would not impact on Liguanea Island fauna (provided that suborbital launches avoid trajectories over the Island). An air burst over Liguanea Island would be a very rare event that could result in mortalities but there would be negligible impact at subpopulation level. Ground bursts on Liguanea Island would be a rarer event than an air burst (provided a flight termination system is used) but could impact more individuals. Although this may result in temporary reductions in ASL pup production, no long-term impact is expected at subpopulation level.

Within the Southern Ocean, including the waters of the Thorny Passage Marine Park surrounding Liguanea Island, there may be occasional debris strike impacts on individual animals on the sea surface but no impact at population level.

Other debris impacts, including ingestion by marine fauna, crushing or smothering of biota, emission of toxic contaminants, noise from debris striking the sea surface and provision of habitat, would be highly localised, the area impacted would be insignificant in comparison to the extent of the receiving environment and population level effects would be negligible.

Launch noise would not impact the hearing of seals on Liguanea Island, or LNFS hauled-out at Cape Wiles, Red Banks or at the base of the cliffs south of the launch sites. Behavioural impacts on seals on Liguanea Island are possible but likely to be short-term. Noise mitigation measures at the launch site may reduce behavioural impacts on species on Liguanea Island, and avoidance of particular periods in the breeding cycles may provide opportunities to further mitigate any potential impacts.

Launch noise, transmitted underwater, would not impact whale hearing, but for some launches may have minor, short-term impacts on the behaviour of whales close to shore. This can be mitigated by pre-launch searches with delay if necessary.

Launch noise would not result in hearing loss or behavioural change for Short-tailed Shearwaters or other birds inhabiting Liguanea Island.

No impacts on marine species are expected from noise associated with construction activities.

The above conclusions are consistent with the findings of a risk assessment undertaken for comparable rocket launches in New Zealand.

7 References

AAC (2017), *Application for a Five-Year Programmatic Permit for Small Takes of Marine Mammals Incidental to Launching of Space Launch Vehicles, Long Range Ballistic Target Missiles, and Smaller Missile Systems at Pacific Spaceport Complex Alaska, Kodiak Island, Alaska.* Alaska Aerospace Corporation.

AECOM (2022a), *Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report*, report prepared for Southern Launch Pty Ltd by AECOM Australia Pty Ltd.

AECOM (2022b), *Whalers Way Orbital Launch Complex Environmental Assessment Report: Noise and Vibration*, report prepared for Southern Launch Pty Ltd by AECOM Australia Pty Ltd.

Australian Museum (2021a), White-faced Heron, Viewed February 2021, https://australian.museum/learn/animals/birds/white-faced-heron/

Australian Museum (2021b), Little Penguin, Viewed February 2021, https://australian.museum/learn/animals/birds/little-penguin/

Australian Museum (2021c), Cape Barren Goose, Viewed February 2021, https://australian.museum/learn/animals/birds/cape-barren-goose/

Back JJ, Hoskins AJ, Kirkwood R, Arnould JPY (2018), Behavioral responses of Australian fur seals to boat approaches at a breeding colony. Nature Conservation 31: 35–52.

Baghurst, B (undated), Seeking whole-of-system understanding: *An integrated study of environmental, economic and social values.* Presentation.

Baker, J.L & Clarkson, P (2014), *Rare and Endemic Mollusc and Specimen Shells in Spencer Gulf*. Chapter 20, Part 3. In - Shepherd, S.A., Madigan, S.M., Gillanders, B.M., Murray-Jones, S. and Wiltshire, D.J. 2014. Natural History of Spencer Gulf. Royal Society of South Australia Inc.

Bannister, J (2018), *Project A7 - Monitoring Population Dynamics of 'Western' Right Whales off Southern Australia 2015-2018: Final Report on Activities for 2017*, National Environmental Science Program, Marine Biodiversity Hub.

Bilgmann, K., Parra, G.J. and Möller, L.M. (2014). Inshore Cetacean Survey between Ceduna and Coffin Bay, eastern Great Australian Bight. Great Australian Bight Research Program, GABRP Research Report Series Number 1, 40pp.

Bilgmann, K., Parra, G. J., Holmes, L., Peters, K. J., Jonsen, I. D. and Möller, L. M. (2019). Abundance estimates and habitat preferences of bottlenose dolphins reveal the importance of two gulfs in South Australia. *Scientific Reports* 9: 8044.

BirdLife Australia (2021a), *Cape Barren Goose*. Viewed February 2021, https://birdlife.org.au/bird-profile/cape-barren-goose.

BirdLife Australia (2021b), *Silver Gull*. Viewed February 2021, https://birdlife.org.au/bird-profile/silver-gull.

BirdLife Australia (2021c), *Sooty Oystercatcher*. Viewed February 2021, https://birdlife.org.au/bird-profile/sooty-oystercatcher.

BirdLife Australia (2021d), *Pacific Gull*. Viewed February 2021, https://birdlife.org.au/bird-profile/pacific-gull.

BirdLife Australia (2021e), *Black-faced Cormorant*. Viewed February 2021, https://birdlife.org.au/bird-profile/black-faced-cormorant.

BirdLife Australia (2021f), *Pied Cormorant*. Viewed February 2021, https://birdlife.org.au/bird-profile/pied-cormorant.

BirdLife International (2021a), Species factsheet: Slender-billed Prion *Pachyptila belcheri*. Viewed February 2021, http://datazone.birdlife.org/species/factsheet /slender-billed-prion-pachyptila-belcheri

BirdLife International (2021b), Species factsheet: Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*. Viewed February 2021, http://datazone.birdlife.org/species/factsheet/atlantic-yellow-nosed-albatross-thalassarche-chlororhynchos

BMT WBM (2018), *Whale strike probability monitoring,* Technical memo for Kangaroo Island Plantation Timbers, Smith Bay Wharf EIS.

Bowles, A.E. 2000. Potential Impacts of USAF atmospheric interceptor technology (*ait*) Launches from the Kodiak Launch Complex, Kodiak Island, Alaska: Monitoring of Noise Levels During the *ait*-2 Launch, 15 September 1999. Final Report Prepared by Hubbs-Sea World Research Institute, San Diego, CA for U.S. Air Force Space and Missile Systems Center. September 5, 2000.

Bray, D.J (2021a). Fishes of Australia. Shortfin Mako, (*Isurus oxyrinchus*), viewed February 2021, https://fishesofaustralia.net.au/home/species/3255#moreinfo.

Brown & Root Environmental (1996), *Environmental Assessment of the Kodiak Launch Complex Kodiak Island, Alaska*, South Carolina, United States of America.

Bryars, S (2003), *An Inventory of Important Coastal Fisheries Habitats in South Australia, Fisheries Habitat Program*, Department of Primary Industries and Resources of South Australia, Adelaide.

Bryars, S., Brook, J., Meakin, C., McSkimming, C., Eglinton, Y., Morcom, R., Wright, A. and Page, B. (2016), *Baseline and predicted changes for the Thorny Passage Marine Park,* DEWNR Technical report 2016/15, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

Burnell, SR (2001), Aspects of the reproductive biology, movements and site fidelity of right whales off Australia, *Journal of Cetacean Research and Management,* vol. *2 (*special issue), pp. 89–102.

Carroll, E, Patenaude, N, Alexander, A, Steel, D, Harcourt, R, Childerhouse, S, Smith, S, Bannister, J, Constantine, R & Baker, C (2011), 'Population structure and individual movement of southern right whales around New Zealand and Australia', *Marine Ecology Progress Series,* vol. 432, pp. 257–268.

Charlton, C, Guggenheimer, S & Burnell, S (2014a), *Long term southern right whale population monitoring at Head of Bight (1991-2013).* Final Report to Commonwealth Government, Australian Antarctic Division, Australian Marine Mammal Centre.

Charlton, C, Guggenheimer, S, Burnell, S & Bannister, J (2014b), *Southern right whale abundance at Fowler Bay and connectivity to adjacent calving ground, Head of Bight, South Australia*. Report to Commonwealth Government, Australian Antarctic Division, Australian Marine Mammal Centre.

Charlton, CM (2017), *Southern Right Whale (*Eubalaena australis*) Population Demographics in Southern Australia*. PhD Thesis, Faculty of Science and Engineering, Centre for Marine Science and Technology, Curtin University, Perth.

Cheshire, A.C., Collings, G.J., Edyvane, K.S. and Westphalen G. (2000), *Overview of the Conservation Status of Australian Marine Macroalgae*. A report to Environment Australia. Department of Environmental Biology, University of Adelaide, July 2000.

Copley, PB (1996), The Status of Seabirds in South Australia, in GJB Ross, K Weaver & JC Greig (eds) *The Status of Australia's Seabirds: Proceedings of the National Seabird Workshop*, Canberra, 1-2 November 1993, pp 139-180. Biodiversity Group, Environment Australia: Canberra.

DAWE (2018), *Australian Marine Parks*. GIS Metadata. Department of Agriculture, Water and the Environment.

DAWE (2021a), *Protected Matters Search Tool.* Department of Agriculture, Water and the Environment, Australian Government, Canberra, , viewed February 2021, https://www.environment.gov.au/epbc/protected-matters-search-tool.

DAWE (2021b). Species Profile and Threats Database. Department of Agriculture, Water and the Environment, Australian Government, Canberra, viewed February 2021, http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

DEE (2018), Consultation Document on Listing Eligibility and Conservation Actions: *Neophoca cinerea* (Australian Sea Lion). Australian Government Department of the Environment and Energy.

DEW 2021a, EGIS data: *Coastal Shoreline Classification*, viewed February 2021, http://location.sa.gov.au/lms/Reports/ReportMetadata.aspx?p_no=1149&pu=y&pa=dewnr. Department for Environment and Water, Adelaide, South Australia.

DEW 2021b, EGIS data: *Marine Benthic Habitats*, viewed February 2021, http://location.sa.gov.au/lms/Reports/ReportMetadata.aspx?p_no=1224&pu=y&pa=dewnr. Department for Environment and Water, Adelaide, South Australia.

DEW 2021c, EGIS data: *New Zealand Fur Seal Colonies*, viewed February 2021, http://location.sa.gov.au/lms/Reports/ReportMetadata.aspx?p_no=1213&pu=y&pa=dewnr. Department for Environment and Water, Adelaide, South Australia.

DEWNR (2012), *Thorny Passage Marine Park Management Plan*, Department of Environment, Water and Natural Resources, Adelaide, South Australia.

DSEWPAC (2013), *Issues Paper for the Australian Sea-lion* (Neophoca cinerea). Department of Sustainability, Environment, Water, Population and Communities, Commonwealth of Australia.

Director of National Parks (2013), *South-east Commonwealth Marine Reserves Network Management Plan 2013-23*, Director of National Parks, Canberra.

Director of National Parks (2018), *South-west Marine Parks Network Management Plan 2018*, Director of National Parks, Canberra.

Dooling, R. J., & Popper, A. N. (2016). *Technical Guidance for Assessment and Mitigation of the Effects of Highway and Road Construction Noise on Birds.* Sacramento, CA: California Department of Transportation, Division of Environmental Analysis.

DSEWPaC (2012), *Conservation Management Plan for the Southern Right Whale: A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011–2021*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPaC (2013), *Issues Paper for the White Shark (*Carcharadon carcharias*).* Department of Sustainability, Environment, Water, Population and Communities, Australian Government, Canberra.

Edyvane, K (1999), *Conserving Marine Biodiversity in South Australia Part 2, Identification of Areas of High Conservation Value in South Australia*, SARDI Report Number 39, PIRSA, F2007/000565-9. SARDI Research Report Series No. 816.

Einoder, L. (2009) *Foraging and reproductive ecology of short-tailed shearwaters terns*. PhD thesis, University of Adelaide, Australia.

Evans K, Charlton, C, Townsend, A, Watson, M, Carroll, E, Double, M, Upston, J, Carlyon, K, Alderman, R (2021), *Estimation of population abundance and mixing of southern right whales in Australian and New Zealand regions*. Report to the National Environmental Science Program, Marine Biodiversity Hub and CSIRO Oceans and Atmosphere.

FAA (2009), *Final Programmatic Environmental Impact Statement for Streamlining the Processing of Experimental Permit Applications*. United States Federal Aviation Administration.

FAA (2016), *Final Environmental Assessment, Finding of No Significant Impact/Record of Decision for the Kodiak Launch Complex Launch Pad 3.* Federal Aviation Administration, United States of America.

FAA (2020), *Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station.* Federal Aviation Administration, United States of America.

FAO (2021), Species Fact Sheets: *Arctocephalus gazella* (Peters 1875). Food and Agriculture Organization of the United Nations, Viewed February 2021, http://www.fao.org/fishery/species/3579/en.

Gales NJ, Shaughnessy PD & Dennis TE (1994) Distribution, abundance and breeding cycle of the Australian sea lion, *Neophoca cinerea* (Mammalia: Pinnipedia). *Journal of Zoology, London* 234, 353–370.

Gill, P.C. (2016). Offshore cetacean aerial surveys in the Great Australian Bight. Final report to SARDI. Great Australian Bight Research Program. Research Report Series Number 10, 26pp.

Goldsworthy, S.D. (2020). Australian sea lion listing assessment. Report to the Department for Environment and Water, Department of Agriculture, Water and the Environment. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2020/000131-1. SARDI Research Report Series No. 1056. 26pp.

Goldsworthy, S.D., Page, B. (2009) *A Review of the Distribution of Seals in South Australia*. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, SARDI Publication No. F2009/000368-1, 21pp.

Goldsworthy, S.D. & Page, B (2010) *Review of the distribution of crested terns, little penguins, short-tailed shearwaters and flesh-footed shearwaters in the South-west Marine Region off South Australia*. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000609-1. SARDI Research Report Series No. 451.12p.

Goldsworthy, S. D., and Shaughnessy, P. D. (1994). Breeding biology and haul-out pattern of the New Zealand fur seal, *Arctocephalus forsteri*, at Cape Gantheaume, South Australia. *Wildlife Research* 21, 365–376.

Goldsworthy, SD, McKenzie, J, Shaughnessy, PD, McIntosh, RR, Page, B, and Campbell, R (2009), An update of the report: Understanding the impediments to the growth of Australian sea lion populations. Report to the Department of the Environment, Water, Heritage and the Arts. SARDI Aquatic Sciences Publication Number F2008/00847-1. SARDI Research Report Series No. 356.

Goldsworthy SD, Hamer D, Page B (2007) Assessment of the implications of interactions between fur seals and the southern rock lobster and gillnet sector of the Southern and Eastern Scalefish and Shark Fishery (SESSF) in South Australia. SARDI Aquatic Sciences Publication Number F2007/000711-1, SARDI Research Report Series No 255.

Goldsworthy, SD, Mackay, AI, Shaughnessy, PD and Holman, D (2015). Maintaining the monitoring of pup production at key Australian sea lion colonies in South Australia (2014/15. Final report to the Australian Marine Mammal Centre. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2010/000665-5. SARDI Research Report Series No. 871. 73pp.

Goldsworthy, S.D., Mackay, A.I., Bilgmann, K., Möller, L.M., Parra, G.J., Gill, P., Bailleul, F., Shaughnessy, P., Reinhold, S-L. & Rogers, P.J. (2017). Status, distribution and abundance of iconic species and apex predators in the Great Australian Bight. Final Report GABRP Project 4.1. Great Australian Bight Research Program, GABRP Research Report Series Number 15, 227pp.

Goldsworthy, S.D., Bailleul, F., Nursey-Bray, M., Mackay, A., Oxley, A., Reinhold, S-L., and Shaughnessy, P.D. (2019), *Assessment of the impacts of seal populations on the seafood industry in South Australia,* Adelaide, June. South Australian Research and Development Institute (Aquatic Sciences).

Goldsworthy, S.D., Hodgson, J. and Holman, D. (2020). Australian sea lion investigations: 2018-19. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2020/000052-1. SARDI Research Report Series No. 1051. 88pp.

Goldsworthy SD, Page B, Hamer DJ, Lowther AD, Shaughnessy PD, Hindell MA, Burch P, Costa DP, Fowler SL, Peters K, McIntosh RR, Bailleul F, Mackay AI, Kirkwood R, Holman D and Bryars S (2022) Assessment of Australian Sea Lion Bycatch Mortality in a Gillnet Fishery, and Implementation and Evaluation of an Effective Mitigation Strategy. Front. Mar. Sci. 9:799102.

Hamer, D. J., Goldsworthy, S. D., Costa, D. P., Fowler, S. L., Page, B., and Sumner, M. D. (2013). The endangered Australian sea lion extensively overlaps with and regularly becomes by-catch in demersal shark gill-nets in South Australian shelf waters. *Biol. Conserv.* 157, 386–400.

Higgins, L.V. (1990). Reproductive behavior and maternal investment of Australian sea lions. PhD Thesis, University of California, Santa Cruz. (pp. 126).

IFAW & MCRL (2013), *Final report for a survey of cetaceans in the eastern Great Australian Bight 26th April – 8th May 2013*, International Fund for Animal Welfare and Marine Conservation Research Limited.

Iron Road (2014), *Central Eyre Iron Project Infrastructure Environment Protection and Biodiversity Conservation Act 1999 (Cth). Referral to Australian Government*. Central Eyre Iron Project.

Johnson, BW (1979), The effects of human disturbance on a population of harbor seals. pp. 422– 432 in *Environmental assessment of the Alaskan continental shelf. Annual reports of principal investigators for the year ending March 1977*, Vol. 1. Receptors—Mammals. U.S. Department of Commerce, NOAA/OCSEAP.

Linnane, A, McGarvey, R, Feenstra, J and Graske, D (2021),. Northern Zone Rock Lobster (*Jasus edwardsii*) Fishery Stock Assessment 2019/20. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000320-15. SARDI Research Report Series No. 1100. 64pp.

McClatchie, S, Middleton, J, Pattiaratchi, C, Durrie D & G Kendrick (eds), (2006), *The South-west Marine Region: ecosystems and key species groups*, report for the Department of the Environment and Water Resources, Hobart, pp. 47–519, viewed February 2021, www.environment.gov.au/coasts/mbp/publications/south-west/sw-ecosystems.html.

McFarlane, D (2016), *Cape Wiles Fur Seal Colony – Kruising Around Australia,* viewed February 2021, https://dimcfarlane369.wordpress.com/tag/cape-wiles-fur-seal-colony

Mackay, A.I. and Goldsworthy, S.D. (2015). *Monitoring southern right whale abundance, distribution and population dynamics at the Great Australian Bight aggregation*. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2014/000052-2. SARDI Research Report Series No. 835. 28pp.

McKenzie, J., Page, B., Shaughnessy, P. D. and Hindell, M. A. (2007b). Age and reproductive maturity of New Zealand fur seals (Arctocephalus forsteri) in southern Australia. *Journal of Mammalogy*, 88(3): 639-648.

McLeay. LJ (2014). Seabirds and Shorebirds of Spencer Gulf. Part B: Seabirds of Southern Spencer Gulf -In Natural History of Spencer Gulf. Chapter 3 Biological systems.

McLeay. LJ, Page BP & Goldsworthy, SD (2017). But first, are you experienced? The consequences of timing, age, and adult condition on reproductive performance in Greater Crested Terns *Thalasseus bergii*. Marine Ornithology 45: 205–215.

Marzin, C (2018), *Takes of Marine Mammals Incidental to Specified Activities: Taking Marine Mammals Incidental to Boost-Back and Landing of Falcon 9 Rockets,* National Marine Fishery Service, Federal Register / Vol. 83, No. 221.

Möller, L.M., Parra, G.J. and Bilgmann, K. (2012). *Population size, structure and habitat preferences of common dolphins in South Australia: enhancing the assessment, reduction and mitigation of fisheries operational interactions*. Australian Marine Mammal Centre, Australian Antarctic Division, Hobart, Australia.

Morrice, M.G., P.C. Gill, J. Hughes and A.H. Levings (2004). Summary of aerial surveys conducted for the Santos Ltd EPP32 seismic survey, 2-13 December 2003. Report # WEG-SO 02/2004, Whale Ecology Group-Southern Ocean, Deakin University.

NIWA (2017), Ecological Risk Assessment of the impact of debris from space launches on the marine environment. Report prepared for the New Zealand Ministry for the Environment by the National Institute of Water and Atmospheric Research.

Oliver, J (2006), *Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Rocket Launches from Kodiak Island, AK,* National Marine Fishery Service, Federal Register / Vol. 82, No. 12.

Pitcher B (2018) *Australian Sea Lion Monitoring Framework: background document*. Report prepared for the Department of the Environment, Canberra.

Pitcher, C.R., Rochester, W., Dunning, M., Courtney, T., Broadhurst, M., Noell, C., Tanner, J., Kangas, M., Newman, S., Semmens, J., Rigby, C., Saunders T., Martin, J., Lussier, W. (2018) *Putting potential environmental risk of Australia's trawl fisheries in landscape perspective: exposure of seabed assemblages to trawling, and inclusion in closures and reserves — FRDC Project No 2016-039*. CSIRO Oceans & Atmosphere, Brisbane, 71 pages.

Pitcher, KW & Calkins, D (1979), Biology of the harbor seal (*Phoca vitulina richardsi*) in the Gulf of Alaska. U.S. Department of Commerce, NOAA, OCSEAP Final Report 19 (1983): 231–310.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., ... & Tavolga, W. N. (2014). Sound exposure guidelines. In ASA S3/SC1. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (pp. 33-51). Springer, Cham.

Rauch, SD (2017), *Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Space Vehicle and Missile Launch Operations at Pacific Spaceport Complex Alaska, Kodiak Island, Alaska***,** National Marine Fishery Service, Federal Register / Vol. 84, No. 69.

Rauch, SD (2019), *Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to U.S. Air Force Launches and Operations at Vandenberg Air Force Base, California***,** National Marine Fishery Service, Federal Register / Vol. 84, No. 69.

Reef Life Survey (2021), *Reef Life Survey Data Portal*, viewed February 2021, http://reeflifesurvey.imas.utas.edu.au/static/landing.html.

Reid, T.A., Hindell, M.A., Eades, D.W. & Newman, M (2002), Seabird Atlas of South-eastern Australian Waters, Birds Australia Monograph 4, Birds Australia, Melbourne.Robbins, RL, Enarson, M, Bradford, RW, Robbins, WD& Fox, AG (2015), Residency and Local Connectivity of White Sharks at Liguanea Island: A Second Aggregation Site in South Australia? The Open Fish Science Journal, 8, 23–29.

Resonate (2022), *Southern Launch - Whalers Way Orbital Launch Complex Environmental Noise Advice*. Report A210940RP1, Revision 1, Resonate Consultants.

Robinson, AC, Canty, P, Mooney, P & Rudduck, P (1996), *South Australia's Offshore Islands,* Australian Heritage Commission and Department of Environment and Natural Resources, South Australia.

Rogers PJ, Drew M, Bailleul F and Goldsworthy SD (2016). *Offshore survey of the biodiversity, distributions and habitat use of pelagic sharks in the Great Australian Bight*. GABRP Research Report Number 7, Great Australian Bight Research Program, August 2016, 77pp.

Sandegren, FE (1969), Breeding and maternal behavior of the Steller sea lion (*Eumetopias jubatus*) in Alaska. M.S. thesis. University of Alaska Fairbanks.

Shaughnessy, P. D., Dennis, T. E. and Seager, P. G. (2005). Status of Australian sea lions, *Neophoca cinerea*, and New Zealand fur seals, *Arctocephalus forsteri*, on Eyre Peninsula and the Far West Coast of South Australia. *Wildlife Research*, 32(1): 85-101.

Shaughnessy, P.D., Goldsworthy, S.D and Mackay, A. (2014). Status and trends in abundance of New Zealand fur seal populations in South Australia. Final report to the Australian Marine Mammal Centre. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2014/000338-1. SARDI Research Report Series No. 781.33pp.

Shepherd, SA, Brook, JB & Bloomfield, A (2005). *A Survey of the Western Blue Groper on Southern Eyre Peninsula, South Australia*. Report for Reef Watch, Conservation Council of South Australia, Adelaide.

Skira, I.J. (1991). The short-tailed shearwater: a review of its biology. *Corella* 15:45-52.

Southall, BL, Bowles, AE, Ellison, WT, Finneran, JJ, Gentry, RL, Greene, CR, Kastak, D, Ketten, DR, Miller, JS, Nachtigall, PE, Richardson, WJ, Thomas, JA & Tyack, PL (2007). Marine mammal noise-exposure criteria: initial scientific recommendations, *Aquatic Mammals*, 33(4), pp.411-521.

Southall, BL, Finneran, JJ, Reichmuth, C, Nachtigall, PE, Ketten, DR, Bowles, AE, et al. (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. *Aquatic Mammals* 45, pp. 125–232.

Stobart, B & Mayfield, S (2021), Western Zone Blacklip Abalone (*Haliotis rubra*) and Greenlip Abalone *(H. laevigata*) Fisheries in 2020/21. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000331-5 SARDI Research Report Series No. 1119. 72pp.

Tixier P, Lea M, Hindell MA, Guinet C, Gasco N, Duhamel G, Arnould JPY (2018), Killer whale (Orcinus orca) interactions with blue-eye trevalla (Hyperoglyphe antarctica) longline fisheries. PeerJ 6.

USAF (1997), Environmental Assessment for the U.S. Air Force *atmospheric interceptor technology PROGRAM*. United States Air Force, Los Angeles Air Force Base, CA. 1v plus Appendices.

USAF (2018), *Application for Incidental Take Regulations and Letters of Authorization; U.S. Air Force Launches, Aircraft and Helicopter Operations at Vandenberg Air Force Base, California*. United States Air Force.

Ward, T.M., Burch, P., Gorman, D. and Begg, G.A. (2012). Estimates of historical commercial fishery catches/effort in final sanctuary and habitat protection zones in South Australia's Marine Parks. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2011/000307-8. SARDI Research Report Series No. 670. 77pp.

Appendix 1. Southern Launch - *Liguanea Island Seal Risk Assessment*

F

EBS ECOLOGY (2022) WHALER'S WAY COASTAL RAPTOR MEMORANDUM

EBS Ecology
112 Hayward Avenue
Torrensville, SA 5031
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t. 08 7127 5607

Memorandum

Subject	Whaler's Way Coastal Raptor Review	**Date**	24/02/2022
Attention	Andrew Curran, Southern Launch	**Project No.**	EX211013
From	Dr Travis How and Angela Carpenter		

1. INTRODUCTION

EBS Ecology were engaged by Southern Launch Space Pty Ltd (Southern Launch) to undertake a review of public and agency submissions provided on the Environmental Impact Statement (EIS) for the Whalers Way Orbital Launch Complex (WWOLC) (the Project) focussing on the coastal raptors Eastern Osprey (*Pandion haliaetus cristatus*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*) (**Error! Reference source not found.**).

Details on the Project, the Project area and the Project components have been provided in other documents associated with the Project. The broad Project details include:

- Development of a launch facility that includes two launch sites, a warehouse/maintenance site, range control building and road upgrades.
- Propose to launch up to 36 orbital and 6 suborbital rockets per year
- Maximum noise generated by the largest rocket to be launched at 130 – 140 dB, which is described as equivalent to a large aeroplane, gunshot or fireworks at 25 metres in Bull and Bebbington (2020).
- Assumed that rockets would be launched in the day or night throughout the year with up to one launch per week, launching at both Site A and Site B (AECOM 2021).

The assessment of coastal raptors and potential issues were addressed in previous documentation, including:

- As part of the EIS documents a Terrestrial Biodiversity Technical Report was prepared by AECOM, initially in September 2020, with a revised report replacing it in June 2021. In November 2020 Jacobs prepared a Coastal Raptor Memorandum with additional

information on the Eastern Osprey (*Pandion haliaetus cristatus*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*).

- From 5 August to 16 September 2021 the EIS documents were released for 30 business days for public and agency comment. Two community meetings were held in Port Lincoln on 24 August 2021. Of the submissions received, twenty-one public submissions contained concerns to impacts on the Eastern Osprey and White-bellied Sea Eagle.

In response to the *Environmental Impact Statement* for the Project, twenty-one public submissions and one State Government Agency submission were received which contained reference to coastal raptors as part of their responses. The relevant submissions were provided to EBS by Masterplan with the submissions being reviewed as part of the Coastal Raptors Review (this memo).

Changes and further work have been undertaken on the Project since the time that the EIS was released. This includes changes to the infrastructure layout and additional noise modelling. These changes and additional information have not been included in this memo, however, have been taken into account when developing the actions required. Background information on both coastal raptor species (Eastern Osprey and White-bellied Sea Eagle) has not been presented in this memo as it is provided elsewhere in Project documentation.

A coastal raptor survey was undertaken by Bebbington (2022) in February 2022. The survey was undertaken by boat between Jussieu Peninsula to North West D'Anville Bay, which is a radius of 10km from the Project Area. The survey was aimed at collecting further information on coastal raptor species in the area. The coastline was inspected for any new nest sites and recent (last season) nest activity.

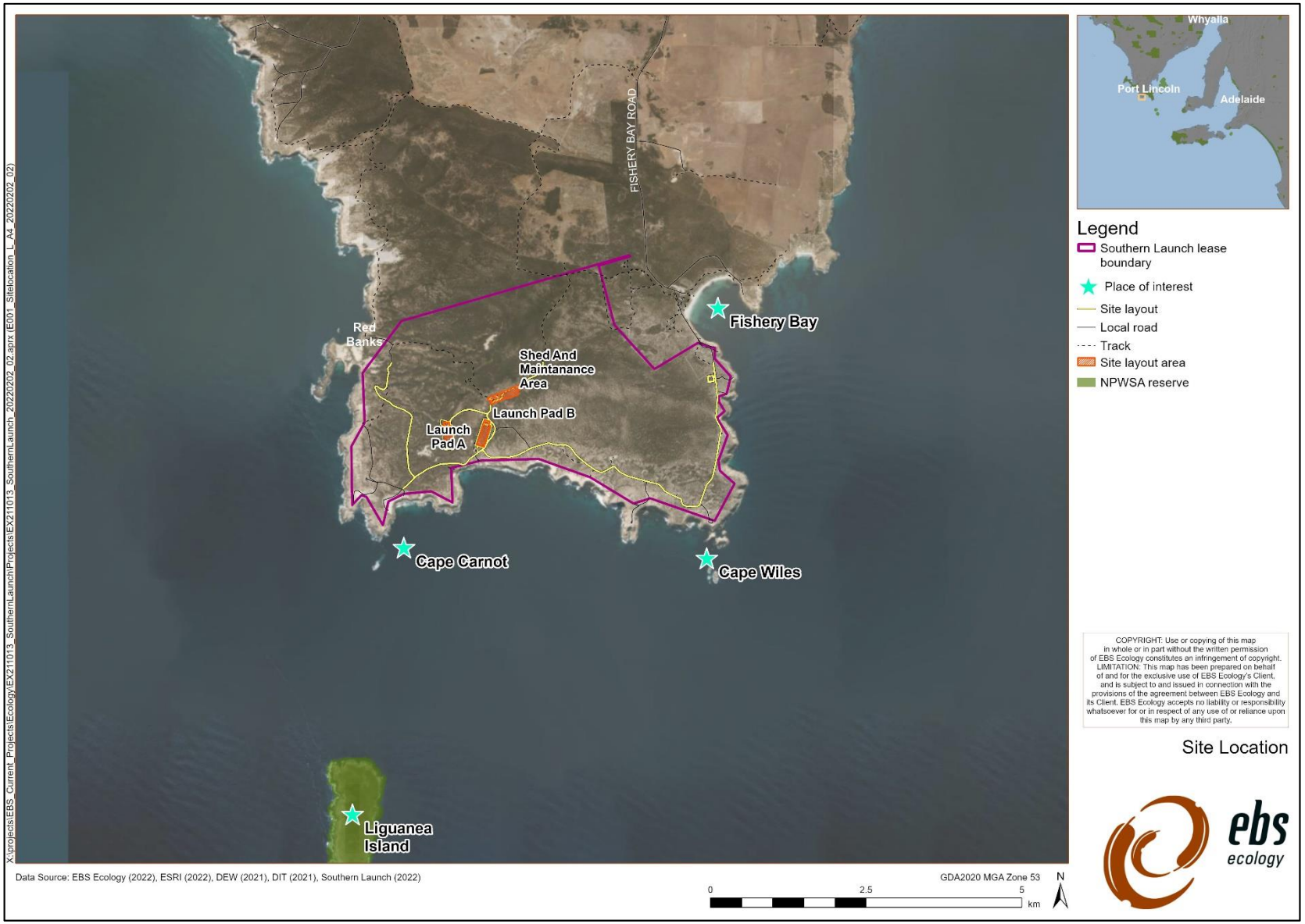


Figure 1. Project location.

2. INFORMATION REVIEWED

The following information was reviewed in order to prepare the response to submissions and develop the required actions to address issues raised:

- Status of Osprey and White-bellied Sea Eagle in SA, other Australian jurisdictions, Nationally and globally.
- Relevant consultant reports:
    - AECOM (2021). Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report. Revised Final 01 June 2021.
    - Bull, Z. and Bebbington, L. (2020). Whaler's Way Raptors. Memorandum from Jacobs to Southern Launch.
    - Bebbington, L. (2022). Coastal Raptor Boat Survey. Jussieu Peninsula to North West D'Anville Bay Southern Eyre Peninsula. A report to Southern Launch Pty Ltd.
- Twenty-one public submissions provided by Masterplan which reference Eastern Osprey and White-bellied Sea Eagle.
- One agency submission by the SA Department for Environment and Water (DEW)

In addition, further information was reviewed such as:

- AECOM (2020). Whalers Way Orbital Launch Complex - Environmental Assessment Report - Noise and Vibrations. September 2020.
- Draft Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) (Southern Launch 2020, 2021, 2021a).
- Journal articles as referenced in this report.

3. PREVIOUS CONSULTANT REPORT KEY FINDINGS

3.1. Terrestrial Biodiversity Technical Report (AECOM 2021).

The Terrestrial Biodiversity Technical Report (AECOM 2021) identified the main impacts to coastal, mobile fauna species such as Eastern Osprey and White-bellied Sea Eagle to be:

(1) the brief adverse behavioural response likely from rocket launches (Section 7.1.9.3 Wildlife Impacts During Operations, page 77) and

(2) whether long term behavioural changes would be caused.

These two potential impacts are not managed under mitigation measures described in the AECOM (2021) report.

3.2. Whaler's Way Raptor's Memorandum (Bull and Bebbington 2020).

Bull and Bebbington (2020) included additional information from field surveys by L. Bebbington in November and December 2020.

Two inactive Osprey nests located 2000 m to 4990 m from the launch sites were identified in the report. Additional information was provided towards the Significant Impact Assessment for the Eastern Osprey (i.e. the status of known nests, photographs, available records and the nearest known active nests, and any sightings that were made during the survey) however the same conclusion was reached that there would be no significant impact.

Whilst no significant impact assessment was carried out for White-bellied Sea Eagle, the following mitigation options for disturbance to White-bellied Sea Eagles included:

- Adopting state-wide 2000 m disturbance buffers (based on recommendations in Dennis *et al.* 2011, Dennis *et al.* 2012) from known active nests, particularly during the breeding season.
- Where there are known nests or territories, construction should occur from mid-January to May, if outside this period (breeding season from May to September) then a precautionary approach would involve receiving confirmation in confidence to understand the exact location and activities (of any eagles) occurring in the area. It is noted that Dennis *et al.* 2015 and Dennis *et al.* 2012 distinguishes between critical breeding mid-May to mid-September and entire breeding season May to December.
- Note that line of sight is critical to disturbance. Not conducting disturbance activities within the line of sight of breeding White-bellied Sea Eagles. i.e. as per criteria in Dennis *et al.* 2012, not within 1000m of a primary nest.
- Development of a species management plan for specific protection and management of breeding refuge habitat in South Australia.
- Subsequent ongoing population monitoring in key habitats.

3.3. Coastal Raptor Boat Survey (Bebbington 2022).

Bebbington (2022) undertook a coastal raptor survey between Jussieu Peninsula to North West D'Anville Bay, which is a radius of 10km from the Project Area. The survey was undertaken in February 2022 from a boat and involved inspecting the coast line for nest sites and recording observations of coastal raptors.

A total of nine observations of coastal raptors were made including five adults, three juveniles and one immature individual. Four Osprey were observed and five White-bellied Sea-eagle.

No additional nests were located within 5km of the Project Area and the two nests previously recorded within 4km of the Project Area had no signs of breeding activity from last season. One observation interest was of a pair of Osprey displaying territorial and pair bonding behaviour was recorded at the old cliff nest site. The old cliff nest site is the same as the nest shown in Figure 2 (in this memo) as Nest Site 01.

4. EIS RESPONSE SUBMISSIONS

4.1. Public submissions

Twenty-one submissions were viewed by EBS Ecology, as provided by Masterplan. These submissions all mentioned coastal raptors within their text and came from a range of stakeholders including local landholders, public citizens, coastal raptor experts, birding groups.

The issues raised in relation to coastal raptors included:

- The effect of noise (particularly from rocket launches) – 12 submissions.
- Coastal raptor nests near the Project Area may be reused – 6 submissions.
- Impact assessment adequacy of survey duration and search for new active nests deficient – 5 submissions.
- A coastal raptor expert was not consulted – 3 submissions.
- Inappropriate local bird enthusiast referenced – 4 submissions.
- Timing of construction and operations – not avoiding the breeding seasons - 4 submissions.
- Noise mitigation measure proposed – scare gun inappropriate – 3 submissions.
- An independent review is required – 1 submission.
- The impact of rocket test launches – 1 submission.
- The impact of toxic fallout – 1 submission.

4.2. Agency (DEW) submission

The SA Department for Environment and Water (DEW) sent in a submission on 16 September 2021, as per below:

"Both Osprey and White-bellied Sea Eagles are known to occur in this area. Both of these species have undergone a significant decline in SA and are now listed as Endangered under the NPW Act. While the Coastal Raptor Assessment (Appendix R) states that there are no known nests near the site, the assessment only checked the known vacant sites, and did not include a comprehensive survey of the area by a suitably qualified raptor expert, as previously recommended by DEW. Therefore, there is a reasonable potential that there is breeding Osprey and/or White-bellied Sea Eagles territories within the area likely to be impacted by the proposal and that these have not been identified and appropriate mitigation and monitoring measures have not been incorporated into the proposal. This is a potentially significant impact on a small and declining population. Should the proposal proceed, a comprehensive survey by a suitably qualified coastal raptor expert should be undertaken and mitigation and monitoring measures identified and implemented."

4.3. Issues Raised

In addition to the potential impacts of the Project on coastal raptor species that have been previously addressed, the issues raised as part of the public and agency consultation have been reviewed. The issues raised have been summarised below (Table 1) and the actions required to be undertaken to address the issues raised have been identified. Further detail on the required actions have been provided in Section 5.

Table 1. Summary of issues raised and required actions to address issues.

Topic	Specific issue raised	Action required
Noise	The effect of noise (particularly from rocket launches) – 12 submissions. Noise mitigation measure proposed – scare gun inappropriate – 3 submissions. The impact of rocket test launches – 1 submission.	1. Implement the coastal raptor monitoring program pre and post construction as per detail provided in Section 5. 2. If active nests are present within survey area, develop and implement an appropriate management plan construction and operation phases of the project 3. Remove scare guns as a noise mitigation measure
'Abandoned' nests	Coastal raptor nests near the Project Area may be reused – 6 submissions.	4. Utilise the term 'inactive nest' instead of 'abandoned nest' where nests are intact but not currently active as these may be utilised in the future. Use the term 'debilitated nest' for any nests that have degraded to a point of non-repair. Consistency of terms will reduce confusion.
Adequacy of on-ground surveys	**Public submissions** Impact assessment adequacy of survey duration and search for new active nests. deficient – 5 submissions. **DEW submission** Should the proposal proceed, a comprehensive survey by a suitably qualified coastal raptor expert should be undertaken and mitigation and monitoring measures identified and implemented."	5. Implement the coastal raptor monitoring program pre and post construction as per detail provided in Section 5. Additional survey undertaken in February 2022 by Bebbington (2022) has added further data on the coastal raptors in the area including pair bonding behaviour at one inactive nest site (Nest Site 01).
Coastal raptor expert	**Public submissions** A coastal raptor expert was not consulted – 3 submissions.	6. Implement the coastal raptor monitoring program pre and post construction as per detail provided in Section 5.

Topic	Specific issue raised	Action required
	DEW submission Should the proposal proceed, a comprehensive survey by a suitably qualified coastal raptor expert should be undertaken and mitigation and monitoring measures identified and implemented."	
Local bird enthusiast	Inappropriate local bird enthusiast referenced – 4 submissions.	No action required, local bird enthusiasts have invaluable knowledge that can inform surveys and monitoring, however a conflict of interest should be avoided.
Timing of construction and operations	Timing of construction and operations – not avoiding the breeding seasons - 4 submissions.	7. Implement coastal raptor monitoring program pre and post construction as per detail provided in Section 5. 8. If active nests are identified within 2km during the pre-construction survey, develop and implement a detailed management plan for the construction phase of the project (refer to Section 5 for further detail).
Independent review	An independent review is required – 1 submission.	This report is an independent review and fills this gap.
Toxic fallout	The impact of toxic fallout – 1 submission.	No action required, refer to the SLR Air Quality Impact Assessment Report (SLR 2020) which assessed the report as low risk.

5. ACTIONS REQUIRED

The following actions have been developed to address the coastal raptor specific issues raised through the submissions associated with the consultation period for the WWOLC EIS. Both public submissions and agency submissions have been taken into account whilst developing the required actions.

The actions required to be undertaken are:

1. A systematic Eastern Osprey and White-bellied Sea Eagle nest survey is to be carried out prior to the commencement of construction (Survey 1) with the aim of identifying the status of any Eastern Osprey or White-bellied Sea Eagle nest within a 6km radius of the Project area. The parameters for this survey include:
    - Inspect all coastline within 6km of the Project area (Figure 2). The 6km radius will incorporate the closest active nests to the Project Area and the extent of the predicted 93 dBA noise contour within which birds may experience temporary hearing loss (threshold shift) from rocket launches (AECOM 2020; Dooling and Popper 2007). The search is to include nearby islands that occur within the 6km radius (such as Liguanea Island). The survey is to include all known nests as well as searches for additional nesting locations.
    - Surveys to be undertaken by suitably qualified and experienced ecologist.
    - Undertake surveys from the water (reduces disturbance to birds and won't require land access).
    - Undertake surveys in September / October providing critical breeding stages (nest building, egg laying and incubation) have finished. At this time, chicks should be present on the nest if it is being actively used. In the case of an attempted nesting event, evidence should be present that the nest has been recently utilised (eg fresh nesting material, white wash).
    - Determine the status of each nest and whether it is being actively used by either species. Observations should include presence of chicks or any other indicators to justify recorded status of the nest.
    - Record specific observations in relation to presence / activity of both species near any identified nest locations.
    - Whilst nest surveys are being undertaken, record all sightings of coastal raptor species, including species, location and activity. If any birds are banded, record band colour and leg.
2. Repeat the systematic Eastern Osprey and White-bellied Sea Eagle nest survey (as detailed in Action 1) for the first two years of facility operation (post-construction) (Surveys 2 and 3).
3. If an active nest, of either species, is recorded within the survey area prior to construction (Survey 1), a detailed construction management plan for coastal raptors will be required. The management plan will include adaptive management measures to ensure impacts during construction are

minimised. The management measures will be dependent on the construction program, timing of works and the proximity of the active nest to the construction areas. Management measures may include times when certain construction activities are not permitted to reduce potential impacts to breeding birds. This management plan will need to be submitted to DEW.

4. If an active nest, of either species, is recorded within the survey area prior to construction (Survey 1), a detailed operational management plan for coastal raptors will be required. Specific adaptive management measures for the operation of the launch facility will need to be included in the plan. Management measures will be based on the proximity of the nest to the launch sites and the time of year of planned activities. This management plan will need to be submitted to DEW.

5. If an inactive nest becomes active after the commencement of the operation phase of the Project or a new nest is constructed after the commencement of the operation phase of the Project, there is no requirement for the development of an operational management plan.

6. At the completion of the second post construction survey (Survey 3), the results need to be collated, analysed and presented to DEW. The results of the post construction surveys will assist in determining if the Project has had a negative impact on the breeding success of either species. If the results suggest that this has occurred, a detailed review of the operations and management of the Project will be required. In addition to any changes to operational management measures, further monitoring will be required to determine if the changes to the operations have alleviated the negative impacts on the nesting success of the Project.

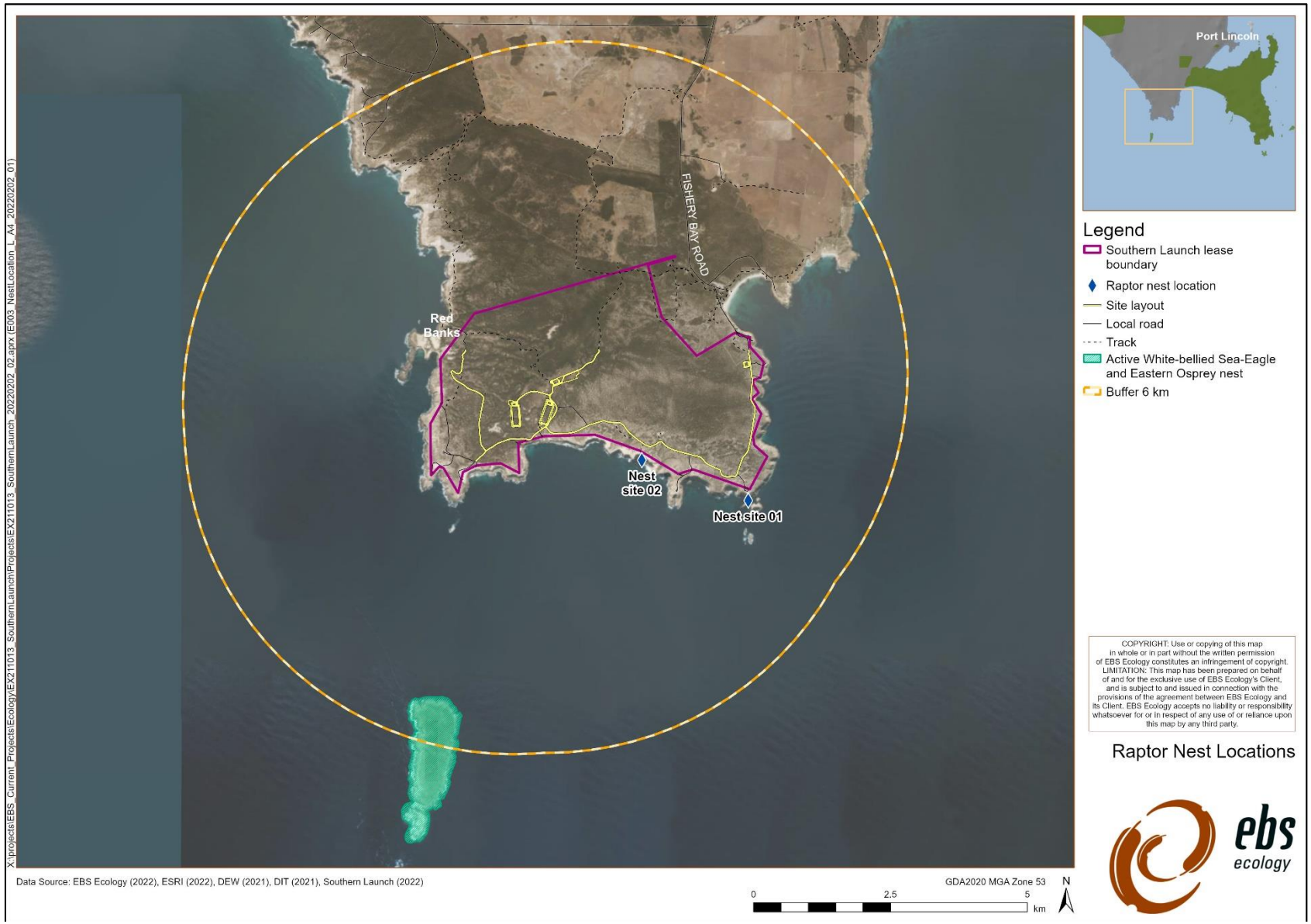


Figure 2. Coastal raptor existing known nest locations. Nest O1 and O2 are currently inactive Eastern Osprey nests.

6. BIBLIOGRPAHY

AECOM (2020). Whalers Way Orbital Launch Complex - Environmental Assessment Report - Noise and Vibrations. September 2020.

AECOM (2021). Whalers Way Orbital Launch Complex Terrestrial Biodiversity Technical Report. Revised Final 01 June 2021.

Bebbington, L. (2022). Coastal Raptor Boat Survey. Jussieu Peninsula to North West D'Anville Bay Southern Eyre Peninsula. A report to Southern Launch Pty Ltd.

Bull, Z. and Bebbington, L. (2020). Whaler's Way Raptors. Memorandum from Jacobs to Southern Launch. 16 November 2020.

Coast Protection Board (2004). Coast Protection Board Policy Document (revised 29 July 2016). Coast Protection Board, Adelaide, South Australia.

Dennis, T.E. and Detmar, S.A. (2018). A review of White-bellied Sea Eagle distribution and population stability over time in South Australia. *South Australian Ornithologist* **43** (1-2).

Dennis (2014). The status of the Osprey (*Pandion haliaetus cristatus*) in Australia. *Journal of Raptor research* **48** (4):408-414.

Dennis, T.E., Fitzpatrick, G.J. and Brittain, R.W. (2012). Phases and duration of the White-bellied Sea-Eagle *Haliaeetus leucogaster* breeding season in South Australia and the implications for habitat management. *Corella* **36** (3) 63-68.

Dennis, T.E, Detmar, S.A, Brooks, A.V. and Dennis, H.M. (2011). Distribution and status of White-bellied Sea-Eagle, *Haliaeetus leucogaster*, and Eastern Osprey*, Pandion cristatus*, populations in South Australia. *The Journal of The South Australian Ornithological Association Inc.* **37** (Part 1).

Dennis T. E. (2007). Reproductive activity in the Osprey (*Pandion haliaetus*) on Kangaroo Island, South Australia. *Emu* **107** (300-307).

Department of the Environment (DotE) (2013). Matters of National Environmental Significance: Significant Impact Guidelines 1.1 *Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia Department of the Environment, Canberra.

Department of Agriculture, Water and the Environment (DAWE) (1 October 2021). Additional information required for preliminary documentation. Whalers Way Orbital Launch Complex, Sleaford, SA.

Detmar, S.A. and Dennis, T.E. (2018). A review of Osprey distribution and population stability in South Australia. *South Australian Ornithologist* **43** (1-2).

Dooling, R.J. and Popper, A.N. (2007). The Effects of Highway Noise on Birds. Environmental

BioAcoustics LLC, Canada.

NSW Office of Environment and Heritage (OEH) (2020). Eastern Osprey – profile. Last updated 18 December 2020. Available at: Eastern Osprey - profile | NSW Environment, Energy and Science. [Accessed 25 November 2021].

NSW Scientific Committee (2009). Eastern Osprey *Pandion cristatus*: Review of Current Information in NSW.

SLR (2020). Whaler's Way Orbital Launch Complex: Air Quality Impact Assessment. August 2020.

Southern Launch (2020). Whalers Way Orbital Launch Complex – Draft Construction Environmental Management Plan (CEMP). 20 May 2020. Revision D.

Southern Launch (2021). Whalers Way Orbital Launch Complex – Draft Construction Environmental Management Plan (CEMP). 20 May 2021. Revision C.

Southern Launch (2021a). Whalers Way Orbital Launch Complex – Draft Operational Environmental Management Plan (OEMP). 20 May 2021. Revision C.

G

COASTAL RAPTOR BOAT SURVEY, BEBBINGTON FEB 2022

Coastal Raptor Boat Survey

Jussieu Peninsula to North West D'Anville Bay

Southern Eyre Peninsula

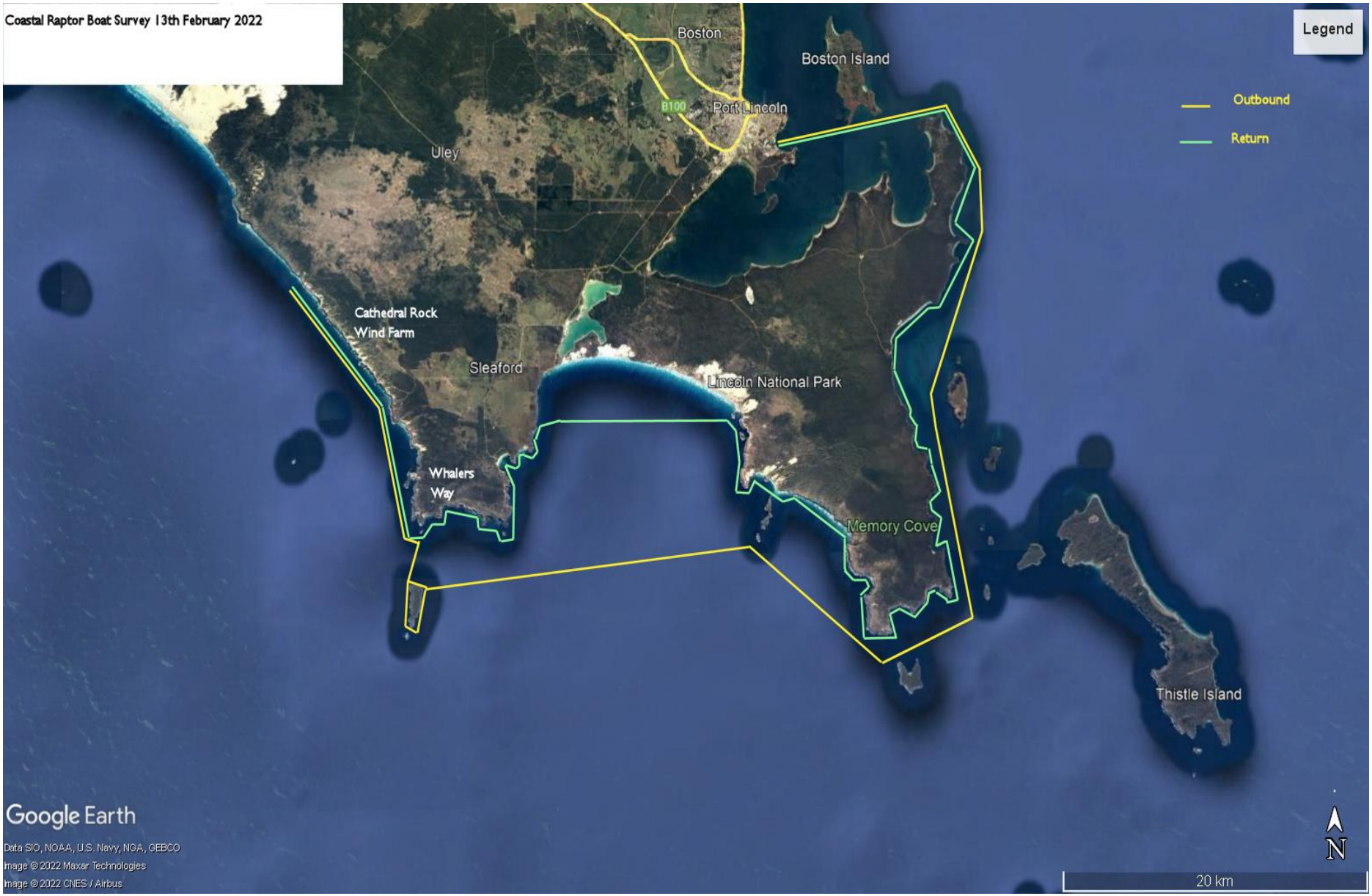
Surveyed by:

Larry Bebbington

Port Lincoln SA

16th February 2022

Ref: RS222SL


Coastal Raptor Boat Survey 13th February 2022
Legend
Outbound
Return
Boston
Boston Island
B100
Port Lincoln
Uley
Cathedral Rock
Wind Farm
Sleaford
Lincoln National Park
Whalers
Way
Memory Cove
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2022 Maxar Technologies
Image © 2022 CNES / Airbus
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20 km

Ref: RS222SL

Survey Overview

Southern Launch Pty Ltd was requested to conduct annual coastal raptor surveys within a 10km radius of the proposed rocket launch facility under application.

Coastal boat surveys were considered to be the most efficient means of locating raptors and the presence absence of birds at existing or new nest sites. Mike Damp of Southern Launch concluded that conducting surveys during breeding or nesting periods had the potential to interrupt breeding or egg laying and delayed boat surveys until February. The delay ensured that any adults that may have established a territory and nest site would still be in the immediate area hopefully with recently fledged young.

A 7.5m open deck aluminium work boat was selected for the survey work, operated by a local cray fisherman with over 30 years' experience fishing the waters within the study area. The craft had to have a useable range of 200+ nautical miles as the study team decided to conduct surveys completely around the southern tip of Eyre Peninsula and return to the Port Lincoln marina. A total of over 170 nautical miles or in excess of 280 kilometres were travelled in the return journey.

Weather conditions were ideal on the outbound leg of the survey with SW winds 8-10 knots and a half metre swell in D'Anville Bay under a light overcast sky. The wind and swells were increasing in the early afternoon so the outbound travel maintained a 500-700m distance from the shoreline to maintain a rapid transit to Thorny Passage and beyond. The return journey was through increasing swells in D'Anville Bay and Thorny Passage but the survey boat was still able to venture into embayments and close proximity to the base of cliffs in deep water.

A pair of Swarovski 10x42 and Pentax 10x43 binoculars were used during survey.

Other observations

The waters from Thorny Passage through to Liguanea Island were highly active during the outbound leg of the survey with large numbers of Dolphins, Sea Lions and Fur Seals present in deeper water. Although a count of seals was not conducted the survey team noted an apparent increase in Fur Seal and pup numbers along the majority of the shore line south of the passage and on Liguanea Island.

The presence of large numbers of dolphins and seals coupled with significant numbers of Crested Terns, Fleshy Footed and Short Tailed Shearwater and Wilsons Storm Petrel suggest that Pilchard schools had been present in the area during early morning.

Species		Phases			Comments
(recorded in order of sighting)	Adult	Juvenile	1st Immature	2cnd Immature	
White Bellied Sea-Eagle *Haliaetus leucogaster*			Y		Single bird observed lofting from Redbanks area flying overhead at 30m heading west.
Osprey *Pandion haliaetus*		Y			Single juvenile bird observed flying overhead 30-50m – full crop – potentially from recently re-established nest site which had been active.
Osprey *Pandion haliaetus*	Y				Pair of birds displaying territorial and pair bonding behaviour at old cliff nest site. During the two boat trips up to 6 people were sighted on the viewing platform above the displaying birds which caused a retreat to the adjacent stack.
White Bellied Sea-Eagle *Haliaetus leucogaster*	Y	Y			Mature adult and juvenile on sandy cliff slope above water. Adult within 10m of juvenile which fed on large prey for the duration of the boats presence 200m from cliff. No other adults or juveniles recorded within 1km either side of location.
White Bellied Sea-Eagle *Haliaetus leucogaster*	Y				Single adult perched on *M. lanceolata* above water on east coast. Full crop.
White Bellied Sea-Eagle *Haliaetus leucogaster*	Y				Single adult perched in large E. diversifolia over water on east coast. Full crop.
Osprey *Pandion haliaetus*		Y			Single juvenile perched on *M. lanceolata* over water east coast. Full crop.
Osprey *Pandion haliaetus*	Y				Single bird flying approaching marina.

Table 1 – Results of Coastal Raptor boat survey conducted 13th February 2022 – Jussieu Peninsula to NW D'Anville Bay Eyre Peninsula

Note: Few adult White Breasted Sea Eagles were recorded west of Cape Wiles (including Liguanea Island) during survey. Sea Eagles however have been observed regularly setting flight and disappearing to the south east for extended periods. This area over 30 kms to the SE near the Continental Shelf is named the "Cabbage Patch" due to a cluster of massive underwater stacks and attracts shoals of small fish and upwelling of pelagic species favoured by Sea Eagles. In addition Sea Eagles spend a considerable amount of time inland bathing in dams and hunting Cape Barren Geese.

H WGA TRAFFIC

WGA
WALLBRIDGE GILBERT AZTEC

Southern Launch
Level 8, 70 Pirie Street
ADELAIDE SA 5000

27h October 2021

Project No. WGA181404

Attention: Andrew Curran

Dear Andrew

SOUTHERN LAUNCH WHALERS WAY ORBITAL LAUNCH COMPLEX - WRITTEN REPRESENTATIONS TRAFFIC RESPONSE

I refer to our meeting held on Monday 6th September 2021 regarding public written representation (objections) to the Southern Launch Development Application, in particular regarding traffic related matters of the proposal.

This letter forms a direct response to those traffic related issues, however, relies heavily upon the work already undertaken from the WGA report titled "Whalers Way Orbital Launch Complex, Transport and Access Impact Assessment (Rev D dated 3 June 2021)", as submitted with the Development Application.

This letter also takes into consideration District Council of Lower Eyre Peninsula (DCLEP) response to the Development Application, with regard to their points made on traffic and road asset impacts.

1. CATEGORY AND NATURE OF REPRESENTATIONS

This document relates to traffic matters under the following general categories, with references to the public representation comments (# as filed) provided:

- Road Safety (Vehicles): 25, 64, 107, 124, 139, 177, 194, 223
- Road Safety (Cyclists): 57, 60, 72, 107
- Road Maintenance: 25, 26, 64, 101, 107, 122, 124, 128, 165, 213, 223, 239, 256
- General Impacts (caused by industrial traffic): 41, 49, 51, 62, 125, 127, 144, 173, 179, 249
- Slope instability and rock fall issues created by heavy traffic: 107, 226, 231.

The relevant parts of respondent comments are provided in Appendix A for reference.

Perceived road safety (vehicles) comments generally relate to the increased volume of traffic (in particular commercial vehicles) proposed to access the rocket launch sites during construction and ongoing operations, and the interaction with other road users (locals and tourists). The road safety issues were generalised as there were no specific sites (intersections) raised as a particular concern.

Perceived road safety (cyclists) issues generally relate to the sealed sections of road that are used by cycling groups (one respondent estimated around 60-80 cyclists use the road network between Port Lincoln and Sleaford). The main section of road of concern is between Port Lincoln and Fishery Bay Road. General concerns relate to sharing the road with commercial vehicles, considering the road width and geometry, and the posted speed of 100km/h. Road upgrades to accommodate cyclists or preferentially provision of separate cycling paths is suggested by two respondents.

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Road Maintenance (wear and tear) is a general concern with the proposed increase in heavy traffic. The respondents have raised general issues such as potholes becoming more frequent, and the onus on rate payers to provide funding toward continual maintenance. A couple of respondents have raised that road building materials (road base rubble) are hard to come by in this location.

Several respondents have provided generalised resistance to the perceived impacts of industrial traffic in the area (increased noise and dust, threats to native wildlife). One respondent raised the matter of dangerous freight (carrying explosive materials) on a school bus route.

Three respondents have speculated that additional heavy traffic may cause land slips and rock falls onto Fishery Bay Beach (10m cliff).

DCLEP's response highlights that the increased traffic during construction and operations of the launch facility will have a relatively significant impact on Proper Bay Road and Fishery Bay Road, and has sought "an agreement where the developer would cover the cost of a portion of yearly cyclical maintenance as well as a portion of (Fishery Bay Road) resheeting costs".

2. INDUSTRIAL TRAFFIC

It is beneficial to define and address this issue first, as it has a bearing on the proceeding sections of road safety and road maintenance.

Foremost, the design vehicle, being a 19m semi-trailer, is a general access vehicle i.e., does not require a notice or permit to access any public road network (including Fishery Bay Road and Right Whale Road). It is quite likely that 19m semis are currently operating on an infrequent basis between Sleaford and Port Lincoln, servicing the agriculture industry in the area (livestock and harvesting). Furthermore, the general area has seen activity from over dimensional vehicles (under permit) to traverse much of this network during construction of the Cathedral Rocks Wind Farm in the mid-2000's.

The Transport and Access Impact Assessment (TIA) Section 5.1 "Impacts on the arterial and local road network" goes into some detail regarding the existing "external" (i.e. between Port Lincoln and Whalers Way) road network and vehicles that currently access this network under gazetted route access.

The northern section of road (Pine Freezer Road, Investigator Road) sees moderate volumes of traffic with high commercial content (2,200 Veh/day with 22% Commercial Content). Therefore, these roads will not experience perceptible increases in commercial traffic due to the proposed development.

Moving southerly onto Proper Bay Road (currently 560 veh/day) and Fishery Bay Road (currently 160 veh/day) the development operational traffic may become perceptible to road users familiar with the current traffic mix and volume, however the volumes are only in the order of 12 heavy vehicles per day during the intensive construction period for a predicted 6 months, reducing to 8 heavy vehicles per day during "peak" launch operations, with heavy vehicle volumes reducing significantly during non-peak events. At the height of operations (by year five) 36 launches per year are envisaged, consequently the pre-launch and demobilisation activity is still only constrained to approximately half the year. Rough approximations indicate that on average the launch operations will involve 460 heavy vehicle trips per annum (based on an average of 23 launches per year involving 20 heavy vehicle trips per launch).

As outlined in the TIA (Section 5.2 "Traffic and Access Requirements Within the Site"), the "internal" network of Whalers Way would likely require some upgrades to make it suitable for more frequent heavy vehicle usage.

With regard to the transport of hazardous goods (with respect to the route being shared with a school bus), Section 8.3 "Dangerous Goods Transport" (of the TIA) explains that the transport of "dangerous goods" is regulated by the Dangerous Substances Act 1979 (SA) and Dangerous Substances Regulations 2008 (SA), and goes into some detail about how these risks are managed, including specific licencing and route assessment requirements.

3. ROAD SAFETY (VEHICLES)

The TIA (Section 5.1) considers the major intersections along this route. The sealed road network was considered to be generally fit for purpose and the intersections were safe in that they had good sight lines, delineation and signage. Whilst it is acknowledged that additional traffic increases exposure to road safety risks, provided that these roads are maintained appropriately, the proposed increase in traffic is not expected to create additional road safety issues.

The unsealed road network (Fishery Bay Road, Right Whale Road) is lower traffic volume (160 vehicles / day) and are also considered to be of a reasonable standard for this magnitude of traffic, provided that the unsealed surface is maintained in an acceptable condition (Section 5 of this letter "Road Maintenance" goes into more detail as to what constitutes acceptable intervention criteria).

The TIA discusses the internal Whalers Way road network in section 5.3. The road network will likely require some upgrades to unsealed road geometry and intersection sight lines to improve general road safety. The TIA assumes the following in Section 5:

The facility will need to exclude the general public through security measures.

Clear safety exclusion zones and "corridors" will need to be established during launch activities.

Therefore, the exposure of heavy vehicles to the general public within the Whalers Way site will be severely restricted, minimising road safety risks between the Southern Launch operations and the general public.

It is recommended that traffic management planning is considered during the "construction" phase of the launch facility, which should also provide some level of consultation with relevant stakeholders to increase their awareness of increased construction activity and associated traffic impacts, for the duration of works. DCLEP correspondence indicates that an Event Management Plan should be prepared for each launch event (including a Traffic Management Plan).

4. ROAD SAFETY (CYCLISTS)

For the region under consideration, cycling is generally a recreational activity that currently occurs within the local road network / routes associated with the development, and "sharing the road" is a consideration for the existing traffic and proposed traffic generated by the development. Whilst there may be some overlap between peak traffic and cycling activity, generally cycling coincides with non-peak traffic times, reducing cycling exposure to higher volume traffic periods somewhat.

As mentioned in Section 3 above, the impacts of construction traffic (predicted 12 heavy vehicles per day for 6 months) on other road users should be considered in a traffic management plan, and targeted stakeholder engagement with cyclist groups would be beneficial to raise public awareness of temporary changes to the road environment.

Strava Heat Map (Figure 1) indicates the most popular cycling route in the area is along Proper Bay Road (white line type), with cycling activities diminishing from the point where Proper Bay Road intersects with Donington Road (Lincoln National Park entrance). Cyclist activity is relatively low along Fishery Bay Road (red line type) and beyond to Whalers Way. Therefore, the main exposure for cyclists is considered to be along Proper Bay Road (particularly Port Lincoln to Donington Road).

Proper Bay Road is currently approximately 6.5m wide with 1.5m unsealed shoulders and is generally flat and straight but with sections that have undulating, winding geometry (e.g. at the tramline crossing which has a reverse curve and reduced sight lines to oncoming traffic). The relatively small proportional increase in traffic proposed by the development (56 vehicles per day with 8 commercial vehicles at peak times of operation) on Proper Bay Road is only expected to slightly increase cyclist exposure to additional traffic.

The council document "DCLEP Level of Service Standards – Road Network (Rev 2 July 2016)", Attachment 3 (provided in Appendix B) identifies the following project candidates under the Eyre

Peninsula Regional Transport Strategy, and nominates them for funding through the State managed "Special Local Roads Program (SLRP)":

- Proper Bay Road is identified as a candidate for "1.2m wide shoulder sealing" at a total cost of $720,000.
- Fishery Bay Road is identified as a candidate for 7.8m wide sealing at a total cost of $2.8m

In the case of Proper Bay Road, where cyclist's exposure is predicted to be the greatest, shoulder sealing with an appropriately smooth surfacing provides the most appropriate treatment on a rural road to provide separation between cyclists and other vehicles, and eliminates edge drops that can otherwise occur on the edge of a narrow road adjacent to an unsealed shoulder.

The project candidates are understood to be relatively high priorities for Council but also are subject to state-wide local government prioritisation processes and the projects remain unfunded at this time.

The sections of unsealed road (Fishery Bay Road, Right Whale Road) and within the internal Whalers Way network, cycling activity is considered to be very low and therefore cyclists' potential exposure to increased traffic is also considered to be very low.

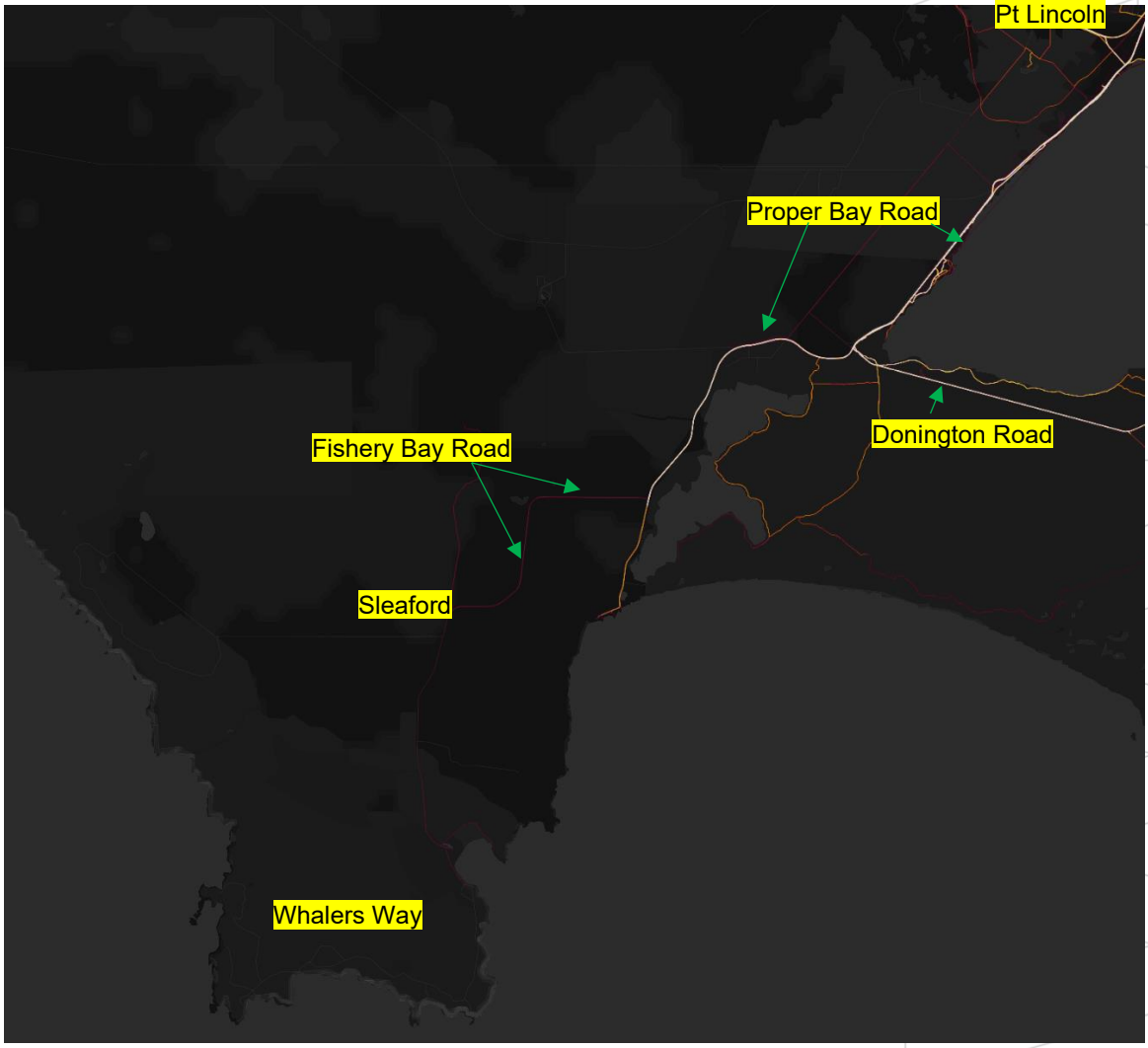

Figure 1 – Cycling Activity "Strava" Heat Map Imagery

5. ROAD MAINTENANCE

Section 5 “Road Access Network” of the TIA identifies the relevant agency for maintenance of the existing road network. These agencies receive funding for the upkeep and maintenance of roads. The majority of road network beyond Yandra Terrace is owned and maintained by DCLEP.

The concerns raised by respondents are understood to be related to the unsealed road network, namely Fishery Bay Road, which would be used more regularly by locals. The TIA addresses this in Section 5.1:

This traffic (an additional 50 vehicles per day) on Fishery Bay Road (if not sealed in the future) may require slightly more frequent grading operations (by Council) on this section of road to maintain the existing shape and ride/roughness (condition) of the road e.g. corrugations may develop more frequently.

DCLEP has responded directly to the above paragraph from the TIA, stating that Fishery Bay Road will require resheeting and possibly may require sealing, rather than more frequent grading.

DCLEP has also requested dilapidation reports be developed, so that road condition can be monitored during the construction period (of the launch facility) and are returned to their pre-construction condition.

The lower order roads (Right Whale Road and Whalers Way) are very low volume and only service a few local properties and provide tourist access to the area. The TIA indicates that these roads may require some upgrades to cater for additional traffic volumes and traffic types.

The council document “DCLEP Level of Service Standards – Road Network (Rev 2 July 2016)” provides descriptions for the various road categories, construction standards, and maintenance standards for sealed and unsealed roads. The document is attached to Appendix B. The road categories are indicated in Figure 2.

Proper Bay Road and Fishery Bay Road are deemed to be category 2 roads. Fishery Bay Road is indicated to be patrol graded 2.5 times per annum on average and re-sheeted on average every 15-25 years. Council correspondence has indicated that the increase in traffic on Fishery Bay Road will reduce the frequency of resheeting to a 10-17 year requirement. The DCLEP assessment however assumes a conservative traffic assumption which requires further refinement with DCLEP.

Category 2 roads have the predicted intervention levels of maintenance of sealed roads as follows (applicable to Proper Bay Road):

CATEGORY 2:

a. Repair surface damage as required
b. Drainage cleaned as required
c. Shoulders re-graded or repaired as required
d. Signage replaced as required
e. Line marking remarked every 3 years
f. Vegetation cleared as required
g. Shoulder weed control as required
h. Reseal frequency 15-25 years

Category 2 roads have the predicted intervention levels of maintenance of unsealed roads as follows (applicable to Fishery Bay Road):

CATEGORY 2:

a. Should be passable comfortably at 80% of the operating speed environment in most weather conditions for 75% of the road length between intersections
b. 2-3 grades per year
c. Repair surface damage as required
d. Drainage cleaned as required
e. Signage replaced as required
f. Vegetation cleared as required
g. Re-sheet frequency 15-25 years

Southern Launch is in the process of negotiating with DCLEP for an agreed maintenance contribution toward the sections of road network that may experience accelerated deterioration.

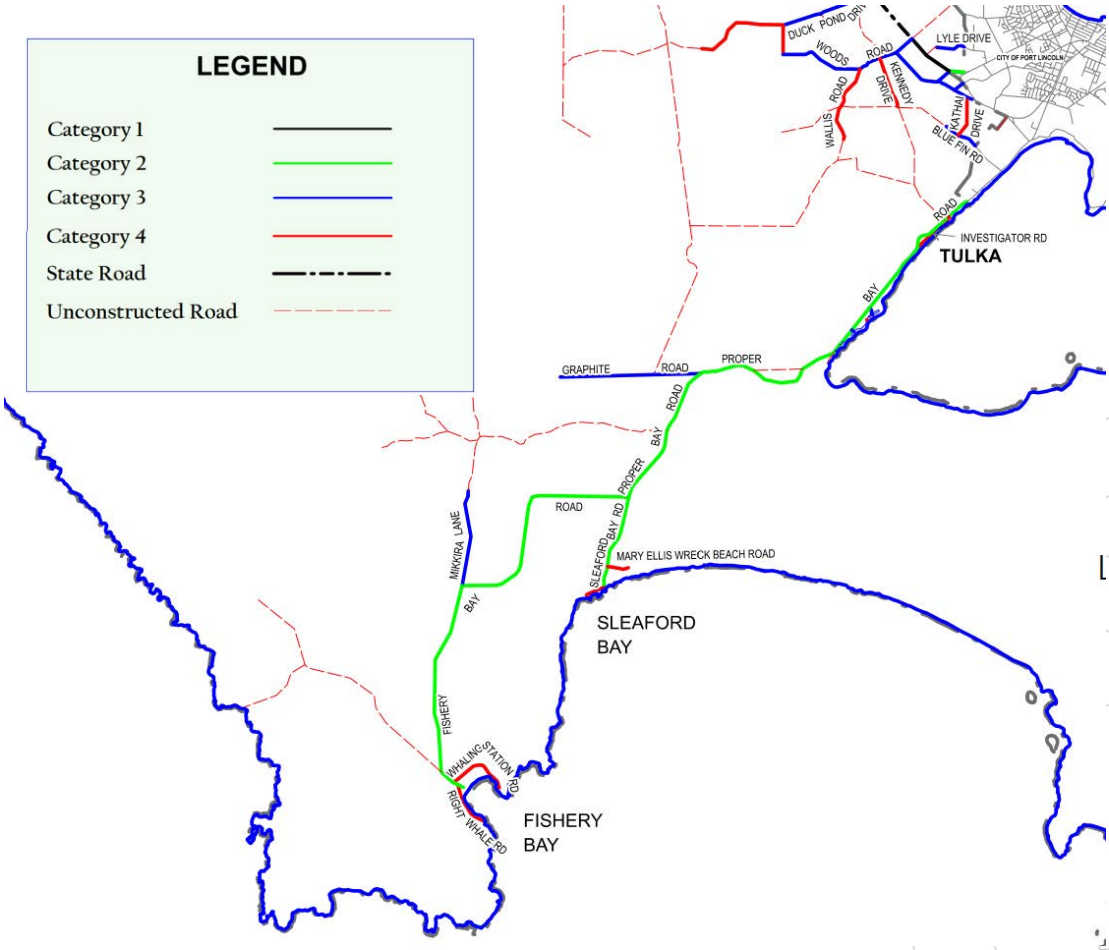

Figure 2 – DCLEP Road Categories from "Level of Service Standards – Road Network"

Granular road building materials are available within Port Lincoln from various sources, for instance DK Quarries is located within 30km by road of the Whalers Road Site. It is possible that road building materials will be sourced and crushed from a nearby "borrow pit" reducing volumes of freight carting rubble via Proper Bay Road, however a representative from DCLEP confirmed that there are currently some environmental approval issues with sourcing materials from borrow pits and carting in rubble may be required for this project.

6. CLIFF INSTABILITY / LAND SLIP / ROCK FALLS CAUSED BY HEAVY VEHICLES

Whilst no geotechnical stability studies have been performed in this part of the site to date as part of the proposed development, regional geology maps indicate that bedrock is exposed at the base of the coastal cliffs. The bedrock is overlain by aeolian calcarenite of the Bridgewater Formation. The calcarenite is variably cemented with zones of strongly cemented rock strength material. The upper 2m or so of the cliffs is likely to comprise unconsolidated sand of modern beaches and dunes.

It is noted that all boreholes drilled during the preliminary geotechnical investigation for the project encountered either dense or cemented materials below about 2m depth, with zones of rock strength materials evident in all boreholes.

The presence of bedrock at the base of the cliffs will reduce the potential (or prevent) the overlying calcarenite from being undercut by wave action.

Based on these geotechnical conditions and a set-back distance of typically 6m to 10m from the road to the top of the cliff, the loads imposed by the 10-12 heavy vehicles per day (on average) are not expected to materially affect the stability of the coastal cliffs. The vehicle speeds are expected to be relatively slow and hence no significant dynamic effects are anticipated. The heavy vehicles will cause deterioration of the road surface, which will require maintenance, which is typical for any unsealed road.

The cliffs are subject to natural erosional and weathering processes and are expected to continue to undergo a gradual degradation over geological time, including during the life span of the proposed development. Such natural degradation may involve local rock falls or slumping, which may pose a hazard to persons on the foreshore. This natural process would not be materially affected by the passage of heavy vehicles along the road.

An on-going monitoring program may be established to record the condition of the adjacent cliff top during the course of the works.

7. SUMMARY

In summary the following findings are drawn from review of public representations:

- 33 public representations raising traffic related matters were submitted in response to the development.
- These matters are summarised into five distinct categories as detailed and addressed above.
- The development proposes a “peak” net increase of 50 vehicles per day, of which 8-12 are commercial vehicles. This is only during peak operational times when the facility is preparing for, or demobilising after rocket launching, thereafter traffic volumes will restore to existing levels.
- The TIA assessment indicates that overall road safety of the public road network will remain satisfactory post development, provided road surfacing and traffic control features are maintained to an acceptable condition.
- Regular cycling activity is generally concentrated to Proper Bay Road (north of Donington Road) and is low beyond the sealed section of road. Post development traffic is unlikely to increase cyclist’s exposure risks to a significant degree, however Event Management Planning and stakeholder consultation is recommended to improve public awareness of specific activities, and decrease exposure risks. Council is strategically seeking funding toward sealed shoulders to this road which will provide high safety benefits for cycling.
- Road maintenance is primarily a function of council however Southern Launch is in the process of negotiating with DCLEP for an agreed maintenance contribution toward any dilapidation of the road asset caused by the development.
- A geotechnical assessment indicates that rock falls and land slips along Right Whale Road are unlikely to be induced by dynamic effects from the proposed development’s increase in heavy traffic.

We trust this response has addressed your requirements, however, should you require any further information we ask you to contact the undersigned.

Yours faithfully

Justin Henderson
for
WALLBRIDGE GILBERT AZTEC

JH:hge

APPENDIX A
RESPONDENT COMMENTS (SPECIFIC TO TRAFFIC)

Representations – Whalers Way (Traffic Related)

Safety: 25, 64, 107, 124, 139, 177, 194, 223

Road Maintenance: 25, 26, 64, 101, 107, 122, 124, 128, 165, 213, 223, 239, 256

General Impacts (to industrial traffic): 41, 49, 51, 62, 125, 127, 144, 173, 179, 249

Geotech issues created by heavy traffic: 107, 226, 231

25. Scholz

- The location will allow for higher degree of safe vehicle access to a launch site that will not compromise shared road usage and safety for existing tourism operations, general public usage and adjoining land holders.
- An existing network of access road and tracks currently exist to service SA Water infrastructure that has no access to the general public or tourism operations and is not the responsibility of the District Council or its ratepayers.
- The road distance of the site from Port Lincoln is relatively similar to the Whalers Way site however most of it can be on the road / track network as described above with agreements made between the proponent and the South Australian Government that will minimise responsibility to the District Council and its limited ratepayer base.

- The trucking in of such large amounts of water as outlined by the proponents will put the existing road network under considerable duress. How will the overall road management to ensure safety for other road users, the road surface, signage etc be undertaken and by whom? Who will be responsible for the financial cost.

26. Solly

It must be clear from the existing roads (tracks) that this is not an environment that will tolerate heavy vehicles and machinery without significant damage.

disruption to the people of all the Lower Eyre Peninsula. There is no train line, there is no major highway to transport all the goods required it would add significantly to the road risk already putting our transport systems under pressure since the removal of the grain train. If this project were to be approved Government would need to budget for major transport and infrastructure upgrades from Port Augusta to Port Lincoln.

41. Gynell

"Concerned that during construction phase 12 Semi Trailers and 15 SUVs will be passing my home per day. During launch will add 15 Semi Trailers and 56 vehicles per day to traffic past home". Noise, Pollution, Dust, Privacy, Safety are all concerning to me"

49. LeBrun

"Traffic through Port Lincoln and along the 10kms of gravel roads to the launch site will be a higher impact."

51. Gigger

greatly exacerbated. Other concerns include increased traffic on the Fishery's Bay road and the subsequent deterioration, risk to wildlife, as well as increased heavy traffic in the local area. Long term prosperity for

62. Thorpe

"Areas of concern include traffic and pollution, public access and impact on wildlife"

64. Hage

Fishery Bay Road is often prone to disrepair and conditions are not conducive to large volumes of traffic.
As of the last few years the District Council of Lower Eyre Peninsula have struggled to economically source materials for the road, and as a result the road has fallen into neglect.
Are Southern Launch going to compensate the DCLEP for the increased use of the road or otherwise invest capital in its upkeep.
Proper Bay Road, south of the locality of Tulka is a corridor for the movement of native wildlife including but not restricted to kangaroos, emu, snakes and Shingleback (Sleepy) lizards, this corridor also extends to Fishery Bay.
As evidenced by the increased level of traffic during the construction of the Cathederal Rocks Wind Farm, a large number of these animals will inevitably be killed.
Fishery Bay Rd is commonly used for the movement of livestock between properties. With increased levels of traffic and without the proper due care the results of a conflict between these two activities could be disastrous.

101. LeBrun

“Who will make the repairs to Fisheries Bay Road? This should be upgraded and maintained by Southern Launch. With Port Lincoln and surrounds needing upgrades to roads then where will the funds come from”

107. Hearn

Fishery Bay road barely copes with the amount of traffic it has now. It would not be unusual for 50 cars to come and go over a day: surfers, beach goers, tourists visiting Whalers Way (before the rocket test launching started), cyclists, young kids just going for a drive or out to camp, plus

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a daily school pick up and drop off service.. On weekends and good weather Fishery Bay is lined with cars.

Fishery Bay road has not been adequately addressed in the proposal. " Some additional maintenance such as more frequent grading" (Appendix AA p47) will not address the very real, very significant risk of loss of life due to the increased traffic and trucks that will be on this road should the proposal go ahead.

In the last two weeks I have had 3 almost crashes with semi-trailers who have been bringing stuff out for Southern Launches test rockets. Fishery Bay road is less than 7 metres wide in places, there are crests and blind corners, parts of the road drop several feet directly at the edge. It is littered with potholes and these have increased dramatically in just the last few weeks, leading to very dangerous driving conditions. Please see attached photos. There are regularly emus, kangaroos and koalas crossing the road and creating more hazards for road users.

Sections of Right Whale Road (which leads from the end of Fishery Bay Road to Whalers Way) are less than 6 meters wide. Parts of this road are less than 10 metres from the edge of fragile cliffs. There have already been large boulders of cliff fall with all the increased traffic. Please see attached photos. They estimate there will be 1400 heavy vehicles accessing the site in the first 6 months alone (Appendix AA page 41) What will this do to our roads? What will this do to these fragile cliffs? What if there are people on the beach when one of these cliff edges collapses from all the increased weight on it?

This road was graded in June and is already in a terrible state with all the increased heavy vehicle traffic. My photos were taken on the 5th September, less than three months since grading! It is neither fair nor reasonable that the upkeep of this road should fall to rate and tax payers to support a private company operating for profit. It is not fair to all the residents who have to drive this road to work every day that their cars should have to suffer all the extra wear and tear created by Southern Launches traffic. Please note all this damage has been caused only by this temporary development, and it already shows what an impact this development will have.

How is it possible to allow such a huge increase in traffic, especially 19m semi-trailers, and not consider the safety of the people who use this road every day? I have approached the District Council of Lower Eyre Peninsula about my safety concerns and was advised they had no comment on any of the issues I attempted to talk to them about. This is unacceptable! Will it take someone to lose their life before the government makes Southern Launch address this issue? Because if nothing is done about Fishery Bay Road then it will only be a matter of time before someone dies as a direct result of this development not addressing the road access issues.

122. Taylor

"Heavy Vehicles thundering up the little fragile gravel road"

124. Sleaford Bay Action Committee

1. Extra Traffic

Significantly, the extra traffic on the Proper Bay and Fishery Bay Roads is of major concern.

The development proposes that **per launch** there will be: 3 Fuel deliveries per week, 3 Oxidiser deliveries per week, Launch vehicle transport to site, 3 crane movements per week, 1 generator fuel delivery per week, 1 septic tank pump out per week, 24 + other vehicles (Staff, VIPs 4WDs, small trucks et.) plus delivery of water, food, sundries. The large delivery vehicles will be 19 metre semitrailers.

The proposal is for 36 (+ 6 suborbital) launches per year, which means that this amount of traffic will be on an almost continuous basis throughout the year. As residents and users of this road, we are extremely concerned about this amount of traffic on our roads, which have not been designed for this purpose.

Proper Bay Road is a single lane bitumen road frequented by local residents, beach goers, surfers and visitors to the area. It is also a favourite route for cyclists, as well as for a family of emus near Tulka which regularly steps onto this road when they are raising their chicks. Kangaroos and koalas, as well as lizards, birds and snakes, also often frequent this area.

Fishery Bay Road is an unsealed road which contains a number of dangerous bends and crests. It deteriorates rapidly, and is graded once a year by the DCLEP, who have recently informed our progress association that they currently have no available quarry material to maintain this road. The Traffic and Access report in the EIS (Appendix AA) omits Fishery Bay road entirely, other than to mention that the Council may need to grade it 'slightly more frequently'.

Farmers along this road often need to use it to run their sheep between paddocks, or to the shearing quarters, and there is often farming vehicles and other machinery present on the road.

The added stress which will come from having to share the roads with heavy vehicles, the increased damage to the road, the risk to our vehicles (residents have already experienced windscreen damage as a direct result of increased heavy vehicle traffic on Fishery Bay Rd due to the test launch), the increased dust and noise, and the effect on wildlife, all combine to make us very uncomfortable with this proposal.

125. Haapanen

“Continuous coming and going of heavy vehicles between sites”

127. Duncan

“increased activity and traffic will created an unsafe environment for birds and animals…condition of the road between Port Lincoln and Whalers Way. It is already quite a busy road used by local landholders, school bus, tourists and recreational fishing, surfing and other beach going families. The roads had been intended for all the extra trucks servicing the proposed development”

128. Gorvell

“The existing roads can barely cope with the traffic now. The District Council responsible is already pleading for materials to rebuild them”.

139. Hicks

ROAD ACCESS: At present, and for quite some time, the Right Whale Road has warning signs that the fragile overhanging cliffs were to be kept away from. What will happen when launch vehicles, cranes, fuel trucks and other heavy vehicles frequent this road. It will certainly interfere with the cliff face and make it even more dangerous for cyclists,local road users, beach visitors, surfers.

144. Casanova

"heavy vehicles impact on pristine wilderness"

152 Threadgold

accumulation of chemical residue deposited on the surrounding area , including my/our home property also increasingly heavy vehicle traffic and dust from road making etc. will be an overwhelming intrusion .

165. Clarke

11. They then went on to allege, that by closing the site to the public , "will reduce the current level of human disturbance " and " it is anticipated that the eastern Osprey may have the opportunity to use the coastline more actively " Completely neglecting to mention the impact of a dozen trucks a day, multiple machines, over 50 light vehicles, helicopters (which fly overhead) and the Launch facility, which
"will generate noise levels equivalent to a small warehouse more than % 99.9 of the time"

13. A local contractor who built a quarry, (with four truck movements a day) was required by the local council to contribute to the Fishery Bay road. There is no such requirement for Southern Launch due to the government's Major Project status, which allows them to ignore the rules the rest of us are subject to, they state " some additional maintenance, such as more frequent grading will likely be required on Fishery Bay road to cater for the additional proposed traffic volumes " I guess the rate payers will be picking up the tab.

173. Green

-Fishery Bay Road being used by an industrial level of heavy traffic

177 Hodson

2. The impact of increased traffic on Proper Bay Road and the Fisheries road. These roads are already very well used, in particular the Proper Bay Road, by tourists, local residents, surfers and cyclists accessing Lincoln National Park, Tulka, Sleaford, Fisheries and Whaler's Way, We are concerned that the increased use of these roads by vehicles, particularly industrial vehicles, travelling to and from the launch site represents a threat to wildlife in the area- including koalas, emus, kangaroos, snakes and sleepy lizards - which frequently cross the road. It will also pose a threat to the safety of children and pets in the Tulka area.

179 Lawler

-Fishery Bay Road being used by an industrial level of heavy traffic

194. Pedler

SCHOOL BUS

Have the Department for Education been fully advised of this Project and what is their opinion of the impact on the Fishery Bay School bus route? Has a risk assessment been done regarding the bus route being exposed to a significant increase in traffic, including heavy vehicles and vehicles carrying highly flammable and explosive contents, children in the bus and those waiting on the side of the road to be picked up or walking along the road to return home?

213. Davison

The road system to this location was never constructed to cope with commercial and heavy traffic in the volumes suggested in the EIS - there appears to be no plan or budget towards the upgrading of the road system to suit the proposed use.

223. Barnes

TRAFFIC_Proper Bay Road/ Fishery Bay Road_App_AA This route will need to be upgraded to allow for this volume of traffic. The EIS makes no mention of this, other than in App AA: (pg 16) "This traffic on Fishery Bay Road may require slightly more frequent grading operations (by Council)." For cyclists, surfers, beach visitors, and local road

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users; these roads will become dangerous. The dangerous section of Right Whale Road, where the fragile overhanging cliffs are less than 10 metres from the road, is completely ignored in the EIS.

226. Archer

"Rocks or boulders have already started falling onto the beach at Fishery Bay. These large trucks are already having an impact on this delicate environment"

231. Lloyd

What about the degradation to the roads with increased volume and large semitrailers and tucks?? Of main concern is the fragile coastline at Right Point near the entrance to Whalers Way. There are already reports from locals of rocks falling onto the beach below. And it is not enough to claim that the council will grade it more often – at who's expense? The ratepayers?? (I am one).

239. Paynter

:Damage to the already inadequate roads

249. Ayers-Lawler

-Fishery Bay Road being used by an industrial level of heavy traffic

256. Masto Myles

I am very concerned too at the proposed loss of native vegetation in the Sanctuary. There are a number of diverse habitats within the Sanctuary within which few weeds exist and Phytopthera is absent. The proposal is to clear 24 Hectares of native vegetation plus a 3 metre buffer on the sides of roads, possibly increasing to 6m on each side. The erosion potential of this level of clearing should also be of concern.

The local roads are not sealed, require frequent upkeep and are already prone to pot-holing. It is certainly not clear to me who will pay for the upkeep of these roads, but I suspect it will not be Southern Launch, as they say the existing road network is adequate.

Representations – Whalers Way (Cycling Related)

57. – Peninsula Pedallers

This submission is made on behalf of Peninsula Pedallers Inc., a Port Lincoln-based cycling group, affiliated with Bicycle SA. I am the Secretary / Treasurer of this organisation.

We are concerned about the heightened risk to cyclists posed by the marked increase in heavy vehicle traffic along the sealed Proper Bay road, both during the construction phase and on-going once rocket launches are a regular occurrence.

This is an issue that the Environmental Impact Statement has failed to address in either the Transport and Access Impact Assessment or Effects on Human Populations analysis.

The sealed road from Port Lincoln to the Fishery Bay road intersection is by far the most popular cycling route in the district for local residents and visitors alike. This is due to the relative safety of the route, with only very occasional heavy vehicle traffic beyond the Port Lincoln city limit, as well as the pleasant bush and coastal vistas. My estimate is that about 60 to 80 cyclists ride part (e.g. into the Lincoln National Park) or all of this route (to the end of the bitumen at Sleaford) on a regular basis, enjoying the excellent recreational and healthy amenity that this route provides.

With the projected 12 heavy vehicle round trips per day during construction, dropping back to 5 per day when the facility is fully operational, and the associated increase in light vehicle traffic, the potential for an accident with a cyclist is unfortunately magnified. The number of crests and sweeping bends on the road impeding sight lines for overtaking and oncoming traffic adds further danger to cyclists on this route.

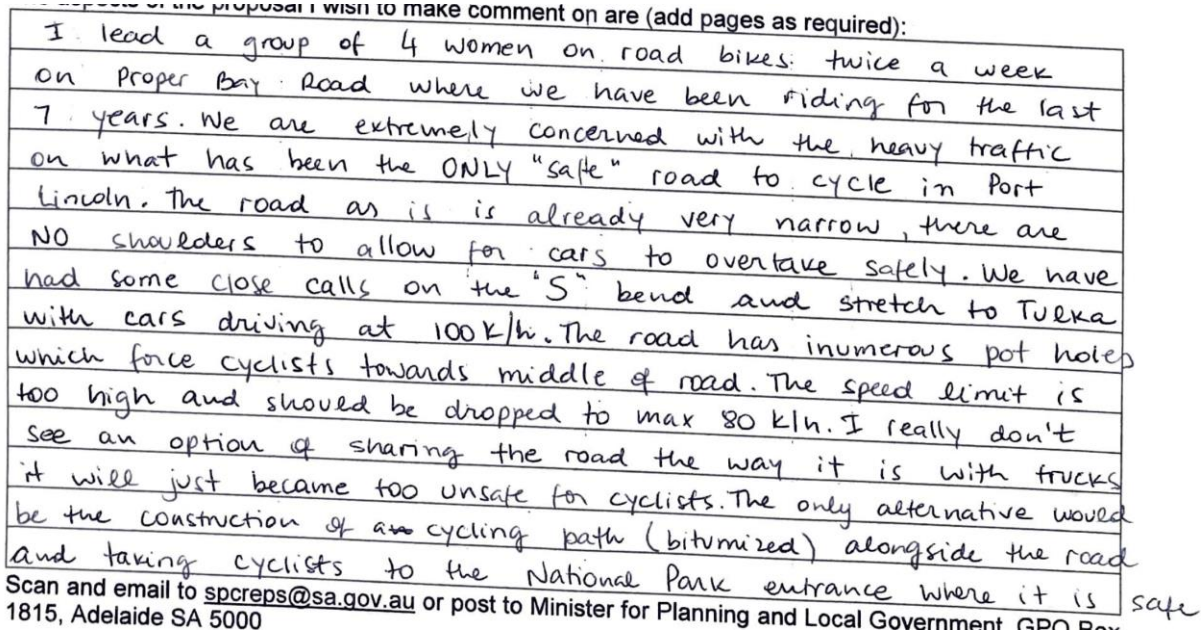
The sealed roadway is only 6.5 m wide, and the apron on both sides is generally in poor condition, with a 10 to 15 cm drop-off along much of the route, posing an additional hazard to cyclists attempting to hug the edge of the seal. The condition of the apron can be expected to deteriorate further when vehicles passing a heavily laden 19 m semi-trailer travelling in the opposite direction move over to the far left of the roadway.

As a cyclist, the prospect of being overtaken by a 19 m long semi-trailer travelling at 100 km/hr on a 6.5 m wide roadway is not something i look forward to. And i fear that this may be a deterrent to cyclists riding this route, especially less experienced or confident riders, resulting in the loss of a great amenity that we now enjoy.

Our members have suggested a number of measures for consideration to protect their safety and enjoyment while continuing to cycle on this route:

- Repairing cracked and pot-holed sections, that force cyclists to move away from the edge of the road.
- Widening the sealed roadway to a minimum of 8 m, and repairing the aprons, or further widening the road to accommodate designated bike lanes along the full length.
- A maximum speed limit of 80 km/hour for semi-trailers.
- Limitations to days and times of heavy vehicle movements.
- Advance notification of heavy vehicle movements to alert cyclists.
- Heavy vehicles to be escorted to alert cyclists and other road users.
- Provision of alternative good quality shared use (walking and cycling) trails in the area, e.g. on the former BHP tram line to Coffin Bay.

60. Lacorte



...proposal I wish to make comment on are (add pages as required):

I lead a group of 4 women on road bikes twice a week on Proper Bay Road where we have been riding for the last 7 years. We are extremely concerned with the heavy traffic on what has been the ONLY "safe" road to cycle in Port Lincoln. The road as is is already very narrow, there are NO shoulders to allow for cars to overtake safely. We have had some close calls on the "S" bend and stretch to Tulka with cars driving at 100 K/h. The road has inumerous pot holes which force cyclists towards middle of road. The speed limit is too high and should be dropped to max 80 k/h. I really don't see an option of sharing the road the way it is with trucks it will just became too unsafe for cyclists. The only alternative would be the construction of a cycling path (bitumized) alongside the road and taking cyclists to the National Park entrance where it is safe

Scan and email to spcreps@sa.gov.au or post to Minister for Planning and Local Government GPO Box 1815, Adelaide SA 5000

72. LeBrun

"cyclists are in direct danger of being injured, maimed or killed by the ever increasing traffic and semi trailer vehicles along Proper Bay Road"

107. Hearn

Fishery Bay road barely copes with the amount of traffic it has now. It would not be unusual for 50 cars to come and go over a day: surfers, beach goers, tourists visiting Whalers Way (before the rocket test launching started), cyclists, young kids just going for a drive or out to camp, plus

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a daily school pick up and drop off service.. On weekends and good weather Fishery Bay is lined with cars.

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ABN 13 559 739 724

R21/20408

16 September 2021

Minister for Planning and Local Government
Attention: Robert Kleeman, Manager, State Assessment
Planning and Land Use Services
Attorney General's Department
GPO Box 1815
ADELAIDE SA 5000
E-mail: spcreps@sa.gov.au

Dear Minister,

Re: WHALERS WAY ORBITAL LAUNCH COMPLEX – ENVIRONMENTAL IMPACT STATEMENT – COUNCIL SUBMISSION

I write in relation to the Whalers Way Orbital Launch Complex Environmental Impact Statement (EIS) which is currently released for public consultation and thank the Minister for the opportunity to comment on this significant development proposal.

This letter outlines the District Council of Lower Eyre Peninsula's (the Council) understanding of the proposed development, the provision of information, the impact on our infrastructure and position on some key planning considerations.

Proposed Development and Provision of Information

The proposal seeks to establish an Orbital Space Launch Facility at Whalers Way, Sleaford and includes the following

- launch pads
- assembly facilities (both temporary and permanent)
- secure block houses, blast walls and firing bunkers
- lightning rods and anemometer towers
- propellant (liquid, hybrid and solid) storage
- diesel power generators and solar arrays
- bunding for blast wave deflection
- office, laboratory and research related facilities
- visitor viewing facilities
- road transport access.

In relation to the information that has been provided with the EIS, Council has focused its comments primarily on elements of the proposal that would have some level of impact upon Council operations.

Impact on Council Infrastructure

Transport and Access (Clause 15)

Page 473 of the EIS states that during standard operations (following construction) the expected additional traffic on access roads will be approximately 56 Vehicles Per Day (vpd) with 8% (4.5vpd) being heavy vehicles. Page 479 details the specific roads that will be utilised by Southern Launch for access to Whalers Way including two roads maintained by Council being Proper Bay Road and Fishery Bay Road. The EIS states that the number of vpd for these roads is unknown.

Page 488 provides the following comment about the impact of the additional vehicles on Council roads as a part of general operations (after construction period);
"An additional 50 vehicles per day using the sealed section of Proper Bay Road is unlikely to have any noticeable effects on pavement life or degradation. The additional traffic generation on Fishery Bay Road may require slightly more frequent grading operations on the affected section of road to maintain the existing shape and ride/roughness (condition) of the road e.g., corrugations may develop more frequently."

Council advises the approximate vpd for the mentioned roads;

Proper Bay Road: 560 vpd
Fishery Bay Road: 160 vpd

56vpd will increase the traffic volume of the roads as follows;

Proper Bay Road: 10% increase
Fishery Bay Road: 35% increase

Council agrees that the 10% increase on the sealed Proper Bay Road is unlikely to have major effects on pavement life or degradation however note that it is a significant increase for that road.

Council notes that a 35% increase on the unsealed Fishery Bay Road is a significant increase and will have a large impact on the pavement life and rate of deterioration.

Council notes that grading the road slightly and more frequently is firstly, not practical, this is because grading routines are heavily dependent on weather and secondly, more frequent grading will actually cause significant long-term issues for the pavement. Each grade deteriorates and eliminates small portions of the pavement, more frequent grading (whilst improving the rideability for short periods of time) has a detrimental effect on the pavement

leading to a lessened life. The major cost is realised in resheeting maintenance. Councils current Level of Service (LoS) dictates a resheeting frequency of 15-25 years for Fishery Bay Road, this vehicle volume growth could result in that requirement being increased to a 10-17 year resheeting requirement.

Generally, the proponent would need to acquiesce to an agreement whereby they would cover the cost of a portion of yearly cyclical maintenance as well as a portion of resheeting costs.

Furthermore, it should be noted that there are significant issues with sourcing rubble in order to maintain Fishery Bay Road. Council have tried unsuccessfully to gain access to rubble in the area. The largest hurdle being the inability to obtain Native Vegetation clearance approvals to either expand existing or establish new rubble pits. An issue being experienced across the entire Council area. The increase of 35% on this road will have significant impact on the road with the increase expected to considerably speed up deterioration of the road pavement.

Council considers it unfair for its ratepayers to be burdened with having to cover the cost of this level of increase caused by what is essentially a private development. Council recommends that the road should be upgraded to a sealed pavement with the cost being borne by the proponent (&/or others).

Page 482 estimates approximately 1,400 heavy vehicles will be required to access the site during construction at a rate of 12 per day over 120 days.

Council will require a dilapidation report to be developed at the proponent's cost and the report should detail the current standard of both Proper Bay and Fishery Bay Roads. Council will require the roads to be returned to their pre-construction condition at proponents cost following construction.

Visual & Amenity Impacts (Clause 16.4.5)

Page 514 states that the proponent does not propose any vantage points or viewing platforms however in Part 4.15.2 of its Emergency Management Plan, the company lists four potential locations where the public would be encouraged to attend to view the launches. It also mentions that *'Southern Launch Media will advise of the best sight locations for viewing'.* Council recognises that the proponent isn't planning on constructing a viewing platform however is concerned that there are a few areas which are likely to be utilised as viewing points and the company has not adequately recognised its responsibilities to put appropriate management plans in place for these areas. The launches will be spectator events whether the proponent constructs viewing platforms or not and Council has some concerns about those places where viewing will occur that are not set up for large numbers of people at one time.

Council also has concerns about the potential traffic increases and congestion that will likely be present in both the Fishery Bay and Sleaford Bay areas during Launch events. It is understood that the events won't be publicly advertised however it is foreseeable that people will be aware of the launches and seek viewing spots at these areas due to the Whalers Way access being closed. It is clear that the proponent also recognises this as evidenced by their FAQ response below:

> Can I come and watch a launch?
>
> Sure! We will be organising dedicated viewing areas so that you and your family can come and watch. Follow us on social to keep up to date when we will be performing launches.

It is not sufficient and irresponsible to only have a SAPOL presence as there needs to be planned management of the parking and viewing areas.

Council believe that the proponent must prepare an Event Management Plan for each launch event. The Event Management Plans should include a Traffic Management Plan for the Sleaford Bay and Fishery Bay areas as there is likely to be very high congestion in those areas surrounding the launch events. It should also include plans for post-launch clean-up of the public viewing areas and additional rubbish collection and disposal.

Council also requests that the proponent be tasked with the responsibility of assisting Council in identifying suitable public launch viewing areas and for the proponent to be responsible for funding any potential on ground works required in those areas and any potential increase in service levels in those areas as may be required.

Additional Planning Considerations

Council acknowledges that a temporary facility (Development Application 21006593) has been approved in order for the company to undertake three test launches to gather empirical evidence relevant to the current assessment of the Whalers Way Orbital Launch Complex (WWOLC). With this in mind, Council notes that many of the key planning outcomes will be informed by the results of the test launches and to a degree do not believe that there is sufficient data yet available to adequately assess the full extent of any environmental impacts at this time.

Council also notes the close proximity of the launch site to residential homes and encourages Southern launch to consider the impact to these ratepayers when scheduling launches.

In addition to the concerns already raised in this submission, Council also requests that in considering this proposal, the Minister also take into account any empirical evidence gained by the test launches as well as any other relevant planning matters including but not limited to the following:

- The key environmental protection outcomes sought by the Conservation Zone, Visitor Experience Sub-Zone and all applicable Overlays;
- Noise and vibration impacts on nearby sensitive receivers (including local fauna);
- The company's General Environmental Duty under the Environmental Protection Act 1993; and
- Vibration impacts on nearby State and Federal Heritage Listed Items, including shipwrecks.

Should you have any questions regarding the matters raised in this letter, please contact Council's Director Development & Environmental Services, Leith Blacker on (08) 8623 0600.

Yours faithfully

DELFINA LANZILLI
CHIEF EXECUTIVE OFFICER

APPENDIX B
DCLEP LEVEL OF SERVICE STANDARDS – ROAD NETWORK

District Council of Lower Eyre Peninsula

Level of Service Standards

-Road Network-

Rev2 – FINAL – July 2016

Contents

Adopted by Council August 2016

1) Context of Service

One of the principal requirements that each local government's community expects is for their Council to manage the road network in a safe and effective manner.

Connectivity for social, freight, and tourism purposes is essential for the social and economic wellbeing of the District and the region. With the population of the Lower Eyre Peninsula being approximately 5,000 and dispersed across almost 5000 square kilometres the requirement for an extensive road network across a range of terrain and soil environments is necessary.

Interspersed within the principal land use of general farming and significant areas of national parks and the Uley Basin water protection zone are 21 population centres and numerous access points to the coastline.

Due to a reliable grain growing region, harvest tonnages are large, and with strong visitation levels by tourists and the seasonal movement of landowners to and within the region over Spring, Summer and Autumn, traffic demand will fluctuate during the year. Generally peak traffic volumes occur in the drier months from mid-October (commencement of harvest) through to mid-April (Easter holidays).

2) Objective of Service

The District Council aspires to provide an appropriate 'fit for purpose' road network.

3) Service Detail

In determining what is 'fit for purpose' requires evaluation of a number of criteria that includes traffic volume and type, trafficable width, all-season access, ride quality, intervention to maintain or renew the trafficable surface and associated elements of kerbing, drainage, signage and vegetation management.

Street lighting and footpaths/walking trails are not included as criteria in this level of service standards as they are treated separately.

a) Road Classification/Functional Road Hierarchy

It is inevitable that the nature of a road network across the size of the District Council will vary due to what function an individual road serves. The development of a uniform approach to road classification across the rural based councils on the Eyre Peninsula required the District Council to review and adopt a new road classification system. The system incorporates both sealed and unsealed standards for rural and urban locations.

A map detailing the road classification of individual roads is provided as an attachment. The following table sets out the functional hierarchy.

TABLE 1

Road Category	*Class type*	*Function description*	*Context*
1	*Arterial*	Major roads (sealed and unsealed) which have a significant freight, social and tourism use. The significance of each traffic type may vary.	• Links service and tourist towns • Gazetted GML route • Unsealed roads are formed and sheeted
2	*Collector*	Main roads (sealed and unsealed) that link to Arterial roads. Principle use is freight and social purposes.	• Link to settlements and towns • Local traffic to Arterial roads • Leads to recreational and tourist features • Unsealed roads are formed and sheeted
3	*Major Local Access*	Consists of sealed and unsealed roads as follows: • Rural Living roads • Urban roads • Farm gate to Collector roads Principle use is freight and social purposes.	• Township roads • Rural Living roads • Access to rural properties • Access to transport routes • Unsealed roads are formed and generally sheeted
4	*Minor Local Access*	Unsealed roads used as farm gate access to Collector or Major Local Access roads.	• Access to rural properties • May provide access to transport routes • Unsealed roads that are typically not sheeted

b) Construction Standards

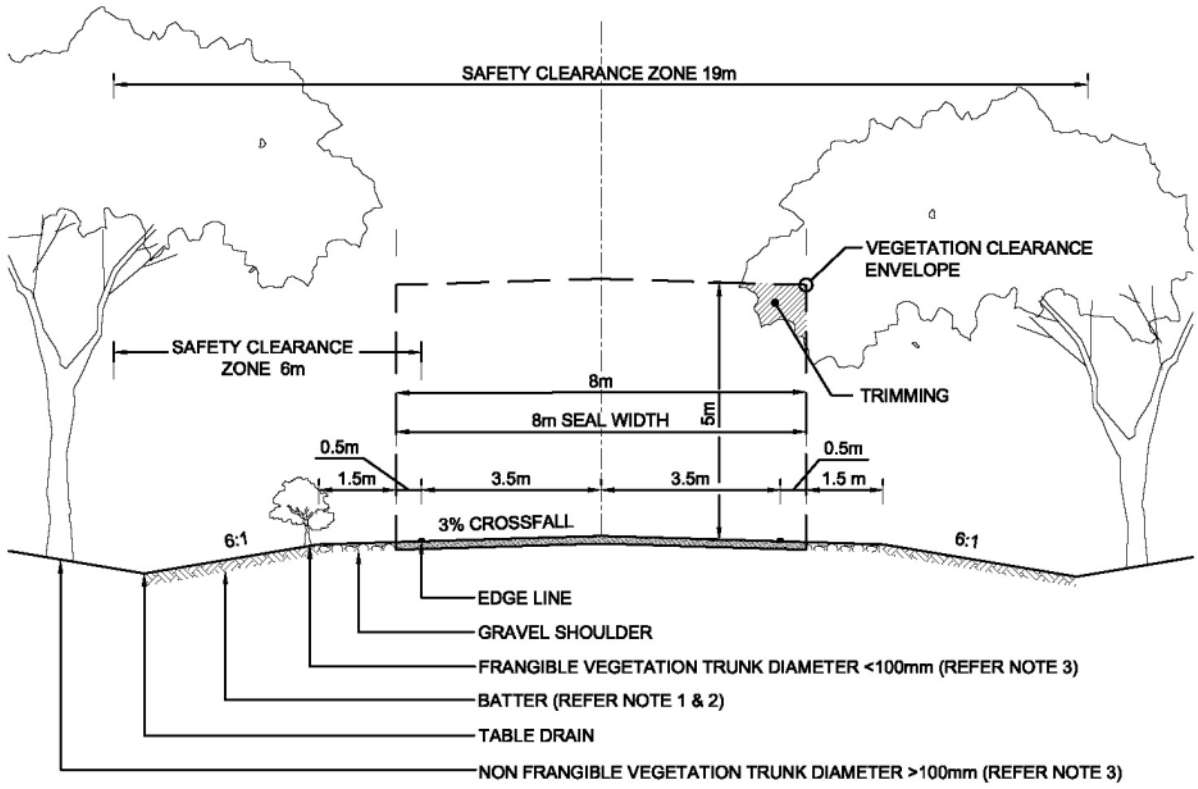
As a guide, the intended standards to be achieved through the implementation of Council's Strategic Plan, Long Term Financial Plan, and Asset Management Plans for the road network are outlines as follows:

TABLE 2

Designation	Typical Road Standard	Comment
Major Towns	sealed road network with kerbing and defined stormwater drainage	
Minor Towns and Coastal Settlements	generally formed and surfaced roads with defined stormwater drainage to protect residential assets	Sealed roads may be provided to address traffic or environmental issues (dust, erosion, topography)
Rural living zone	sealed road network with defined stormwater drainage to protect residential assets (may include isolated sections of kerbing)	Current land division policy requires sealed roads. Older rural living land divisions did not.
General Farming zone	Combination of formed and rubble sheeted and formed natural surface roads except where roads are Category 1 or 2 and have been included in the Eyre Peninsula Regional Transport Strategy.	

To interpret the descriptions in the following tables, a schematic of the terms used a typical cross section courtesy of the DC Wudinna is provided. The sample shows a Category 1 A road.

FIGURE 1



Note: the above cross section terminology is under review by the rural based EPLGA councils to resolve conflicts with road management and vegetation management.

The following tables set out the desired construction standards for the respective categories of roads.

TABLE 3.1

Road Category	***Class type***	***Surface***	***Construction standard /description***
1 A	Arterial	Sealed	• Safety Clearance – 19 m • Vegetation envelope – 8 m • Formation width – 8 m • Pavement width – 8 m • Seal width – 7m plus 2 x 0.5m sealed shoulders • Pavement thickness – subject to design • Shoulder width – 1.5 m beyond edge of seal • Batter width – variable at 1:6 slope
1B	Arterial	Unsealed	• Safety Clearance – 17 m • Vegetation envelope – 8 m • Formation width – 8 m • Sheeted width – 8 m • Pavement thickness – 150 mm • Batter width – 1.5 m minimum (maximum 1:4 batter slope to table drain or natural surface)

TABLE 3.2

Road Category	*Class type*	*Surface*	*Construction standard /description*
2 A	Collector	Sealed	• Safety Clearance – 17.6 m • Vegetation envelope – 8 m • Formation width – 7.0 – 7.2 m • Pavement width – 7.0 – 7.2 m • Seal width – 6.6m plus 2 x 0.2 - 0.3m sealed shoulders • Pavement thickness – subject to design • Shoulder width – 1.5 m beyond edge of seal • Batter width – variable at 1:6 slope
2 B	Collector	Unsealed	• Safety Clearance – 15 m • Vegetation envelope – 8 m • Formation width – 8 m • Sheeted width – 8 m • Pavement thickness – 150 mm • Table drain CL offset – 1.0 m

TABLE 3.3

Road Category	*Class type*	*Surface*	*Construction standard /description*
3 A	Major Local Access	Sealed (Rural Living)	• Safety Clearance – 17.6 m • Vegetation envelope – 8 m • Formation width – 7.0 – 7.2 m • Pavement width – 7.0 – 7.2 m • Seal width – 6.6m plus 2 x 0.2 - 0.3m sealed shoulders • Pavement thickness – subject to design • Shoulder width – 1.5 m beyond edge of seal • Batter width – variable at 1:6 slope
		Sealed (Urban)	• Formation width – 8.6 (seal plus kerbs) • Pavement width – 8.6 m (seal plus kerbs) • Seal width – 7.4m (plus 0.6m for kerb channels) • Kerbing – kerb and channel both sides • Pavement thickness – subject to design • Verge width –varies – minimum of 3m graded at 2%
3 B	Major Local Access	Unsealed	• Safety Clearance – 14 m • Vegetation envelope – 8 m • Formation width – 8 m • Sheeted width – 8 m • Pavement thickness – 100 mm • Table drain CL offset – 1.0 m

Roads within urban areas (not Rural or Rural Living) will be considered to be Cat 3 roads for classification purposes however the actual construction standards will vary.

In general terms the above table states the minimum standard to apply.

TABLE 3.4

Road Category	*Class type*	*Surface*	*Construction standard /description*
4	Minor Local Access	Unsealed	• Safety Clearance – 10 m • Vegetation envelope – 8 m • Formation width – 4 – 7 m • Table drain CL offset – 1.0 m; Batter width – 1.0 m

c) Maintenance Standards

Maintenance requirements vary between the road classes and whether sealed or unsealed.

i) Sealed Roads

The predicted intervention levels for maintenance of sealed roads are listed as follows:

CATEGORY 1:

a. Repair surface damage as required
b. Drainage cleaned as required
c. Shoulders re-graded or repaired as required
d. Signage replaced as required
e. Line marking remarked every 3 years
f. Vegetation cleared as required
g. Reseal frequency 10-20 years

CATEGORY 2:

a. Repair surface damage as required
b. Drainage cleaned as required
c. Shoulders re-graded or repaired as required
d. Signage replaced as required
e. Line marking remarked every 3 years
f. Vegetation cleared as required
g. Shoulder weed control as required
h. Reseal frequency 15-25 years

CATEGORY 3:

Rural Living:

a. Repair surface damage as required
b. Shoulders re-graded or repaired as required
c. Drainage cleaned as required
d. Signage replaced as required
e. Line marking remarked every 5 years
f. Vegetation cleared as required
g. Shoulder weed control as requirec
h. Reseal frequency 20-30 years

Urban:

a. Repair surface damage as required
b. Shoulders re-graded as required
c. Drainage cleaned as required
d. Verge spraying/slashing
e. Signage replaced as required
f. Line marking remarked every 5 years
g. Vegetation cleared as required
h. Reseal frequency 20-30 years

Note: Street sweeping of kerblines is a component of drainage maintenance.

CATEGORY 4:

Not applicable

ii) Unsealed Roads

The predicted intervention levels for maintenance of unsealed roads are listed as follows:

NOTE: The intervention level for maintenance grading is based on a number of factors, mainly triggered by surface conditions (corrugations, potholes, scoured sections). These surface conditions impact on the comfortable driving (operating) speed. The indicative percentages shown for Category 1, 2 and 3 roads are to be used as a guide as the expectation is that maintenance grading programs are aimed to avoid the road reaching that condition. The road length has been separated in to road lengths as traffic and environmental conditions will vary along the length of a road.

CATEGORY 1:

a. Should be passable comfortably at the operating speed environment in most weather conditions for 75% of the road length between intersections
b. 2-3 grades per year
c. Repair surface damage as required
d. Drainage cleaned as required
e. Signage replaced as required
f. Vegetation cleared as required
g. Re-sheet frequency 10-20 years

CATEGORY 2:

a. Should be passable comfortably at 80% of the operating speed environment in most weather conditions for 75% of the road length between intersections
b. 2-3 grades per year
c. Repair surface damage as required
d. Drainage cleaned as required
e. Signage replaced as required
f. Vegetation cleared as required
g. Re-sheet frequency 15-25 years

CATEGORY 3:

a. Should be passable comfortably at 50% of the operating speed environment in most weather conditions for 75% of the road length between intersections
b. 1-2 grades per year
c. Repair surface blowouts as required
d. Drainage cleaned as required
e. Signage replaced as required
f. Vegetation cleared as required
g. Re-sheet frequency 20-30 years

CATEGORY 4:

a. Minimal attention
b. 1 grade per 2 years
c. Re-sheet frequency not applicable, short sections may be sheeted to reduce damage/erosion.

4) Frequency of Service

The frequency of service has been identified in part in the previous Section. The predicted frequencies for the individual service interventions are described in this Section.

TABLE 4 - SEALED ROADS

Item	Service Description	Road Category	Frequency	Comment
1	Reseals	1 A	10 – 20 yrs	The frequency periods are a guide only and many roads may not require resealing within the time ranges stated.
2		2 A	15 – 25 yrs	
3		3 A	20 – 30 yrs	
4	Sealed road - potholes	All	Repair within 1 wk	Where conditions prevent repairs, install temporary signs as necessary
5	Sealed road - shoulder grading	All	Monitor – or every 5 yrs	
6	Drainage – table drains	All	Monitor – or every 5 yrs	
7	Drainage – pipes/culverts	All	Monitor – or every 2 yrs	
8	Signage –guideposts	All	Repair within 2 wks	
9	Signage – road names	All	Repair within 4 wks	
10	Signage - safety	All	Interim or repair within 2 days	
11	Signage – information	All	Repair within 6 wks	
12	Line marking	All	Monitor – or every 3 or 5 yrs	Subject to road Category
13	Vegetation clearance – envelope	All	Monitor	
14	Vegetation clearance – safety zone	All	Monitor	
15	Weed control – general	3 A	Monitor – or every 2 yrs	
16	Weed control – fire plan	All	Monitor – or every 12 mths	

TABLE 5 - UNSEALED ROADS

Item	Service Description	Road Category	Frequency	Comment
1	Re-sheeting	1 B	10 – 20 yrs	The frequency periods are a guide only and many roads may not require resheeting within the time ranges stated.
2		2 B	15 – 25 yrs	
3		3 B	20 – 30 yrs	
4		4 B	n/a	
5	Surface maintenance -Patrol grading	1 B	2 – 3 per yr	Indicative – subject to road condition
6		2 B	2 – 3 per yr	Indicative – subject to road condition
7		3 B	1 – 2 per yr	Indicative – subject to road condition
8		4 B	0 – 1 per 2 yrs	Indicative – subject to road condition
9	Surface maintenance - safety	1 B, 2 B	• Interim (signs) within 2 days • Repair within 2 wks	
10		3 B	• Interim (signs) within 2 days • Repair within 4 wks	
11		4 B	• Interim (signs) within 2 days • Repair within 6 wks	
12	Drainage – table drains	All	Monitor – or every 5 yrs	
13	Drainage – pipes/culverts	All	Monitor – or every 2 yrs	
14	Signage –guideposts	All	Repair within 2 wks	
15	Signage – road names	All	Repair within 4 wks	
16	Signage - safety	All	Interim or repair within 2 days	
17	Signage – information	All	Repair within 6 wks	
18	Vegetation clearance – envelope	All	Monitor	
19	Vegetation clearance – safety zone	All	Monitor	
20	Weed control – general	All	Monitor – or every 4 yrs	
21	Weed control – fire plan	All	Monitor – or every 12 mths	

5) Performance and Customer Service Standards

The performance of the Council in meeting the service standards listed can be monitored at various levels.

a) Customer Requests – Maintenance

The monitoring of response times for customer generated requests is undertaken as part of the Customer Service Charter reporting.

These will be reported on an annual basis through the Council's Audit Committee

b) Customer Requests - Construction

These requests will typically require budget consideration and the performance of response is not practical to monitor or report as Council's financial capacity may not be sufficient to adopt all requests.

c) Patrol Grading – Standards

The effectiveness of the patrol grading activity is monitored internally within the Works and Infrastructure. Effectiveness is measured by shape (crossfalls), best use of existing pavement material (size and placement of windrows), and drainage maintenance (clear table drains and offshoots)

d) Patrol Grading - Frequency

Records are kept of all patrol grading and improvements in monitoring by GPS tracking and electronic records will enable monitoring of the number of grades and which sections of roads on an annual basis.

The numbers of patrol grades nominated in the previous section are a guide and are influenced by seasonal conditions, the nature of the road pavement, traffic volumes and terrain. The basic principle is that if a road meets the respective road condition standard then it does not require grading.

6) Cost

There are two components to the cost of providing road networks services, namely Capital and Recurrent expenditure.

When preparing and reviewing Council's Long Term Financial Plan (LTFP) allocations are estimated at a program level over a forward 10-year period. The Council's Strategic Plan which is prepared and reviewed on a four year cycle sets a more detailed framework with Capital expenditure allocated at a project level and Recurrent expenditure at the program level.

Over the past seven years Council has averaged expenditure in respect of the maintenance or expansion of the road network as follows:

TABLE 6

Description	Capital	Recurrent
Sealed Roads	800,000	400,000
Unsealed Roads	600,000	450,000

NOTE: The above amounts have been rounded and provide an indicative value. These amounts will vary from year to year. The above amounts are costs associated with road surface, drainage, and signs and lines.

Funding is sourced from three different streams, namely rate revenue, loan borrowings, and government grants/private contributions.

7) Other Relevant Considerations

The primary focus of this document is the existing as-constructed road network.

Where there is an identified need to create new roads or to upgrade existing roads for new land divisions, businesses, mining operations, natural tourist attractions etc the assessment of what function and therefore construction standard will be based on this document.

a) Guidelines for assessing rural road sealing requests

The constructing and sealing of existing unsealed roads is desired by residents within the urban and rural living areas. Council does not have an adopted policy that dictates the upgrading of roads, and is unlikely to due to the high cost of construction, and the subsequent cost of maintenance.

When reviewing the Strategic Plan every 4 years it is necessary to re-assess predictions of timing with respect to the sealing of individual roads considered to be eligible for sealing. Roads that have previously been identified or other roads newly under consideration require assessment as to whether the estimated priority for the work has changed such as increased rate of housing developments leading to increased traffic volumes or recent land divisions changing predicted traffic patterns.

To assist the assessment process for determining if a road should be sealed, a guideline has been developed based on a literature review of similar methodologies across several States. The guideline is provided as **Attachment 5**.

b) Eyre Peninsula Regional Transport Strategy

The Strategy is prepared and reviewed by the Eyre Peninsula Local Government Association (EPLGA) and seeks to identify road network requirements and expectations within the Eyre Peninsula region. It refers to other State and regional plans and strategies to

account for future transport needs associated mining and other developments of State significance.

The roads identified within the Transport Strategy are considered on merit to be eligible roads for application under the Special Local Roads Program (SLRP). The assessment of applications is made at the regional level by independent consultants engaged by the EPLGA to score the respective roads based on the agreed criteria. The Local Government Transport Advisory Panel (LGTAP) also undertakes a review of the applications, and ultimately recommends roads to be funded under the State wide program.

The roads considered eligible for the SLRP are to be listed as Category 1 or 2 roads within the respective Council.

Given the competitive process under the SLRP guidelines, roads considered for upgrading to a sealed standard, or in some cases resealed or reconstructed, cannot confidently programmed for actual works – only listed in anticipation within the Council's Strategic Plan and LTFP.

Indicative cost estimates for the roads listed in the Regional Strategy are provided in Appendix 3

Attachments

Attachment 1 - Lengths of Roads per Category

TABLE 7

Category	Sealed Length	Unsealed Length	Total
1	43.206	13.496	56.702
2	43.183	225.173	268.356
3	55.578	660.228	715.806
4	.093	287.243	287.336
	142.060 km	**1186.140 km**	**1328.200 km**

CATEGORY 1

Road_Name	Length
AIRPORT LANE	5.383
BRATTEN WAY	37.053
FLINDERS HIGHWAY	6.16
MERINTHA CREEK ROAD	8.106
Grand Total	**56.702**

CATEGORY 2

Road_Name	Length
ARCHIE GRIFFITHS ROAD	0.096
BROCCABRUNA DRIVE	6.146
CHAPMAN ROAD	15.251
CHARLTON GULLY ROAD	16.291
CHARLTON TERRACE	0.578
COCKALEECHIE ROAD	0.056
COLES POINT ROAD	12.757
DUCK LAKE ROAD	17.74
FARM BEACH ROAD	10.051
FISHERY BAY ROAD	12.328
GAWLER PONDS ROAD	6.599
GLOVER ROAD	4.56
GREEN PATCH ROAD	6.654
HAIGH DRIVE	3.947
HULL ROAD	3.697
HYDE ROAD	13.13
KAPINNIE ROAD	0.467
KELLIDIE BAY ROAD	5.681
KOPPIO ROAD	6.54
LAWRENCE ROAD	1.276
MAIN STREET	0.248
MURRAY DRIVE	7.119
OLD WEST ROAD	0.209
POINT DRUMMOND ROAD	16.808
POUND LANE	2.949
PROCTOR ROAD	0.044
PROPER BAY ROAD	13.689
RICHARDSON ROAD	4.809
ROBERTS ROAD	2.548
SHELLY BEACH ROAD	1.125
SHEPPERD ROAD	9.501
SLEAFORD BAY ROAD	2.696
SNAPPER HILL ROAD	4.859
SULLIVAN DRIVE	8.592
THE HAVEN DRIVE	1.613
TOD RIVER ROAD	1.544
WARROW ROAD	30.293
WEST BAY ROAD	1.017
WHITE FLAT ROAD	10.619
WINE SHANTY ROAD	3.58
WINTER HILL DRIVE	0.649
Grand Total	**268.356**

CATEGORY 3

Road_Name	Length
AGARS LANE	0.267
ALBATROSS COURT	0.169
ALBERT LANE	0.535
ALEPPO AVENUE	0.113
ALMONTA CLOSE	0.094
ANT HILL ROAD	3.718
ARCHIE GRIFFITHS ROAD	4.474
ARTHUR STREET	0.357
ARTHUR WHITE DRIVE	0.224
ASHMAN ROAD	3.214
AVERIS ROAD	0.617
BAINES ROAD	5.722
BALD HILL ROAD	7.872
BARNS ROAD	0.267
BARTLEY ROAD	5.58
BAY STREET	0.05
BEACH ROAD	6.909
BELL TERRACE	0.417
BENJAMIN ROAD	0.416
BENSON AVENUE	0.197
BLUE FIN ROAD	0.983
BORLASE ROAD	4.974
BOUNDARY ROAD	0.616
BRADLEY COURT	0.112
BRIGETTE AVENUE	0.125
BRIMPTON LAKE ROAD	15.345
BRONZE WING DRIVE	0.926
CAMPBELL COURT	0.071
CEA-JAY STREET	0.218
CEMETERY CLOSE	0.287
CEMETERY HILL ROAD	3.033
CENTRAL STREET	0.302
CHALLIS LANE	1.09
CHURCH ROAD	0.203
CLARKES LANE	9.286
COAST ROAD	14.047
COCKALEECHIE HALL ROAD	4.483
COCKATOO ROAD	1.594

CATEGORY 3 cont'd

COMMERCIAL ROAD	0.212
CONCORDE ROAD	1.865
COOPER STREET	0.145
CORMORANT DRIVE	0.487
CORREA DRIVE	0.162
CRANSTON STREET	0.233
DODD ROAD	0.292
DODD STREET	0.14
DOLPHIN DRIVE	1.345
DORWARD STREET	0.872
DOUDLE DRIVE	5.86
DOUGLAS STREET	0.496
DOUGLAS WELL ROAD	20.265
DUCK POND DRIVE	2.585
DURDIN STREET	0.508
EAST TERRACE - 186	0.761
EAST TERRACE - 187	0.136
EAST TERRACE - 289	0.13
EASTON ROAD	1.135
EGRET COURT	0.158
EIGHTH STREET	0.731
ENDEAVOUR COURT	0.203
ESPLANADE	2.606
EXCHANGE ROAD	7.171
FALCON COURT	0.154
FIRST STREET	0.348
FIRTH AVENUE	0.485
FISHERMANS WELL CRESCENT	0.166
FLINDERS AVENUE	0.67
FLINDERS STREET	0.357
FLORENCE STREET	0.16
FLOUNDER CRESCENT	0.317
FORD AVENUE	0.444
FORD STREET	0.116
FOREST ROAD	1.839
FOSTER ROAD	2.678
FRENCHMAN ROAD	5.599
FUSS STREET	0.256
GANNET COURT	0.175
GAP ROAD	23.406

CATEGORY 3 cont'd

GERSCHWITZ ROAD	5.57
GILES ROAD	0.759
GLEDSTANES TERRACE	0.834
GRANITE WAY	0.215
GRAPHITE ROAD	3.801
GREBE COURT	0.08
GREEN ROAD	10.403
GREENLY AVENUE	1.113
GRIMM ROAD	0.557
GRUBBED ROAD	5.249
GULF STREET	0.093
HAGGARTY STREET	0.353
HALL STREET	0.347
HARDER STREET	0.556
HAROLD FREEMAN ROAD	11.803
HARRIS ROAD	5.6
HAWSON STREET	0.264
HAYMAN DRIVE	0.428
HEARD ROAD	4.709
HENDERSON COURT	0.21
HERON COURT	0.077
HIDDEN VALLEY LANE	1.652
HIGH STREET - 286	0.329
HIGH STREET - 287	0.242
HILLVIEW STREET	0.107
HINTON STREET	0.162
HIRSCHAUSEN ROAD	0.842
HOLLY RISE	0.642
HOWARD AVENUE	1.563
HOWELL ROAD	13.747
HULL ROAD	2.008
HURRELL ST	0.101
HURRELL STREET	0.186
HUT ROAD	2.629
JEANES STREET	0.247
JUBILEE DRIVE	0.954
KELLY ROAD	3.212
KENT STREET	0.32
KESTREL COURT	0.648
KEWELL ROAD	0.571

CATEGORY 3 cont'd

KIANA ROAD	13.287
KING ROAD	0.426
KINGFISHER ROAD	0.115
KOOKABURRA DRIVE	0.213
KOOLIDIE ROAD	14.709
LADY FRANKLYN ROAD	3.136
LAUBE STREET	0.227
LAWRENCE ROAD	13.748
LAWRIE ROAD	10.462
LEAR STREET	0.248
LIGHT ROAD	0.781
LIMESTONE LANE	0.254
LITTLE SWAMP LANE	3.493
LOLLER ROAD	4.56
LONG BEACH ROAD	1.033
LORIKEET COURT	0.521
LOUTH TERRACE	0.57
LYLE DRIVE	0.795
MacDONALD DRIVE	6.317
MAIN STREET	0.192
MARBLE CREEK ROAD	0.188
MARBLE VIEW ROAD	3.936
MARRIE ROAD	8.521
MARTINDALE STREET	0.165
MAURICE STREET	0.467
MAZDA DRIVE	0.587
MCCRACKEN STREET	0.174
McFARLANE ROAD	13.236
MCFARLANE STREET	0.533
McFAYDEN STREET	0.549
MEGAW STREET	0.253
MEIKLE STREET	0.246
MENA ROAD	7.885
MICKAN WEST ROAD	1.743
MIKKIRA LANE	2.641
MINNAMURRA STREET	0.184
MINNIRIBBIE ROAD	4.252
MITSHAN ROAD	20.373
MOODY LANE	4.275
MOONLIGHT BAY ROAD	6.914

CATEGORY 3 cont'd

MORGAN LANE	1.246
MORGAN ROAD	0.658
MORRIS STREET	0.122
MORTLOCK STREET	0.482
MOUNT DRUMMOND ROAD	28.976
MYERS STREET	0.54
NANCY ROAD	0.34
NATASHA DRIVE	0.332
NEWELL DRIVE	0.242
NICHOLSON AVENUE	0.328
NORTH TERRACE	0.249
NORTON LANE	2.294
NOSWORTHY STREET	0.122
OLD CEMETERY ROAD	0.729
OLD RACECOURSE ROAD	2.188
O'MALLEY STREET	0.416
O'SHANAHAN DRIVE	0.198
OSPREY COURT	0.243
OYSTER AVENUE	0.105
PANORAMIC DRIVE	1.536
PARADISE COURT	0.108
PATRICK STREET	0.105
PEARSON STREET	0.215
PEDLER ROAD	6.386
PEELINA ROAD	2.209
PELICAN COURT	0.303
PENMARRIC LANE	0.719
PENNY LANE	0.471
PENSHURST AVENUE	0.077
PETREL COURT	0.311
PHILLIPS STREET	0.252
PINE CRESCENT	0.652
PINES ROAD	2.778
POBKE ROAD	1.166
PONTON GROVE	0.347
POYNTZ STREET	0.248
PRICE STREET	1.214
PROCTOR ROAD	4.568
PROUDE GULLY ROAD	10.03
PUCKRIDGE ROAD	3.567

CATEGORY 3 cont'd

QUARTZ HILL ROAD	3.882
RAILWAY TERRACE - 245	1.332
RAILWAY TERRACE - 247	1.116
REDGUM ROAD	1.578
RESERVOIR DRIVE	8.726
ROBINS ROAD	10.103
RODGERS ROAD	5.966
ROE STREET	0.267
ROEDIGER ROAD	5.585
SABEY ROAD	0.161
SABINE STREET	0.308
SANCTUARY DRIVE	0.972
SANDPIPER COURT	0.204
SARAH COURT	0.44
SAWYER STREET	0.131
SEA EAGLE COURT	0.737
SEAVIEW AVENUE	0.104
SEAVIEW ROAD	0.113
SECKER COURT	0.104
SECOND STREET	0.349
SERENA STREET	0.117
SETTLERS ROAD	42.429
SHEARWATER DRIVE	0.854
SHEOAK ROAD	0.961
SHEPPERD AVENUE	1.045
SHEPPERD ROAD	11.392
SHORT STREET	0.049
SINCLAIR ROAD	5.041
SIVIOUR STREET	0.426
SLATERS COURT	0.101
SMITH ROAD	5.527
SOLLY TERRACE	0.351
SOPHIE CRESCENT	0.261
SOUTH EAST TERRACE	0.304
SOUTH TERRACE	0.307
SPRING ROAD	0.803
SPUR ROAD	0.569
ST ANDREWS ROAD	0.16
STAMFORD DRIVE	1.04
STANTON ROAD	0.713

CATEGORY 3 cont'd

STARFISH LANE	0.134
STINKY CREEK ROAD	0.189
STORMBIRD DRIVE	0.821
STORY TERRACE	0.083
STRAWBERRY HILL ROAD	22.433
SWALLOW DRIVE	0.507
TAPLEY STREET	0.241
TATTLER ROAD	0.336
TAYLOR ROAD	1.292
THE GOAT TRACK	5.233
THE HAVEN DRIVE	0.264
THIRD STREET	0.365
THORNBILL ROAD	0.504
TIATUKIA DRIVE	1.583
TILLER LAKE ROAD	5.356
TOM BOTT LANE	0.514
TOOLILLIE GULLY ROAD	1.413
TRIGG STREET	0.131
TULKA ESPLANADE	0.361
TUMBY BAY ROAD	0.977
UMLAUF STREET	0.202
UNNAMED	0.524
VICTORIA AVENUE	0.167
VONNIE ROAD	0.099
WAGNER ROAD	5.489
WAKELIN ROAD	0.842
WALKOM STREET	0.375
WALLACE COURT	0.08
WALTER STREET	0.235
WANGARY STREET	0.197
WANILLA TERRACE	0.451
WARNER STREET	1.645
WARROW STREET	0.667
WARUNDA ROAD	15.749
WATKINS ROAD	1.844
WATTLE DRIVE	2.286
WEASHIR STREET	1.332
WEST TERRACE	0.303
WHITING AVENUE	0.104
WILDELOO ROAD	5.577

CATEGORY 3 cont'd

WOODS ROAD	3.941
WOOLSHED DRIVE	0.94
WYLIE ROAD	2.297
YELTUKKA ROAD	7.844
YORKIES GULLY ROAD	8.212
Grand Total	**715.806**

CATEGORY 4

Road_Name	Length
BLACK SWAN LANE	1.262
BROAD LANE	1.184
COOMBS ROAD	1.563
COOMUNGA LANE	0.637
COOPER LANE	1.024
COOYAMOOLTA LANE	0.352
DERRINGTON DRIVE	1.083
DIAMOND FIRETAIL ROAD	0.651
DOUGLAS WELL ROAD	2.277
DURDIN DRIVE	1.89
EASTON ROAD	0.556
ESTUARY LANE	0.356
EUCALYPTUS DRIVE	0.664
GOOGS LANE	0.199
GREEN LANE	2.429
GREENLY BEACH ROAD	7.614
GUN CLUB ROAD	0.346
HAGE ROAD	1.675
HALL BAY ROAD	2.083
HAMMONDS ROAD	3.568
HANNAFORD ROAD	2.579
HAROLD FREEMAN ROAD	0.701
HASSELL ROAD	0.226
HIGGINS ROAD	4.566
HILL ROAD	4.952
HIRSCHAUSEN ROAD	1.499
HOUSTON LANE	1.56
INVESTIGATOR ROAD	1.243
KAPUNTA LANE	5.477
KATHAI DRIVE	1.128
KATIES LANE	1.859
KENNEDY DRIVE	1.42
LADY FRANKLYN ROAD	3.819
LEDGE LANE	0.311
LOVEGROVE LANE	0.806
MARY ELLIS WRECK BEACH ROAD	0.581
McAVANEY LANE	3.528
McLEOD LANE	1.552

CATEGORY 4 cont'd

MEANEY ROAD	3.166
MICKAN EAST ROAD	2.329
MYALPA ROAD	0.741
NEIDECK ROAD	0.384
OLD COAST ROAD	7.07
PEAKE LANE	0.608
PEARLAH LANE	0.374
PENDALE ROAD	1.276
PENINSULA DRIVE	2.094
PINTA TRACK	3.536
POONA LANE	6.996
POPE DRIVE	4.249
PUCKRIDGE ROAD	0.986
RANGE ROAD	1.635
RIGHT WHALE ROAD	1.242
RUSHMERE LANE	3.304
SCHWERDT LANE	0.878
SEAL CORNER	0.884
SHELLY BEACH ROAD	1.462
SHINGLEBACK ROAD	2.298
SLATERS LANE	2.409
TURTLE LANE	1.604
ULINA LANE	9.197
UNNAMED306	0.75
UNNAMED312	1.457
UNNAMED314	0.913
UNNAMED315	4.79
UNNAMED316	14.78
UNNAMED317	0.77
UNNAMED319	2.829
UNNAMED320	7.439
UNNAMED322	2.356
UNNAMED324	3.078
UNNAMED325	0.149
UNNAMED326	3.718
UNNAMED327	3.524
UNNAMED331	1.487
UNNAMED332	4.716
UNNAMED333	2.345
UNNAMED334	0.049

CATEGORY 4 cont'd

UNNAMED335	0.045
UNNAMED337	4.099
UNNAMED338	0.046
UNNAMED339	1.797
UNNAMED342	1.971
UNNAMED343	1.502
UNNAMED345	0.121
UNNAMED348	0.786
UNNAMED349	0.736
UNNAMED350	5.854
UNNAMED351	0.747
UNNAMED352	0.468
UNNAMED353	1.11
UNNAMED360	1.155
UNNAMED363	0.335
UNNAMED366	2.589
UNNAMED367	0.041
UNNAMED368	4.936
UNNAMED369	4.05
UNNAMED370	0.204
UNNAMED372	0.395
UNNAMED373	0.363
UNNAMED374	0.28
UNNAMED375	0.315
UNNAMED376	1.257
UNNAMED377	0.845
UNNAMED381	1.856
UNNAMED382	1.647
UNNAMED385	3.232
UNNAMED386	2.375
UNNAMED387	0.53
UNNAMED388	3.207
UNNAMED398	0.892
UNNAMED399	0.481
UNNAMED404	2.009
UNNAMED405	6.756
UNNAMED410	0.243
UNNAMED424	0.523
UNNAMED450	1.055
UNNAMED462	0.591

CATEGORY 4 cont'd

UNNAMED471	0.068
UNNAMED478	0.84
UNNAMED487	0.532
UNNAMED514	2.471
UNNAMED544	0.907
UNNAMED561	0.553
UNNAMED589	0.124
UNNAMED591	0.122
UNNAMED592	12.163
UNNAMED593	0.82
UNNAMED594	2.656
UNNAMED597	8.454
UNNAMED607	2.021
UNNAMED611	0.015
UNNAMED639	0.133
UNNAMED644	0.636
UNNAMED651	0.553
UNNAMED659	0.984
UNNAMED668	0.057
UNNAMED702	0.055
WALLIS ROAD	2.163
WHALING STATION ROAD	1.732
WINCH ROAD	0.947
WINDEMERE ROAD	3.794
Grand Total	**287.336**

Attachment 2 – Annual Patrol Grading Estimates

TABLE 8

Road Category	Unsealed Length	Ave km per Grader per day See Note I	Ave number of Grades per annum	Number of grading days
1	14	6 (5)	2.5	6 (7)
2	222	6 (5)	2.5	93 (111)
3	661	6 (5)	2.0	220 (264)
4	318	8	0.5	20
			TOTAL	**339 (402)**
	Average number of days per grader (4)			**85 (101)**

NOTES:

I. *Estimates are provided to indicate capacity 'average' annual capacity to maintain the network.*

II. *Length of road graded per day will vary, but unlikely to exceed the indicative rate. The numbers in brackets show impact of reduced grading per day*

III. *The average total number of grading days per annum over the past 6 years is 372 days per annum.*

Attachment 3 – Regional Road Strategy Project Cost Estimates

TABLE 9

Road (Category)	Section	Length	Standard	Estimate
Proper Bay Road (Cat 2)	Boundary to Fishery Bay Rd	13.3km	Sealed 1.2m shoulders	$720,000
Fishery Bay Road (Cat 2)	Proper Bay Rd to end	12.3km	7.8m seal	$2,800,000
Sleaford Bay Road (Cat 2)	Fishery Bay Rd to end	2.6km	7.8m seal	$600,000
Pound Lane (Cat 2)	Flinders Highway to existing seal	2.3km	7.8m seal	$550,000
Farm Beach Road (Cat 2)	Eighth St to end	9.4km	7.8m seal	$2,300,000
Airport Lane (Cat 1)	Coffin Bay Rd to Lincoln Highway	5.4km	7.8m seal	$1,300,000
			TOTAL	**$8,270,000**

NOTE: sealed width exceeds standard design due to traffic volumes, speed environment and mix of vehicles.

Attachment 4 – Project Cost Estimates for Various Roads

Category 1 Roads not listed in Regional Strategy

Merintha Creek Road was listed in the Regional Strategy. Whilst it serves as a significant link between Tod and Flinders Highways, the traffic volumes would justify sealing the road.

Should the road be required in the future for transport of sand to the Whyalla refinery, the estimated cost to construct and seal the pavement is $2,400,000.

Category 3 Roads within Urban (Built Up) Areas

Subject to the evaluation of road standards within urban and Rural Living areas that includes towns and settlements the following estimates are provided as indicative costs for cost benefit assessment.

Cost estimates (February 2016) are based on kerbed and sealed road standard.

TABLE 10

Road Name	Length	Estimate
ALBERT LANE, Cummins	0.535	**214,000**
BAY STREET, Coffin Bay	0.05	**20,000**
BELL TERRACE, Yeelanna	0.417	**166,800**
BOUNDARY ROAD, Boston - **see Notes I & III**	0.616	**246,400**
CRANSTON STREET, Yeelanna	0.233	**93,200**
EAST TERRACE, Cummins	0.532	**212,800**
EAST TERRACE, Coulta	0.136	**54,400**
EAST TERRACE, Wangary	0.130	**52,000**
EGRET COURT, Coffin Bay	0.158	**63,200**
EIGHTH STREET, Wangary	0.480	**192,000**
FIRST STREET, Wangary	0.348	**139,200**
FISHERMANS WELL CRESCENT, Tulka	0.166	**66,400**
FLINDERS STREET, Edillilie	0.357	**142,800**
FLORENCE STREET, Cummins	0.057	**22,800**
FORD AVENUE, Boston - **see Note II**	0.444	**133,200**
GANNET COURT, Coffin Bay	0.175	**70,000**
GREBE COURT, Coffin Bay	0.08	**32,000**
HERON COURT, Coffin Bay	0.077	**30,800**
HIGH STREET, Wangary	0.329	**131,600**
HURRELL STREET, Coffin Bay	0.059	**23,600**
KINGFISHER ROAD, Tulka	0.115	**46,000**
LIMESTONE LANE, Coffin Bay	0.083	**33,200**
MAIN STREET, Wangary	0.192	**76,800**
MAURICE STREET, Coulta	0.467	**186,800**
MEGAW STREET, Yeelanna	0.253	**101,200**

Road Name	Lengths	Estimate
MORRIS STREET, Yeelanna	0.122	**48,800**
MORTLOCK STREET, Wanilla	0.224	**89,600**
NORTH TERRACE, Edillilie	0.249	**99,600**
OSPREY COURT, Coffin Bay	0.243	**97,200**
PARADISE COURT, Coffin Bay	0.108	**43,200**
PELICAN COURT, Coffin Bay	0.303	**121,200**
PENSHURST AVENUE, Boston	0.077	**30,800**
POYNTZ STREET, Edillilie	0.248	**99,200**
ROBERTS ROAD, Tiatukia – **see Note II**	2.380	**714,000**
SABEY ROAD, Cummins	0.057	**22,800**
SABINE STREET, Coulta	0.308	**123,200**
SANCTUARY DRIVE, Boston – **see Note III**	0.972	**388,800**
SANDPIPER COURT, Coffin Bay	0.204	**81,600**
SECOND STREET, Wangary	0.349	**139,600**
SHEOAK ROAD, Tulka	0.771	**308,400**
SIVIOUR STREET, Cummins	0.203	**81,200**
SMITH ROAD, Yeelanna	0.505	**202,000**
SOUTH TERRACE, Coulta	0.307	**122,800**
ST ANDREWS ROAD, Cummins	0.057	**22,800**
STORY TERRACE, Mount Hope	0.083	**33,200**
THIRD STREET, Wangary	0.191	**76,400**
TUMBY BAY ROAD, Cummins	0.132	**52,800**
WAKELIN ROAD, Boston – **see Note III**	0.842	**336,800**
WANGARY STREET, Wanilla	0.197	**78,800**
WANILLA TERRACE, Wanilla	0.451	**180,400**
WARROW STREET, Wanilla	0.415	**166,000**
WATTLE DRIVE, Tulka	0.195	**78,000**
WEST TERRACE, Edillilie	0.303	**121,200**
TOTALS	**16.985 km**	**$6,511,600**

NOTE:

I. *Boundary Road cost estimate is half the estimated total – assumes 50% contribution by City of Port Lincoln*
II. *Rural Living zone, sealed with no kerbing*
III. *Rural Living, sealed with kerb (for drainage management)*

Attachment 5 – Methodology for Assessing Rural Road Sealing Projects

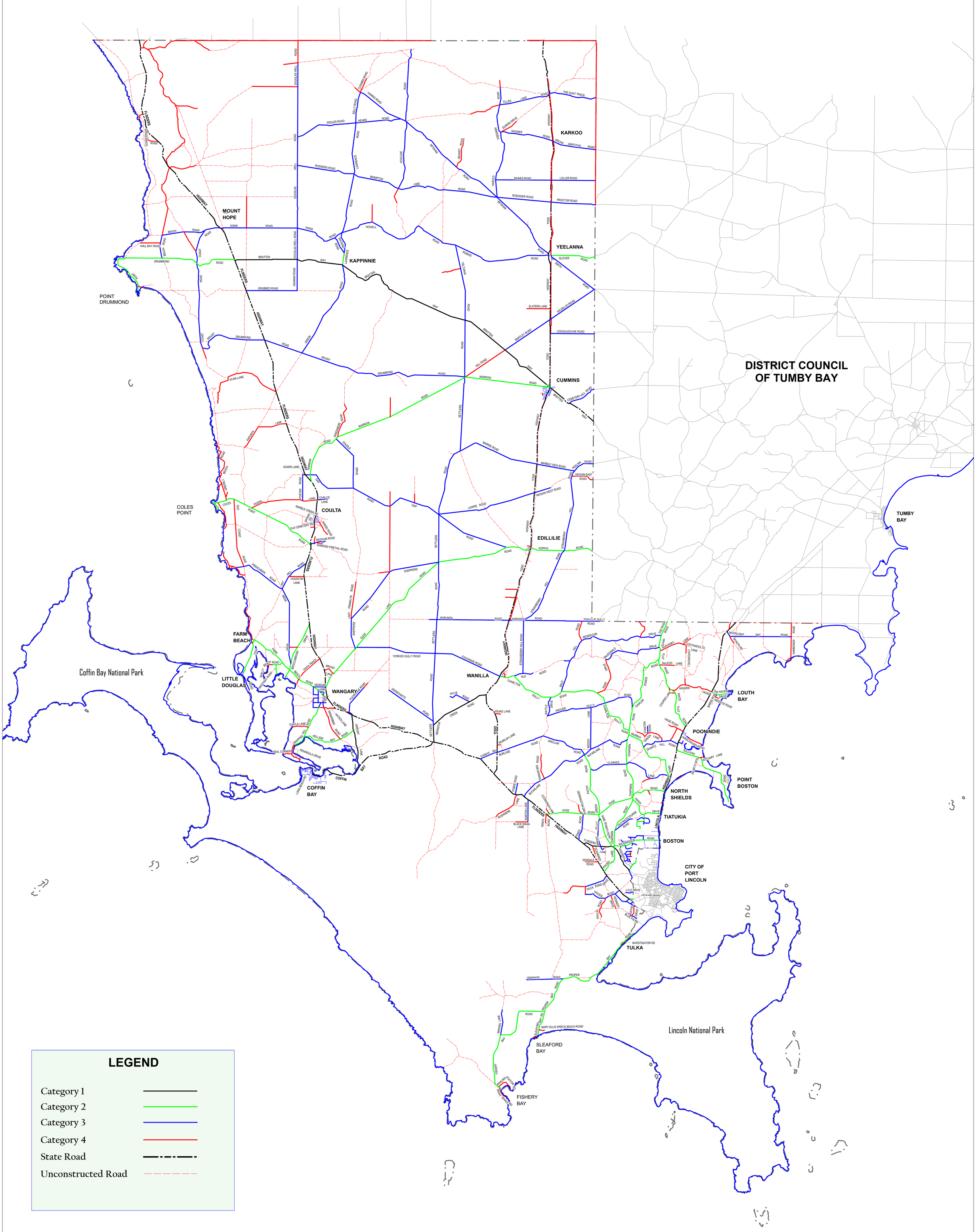
TABLE 11

Criteria	Points - Description	Point Score	Weighting	Score
Traffic Volumes	Add 1 point for every vehicle Additional 1 point for every commercial vehicle (max of 20% of AADT) Additional 25 points if road is a school bus route		1	
Strategic Significance	Examples: Tourist location/facility, land development (abutting or servicing), industry or mines, etc Nil 0 - (No Through Road; < 10Ha; - no farms) Low 2 - (No Through Road; some > 10Ha; - farms, tourist) Medium 4 - (Through Road with 1-2 Tourist facilities) High 6 - (Through Road with 2+ Tourist facilities or major link)		5	
Costs incurred in maintaining unsealed road	Low 1 - (close to depots, suitable gravel/limestone and water) Medium 2 - (2 of the above) High 5 - (none of the above)		10	
Geometric design and safety features of unsealed road	Take in to account the standard of the current geometric design of the unsealed road. This includes vertical/horizontal alignment, sight distance, etc. Safety features of the unsealed road include actual/potential accidents. 0 - poor horizontal and vertical alignment 1 - good horizontal and/or vertical alignment 2 - poor horizontal and/or vertical alignment 4 - good horizontal alignment 6 - good horizontal and vertical alignment		10	
Pavement subject to inundation and road side drainage	8 - Unlikely and good longitudinal drainage 5 - Infrequent inundation and/or poor cross drainage 2 - Frequent inundation and/or poor cross and longitudinal drainage		5	

Attachment 6 – Functional Road Hierarchy Map

District Council of Lower Eyre Peninsula

Functional Road Hierarchy Classification - July 2016



WGA
WALLBRIDGE GILBERT AZTEC

Southern Launch
Level 8
70 Pirie Street
ADELAIDE SA 5000

13th February 2022

Project No. WGA181404

Attention: Andrew Curran

Dear Andrew

SOUTHERN LAUNCH, WHALER'S WAY – SITE A RELOCATION

This letter has been prepared in response to a request from Southern Launch on the 10th of November 2021 and addresses the current proposed Stormwater Management Plan for the Whaler's Way Site A launch site (reference *Southern Launch Space Pty Ltd, Whalers Way Orbital Launch Complex, Stormwater Management Plan, Project No. WGA181404, Doc No. WGA181404-CV-RP-0001 Rev. C dated 22 February 2021)*.

The previously proposed Site A location has been relocated approximately 650 metres to the southeast of the previous location as shown in Figure 1 below. Note that the previous proposed site location is shown by the green area.

Figure 1 *Relocated Site A Location*

60 Wyatt Street
Adelaide SA 5000
T: 08 8223 7433
WGASA Pty Ltd
ABN 97 617 437 724

WGA notes that the new launch Site A maintains the previous design layout. In particular the following elements are not affected by the proposed relocation:

- Overall Site A area, including the proportion of impervious and pervious areas within the launch site.
- Launch site general layout (note no change to the orientation of the launch site).

Given the design elements stated above remain consistent and are not impacted by relocation of the site, the current proposed Stormwater Management Plan developed by WGA is still relevant to the new location.

Yours faithfully

Tom McFarlane
for
WALLBRIDGE GILBERT AZTEC

TJM;jkl

I SA BUSHFIRE SOLUTIONS – BUSHFIRE EMERGENCY MANAGEMENT PLAN

SOUTHERN LAUNCH

Bushfire Emergency Plan

Whalers Way

August 2022

Table of Contents

For details on the status of this Plan, refer to Southern Launch Management.

This Bushfire Emergency Management Plan has been assessed and endorsed by:

Andrew Curran
General Manager – Infrastructure
Southern Launch

3 August 2022

Plan prepared by

SA Bushfire Solutions
PO Box 1598, Renmark SA, 5341
0427 604 253
www.sabushfiresolutions.com.au

1. Executive Summary

South-eastern Australia is one of the most fire prone regions in the world.

The objective of all bushfire management activities is to reduce the impact and consequences of bushfire on people, property and the environment, with the protection of human life as the highest priority.

Bushfire safety is considered a shared responsibility between the government (State and Local), the fire services, local communities, and individuals. All parties are responsible for preparing prior to the fire season to protect themselves and their interests from the potential impacts of bushfire.

The changing climate is increasing the frequency of extreme fire weather events and the size, scale, ferocity, and impact from bushfires. Such events pose a continuous challenge to agency fire suppression capacity and capability and an increased threat to life, property, and environmental assets.

The lease area is dominated by coastal native vegetation which burns readily under most conditions and under extreme weather conditions a bushfire in this vegetation type will likely be uncontrollable.

Southern Launch Management acknowledge their responsibility to reduce the likelihood and impact of bushfires within and escaping the lease area and are committed to implementing preventative measures and complying with recommendations.

The context of this Bushfire Emergency Plan (BEP) has included a full assessment of the bushfire risk within the Southern Launch lease site, from both external and internal fire ignitions. The four key elements of the Plan include:

1. An assessment of bushfire risk across the site
2. Recommendations regarding preparing for bushfire and the implementation of bushfire risk reduction activities.
3. Detailed information and guidance on bushfire readiness and bushfire emergency management procedures
4. Specific actions to guide Southern Launch staff, contractors and visitors on the actions should a bushfire occur.

The Primary Action in response to forecast fire weather conditions or a reported bushfire is to evacuate all staff, contractors, and guests.

The Secondary Action is where staff and guests are not able to safely evacuate and must be safely moved to an appropriate shelter in place location.

This Bushfire Emergency Plan makes 25 recommendations to reduce bushfire risk to Southern Launch personnel and the surrounding landscape.

The implementation of these recommendations by Southern Launch will assist mitigate the likelihood and consequence of bushfire, guide response actions and provide strategic direction for future investment and planning with specific focus on the protection of life and property as it relates to bushfire.

2. Purpose

This Bushfire Emergency Plan (BEP) is focussed on addressing the risks posed by a bushfire. The BEP aligns with the *Australian Standard 3745 - 2010 Planning for Emergencies in Facilities* and is best practice.

The Primary objective of the BEP is to ensure all staff, contractors and visitors are evacuated early from the site and are moved to another location away from the potential effects of bushfire.

It documents the organisational arrangements, systems, strategies, and procedures relating to forecast fire danger conditions or an actual bushfire threat.

The risk assessment identifies the potential bushfire risks that Southern Launch may be exposed to with all operations and occupancy on the site.

The BEP is a sub plan of the Southern Launch Emergency Management Plan and applies to all staff, visitors, and contractors. It is the responsibility of all employees, visitors, and contractors to become familiar with the plan and to act accordingly in the event of an emergency.

This plan is authorised by the Emergency Management Committee (EMC) for Southern Launch.

3. Distribution

A copy of the Bushfire Emergency Plan has been distributed to:

Name	Position Title	Organisation name	Email address
Andrew Curran	General Manager - Infrastructure	Southern Launch	Andrew.curran@southernlaunch.space
Southern Launch	Emergency Management Committee	Southern Launch	Andrew.curran@southernlaunch.space
CFS Region 6	Regional Planning Officer	SACFS	TBA by SACFS

4. Administration

4.1 Version control

Version 1	Prepared by	Endorsed by
August 2022	Brett Stephens Director SA Bushfire Solutions brett@sabushfiresolutions.com.au	Andrew Curran General Manager – Infrastructure Southern Launch Andrew.curran@southernlaunch.space
August 2023	Next Review Date	

4.2 Plan review

This plan will be reviewed and updated annually. The version control table will be completed annually to demonstrate currency.

All reviews will be completed by the 1st of July each year, the Bushfire Management Operational Schedule (BMOS) will be completed before the 1st November or the commencement of the declared Fire Danger season.

The review team will consist of the Southern Launch Emergency Control Organisation (ECO) representatives and endorsed by the EMC.

The review process shall include the review of any incidents or near misses that may have occurred in the previous 12 months with learnings to be incorporated into the plan.

4.3 Responsible Organisation

The Responsible Organisation for the development, maintenance and exercising of this Bushfire Emergency Plan is the Southern Launch Emergency Control Organisation (ECO) that includes Senior Managers and Staff.

The Responsible Organisation is also accountable for ensuring the EMC meets annually and reviews this plan.

4.4 Responsible Person

The Responsible Person is the Chief Bushfire Warden. The Chief Bushfire Warden is accountable for liaising with the district council of Lower Eyre Peninsula, the South Australian Country Fire Service (SACFS) and other emergency services on preparedness activities and to ensure the updated plan is reviewed and endorsed annually and where appropriate updated in the Lower Eyre Peninsula (LEP) Bushfire Management Area Plan (BMAP).

4.5 Communication and Consultation

Southern Launch will use the methods detailed below to communicate to employees, subcontractors, and visitors' information regarding Bushfire Emergency Management.

Health, Safety and Environment (HSE) Notice Boards

Southern Launch offices and support bases will have a HSE notice board. The setup and maintenance of notice board is the responsibility of the People & Safety Coordinator, or delegate.

The notice board will display:

- WHS Policy,
- WHS Alerts & Bulletins; including Fire Danger Ratings and Total Fire Bans for the Lower Eyre Peninsula,
- Road Closures,
- Emergency communication contacts,
- Bushfire Emergency Plan

Bushfire Emergency Plan and Evacuation Plan

All sites will have the Bushfire Emergency Plan and Evacuation Plan posted in prominent locations around buildings and will contain:

- Site Layout Plan
- Bushfire Evacuation Procedures
- Bushfire Sheltering Procedures
- Access routes to evacuation point.
- First aid location(s).
- Fire protection equipment.
- Emergency Contacts List and
- Exclusion areas.

Emergency Contacts List

Emergency Contacts List will be updated on a six-monthly basis.

Bushfire Management Area Plan

The Chief Bushfire Warden will liaise with members of the Eyre Peninsula Bushfire Management Area Committee (BMAC) and provide regular updates on the progression of all mitigation activities. Where appropriate the Chief Bushfire Warden will seek to review the committees' risks ratings and treatment strategies identified in the plan.

5. Emergency Contacts

The following tables identifies important contacts and information sources for bushfire emergency management purposes.

Dial '000' for emergency assistance.

5.1 24 Hour Emergency Contacts

Name / Contact	Phone Number	Details / Function
Emergency Services	000	To report a new bushfire or emergency
SACFS Hotline	1300 362 361	Access updated information
SACFS	SA CFS Warnings and Incidents	Incident Information
SACFS Regional Operations	(08) 8682 4266	To liaise with SACFS Region 6.

5.2 Southern Launch Contact Numbers

Contact	Phone Number	Role
Andrew Curran	0487339373	General Manager - Infrastructure
Brenton Ellis	0437165451	Site Operations Manager

5.3 Southern Launch Emergency Bushfire Contacts

Title	Name	Phone Number / Satellite Phone Number
Chief Bushfire Warden	Brenton Ellis	0437165451 / TBA by Southern Launch
Deputy Bushfire Warden	Peter Bailey	TBA by Southern Launch
Building Warden	Adam Scott	TBA by Southern Launch
First Aid Officer	Dr Mike Damp	TBA by Southern Launch

5.4 Radio Communications

UHF Channel	Purpose
	TBA Designated Site Channel for internal communication

6. Potential Bushfire Scenarios

Bushfires are dynamic events with many contributing factors affecting fire behaviour and controllability, the scenarios in the table below are generic in nature and all events that occur within the lease area should be individually assessed as to their potential impact.

The Chief Bushfire Warden should have a basic understanding of bushfire awareness and other landscape bushfire mitigation activities to enable the initial assessment of any event and ensure that early engagement with arriving emergency services occurs immediately.

Scenario	Description
Radiant Heat, Direct Flame contact or Ember attack.	Bushfires may impact on the site and Southern Launch infrastructure through radiant heat, direct flame contact or embers landing on and around the site and starting small fires. These fires may increase in size and under elevated fire danger conditions quickly become uncontrollable.
Bushfire burning to the North from outside the lease area.	The potential scenario is a bushfire starting in areas outside of the lease area to the North. An uncontrollable fire to the north under a northerly influence could freely travel and enter the lease area. Vegetation adjacent to the lease area will support a bushfire with minimal restrictions eg other previous bushfire scars, existing roads, and fire access tracks.
Bushfire burning to the North and West, of the sites (launch pads, workshop and range control).	The potential scenario is a bushfire starting in areas to the North and West of the sites. Elevated fire danger days with northerly winds (and a southwest wind change) pose the greatest bushfire risk to the property. Vegetation surrounding the site will support a bushfire with minimal restrictions other than Southern Launch vegetation management activities, previous bushfire scars, existing roads and fire access tracks or other bushfire mitigation activities. The fire behaviour could be of extreme intensity with high rates of spread and potential to impact the sites infrastructure.
Bushfire burning to southern end of the site.	The potential scenario is a bushfire starting in areas to the south of the site. Vegetation surrounding the site will support a bushfire although the vegetation on the southern sides of the sites has reduced likelihood due to proximity to the coastline, overall reduced fuel hazard and discontinuous fuel arrangement. The fire behaviour could be lower intensity with lower rates of spread and less likely to impact the sites infrastructure under an easterly and southerly wind. Coastal heath and scrub vegetation can readily burn when exposed to increased wind speeds.
Inability to leave the site in the event of a bushfire.	The egress path to the SACFS Bushfire Safer Places and Places of Last Resort requires travel through areas that could be threatened or impacted by bushfire. Staff, contractors, and visitors could become trapped and unable to safely leave the site. A shelter in place option has been recommended at range control.

7. Factors Contributing to Bushfire Risk

The Lower Eyre Peninsula (LEP) Bushfire Management Committee (BMC) provides strategic direction for bushfire management planning in the LEP Bushfire Management Area (BMA) across the landscape in a tenure blind approach to managing bushfire risk.

The BMC follows an established process to identify bushfire risks and recommend treatment strategies in their pre-determined geographic area as per their legislative responsibilities. The committee seeks to implement bushfire mitigation measures in a coordinated fashion across the landscape but does not have the resources to identify and recommend treatment strategies for every individual property or local area.

While the key bushfire drivers of weather and topography in an area cannot be modified to reduce the fire hazard, there is opportunities to create a reduction in the flammable bushfire fuels in an area. This reduction in the available bushfire fuel reduces the flame height and intensity of a bushfire.

Where there is the ability to reduce flame height and bushfire intensity there is a corresponding increase in suppression effectiveness. This includes firefighters being afforded the opportunity to work in a safer environment.

7.1 Site Description

The Southern Launch facility is located 33km to the southwest of Port Lincoln on the southernmost tip of the Eyre Peninsula coastline of South Australia at Whalers Way.

The landscape within the area is rolling sandhills covered by a low hardy scrub and areas of Mallee covering the sand dunes and low rises.

The coastal areas have very high cliffs with limited access to the shoreline.

7.2 Site Management and Operation

Southern Launch operates the Whalers Way Orbital Launch Complex, a multi-user commercial facility being constructed on the site.

The area of operation is on privately owned land and subject to a lease and management agreement between Southern Launch and the property owners.

Southern Launch will be operating two launch facilities. These are:

- Launch Facility A will launch larger rockets (up to approximately 100 tonnes) requiring a safety exclusion zone of 3,000 metres.
- Launch facility B will be launching smaller rockets (up to approximately 60 tonnes) and will require a smaller safety exclusion zone of 2500 metres.

Both launch sites, other built operational buildings and the range control will have vegetation management zones around them to manage the potential bushfire risk. This will consist of a fuel reduced area to prevent direct flame contact on the assets, minimise radiant heat, possible ignitions from ember attack and operational failure.

The minimum vegetation management zone (Asset Protection zone) around the launch sites will be 60m.

It is expected that there will be 4 people on site daily and those numbers are likely to increase to up to 40 people during launch operations.

The main observation area (range control) during launch operations is approximately 4 km from the launch sites.

Building Design and Construction

The engineering, design and construction of the launch facilities and other proposed infrastructure has not been assessed as part of this report.

It has however been noted through the bushfire assessment that the facilities will be included in the asset protection strategies. Specific mitigation strategies put in place to limit the potential impact to assets and infrastructure from ignitions caused by launch operations include inground bunkers, deluge systems and vegetation management around launch sites.

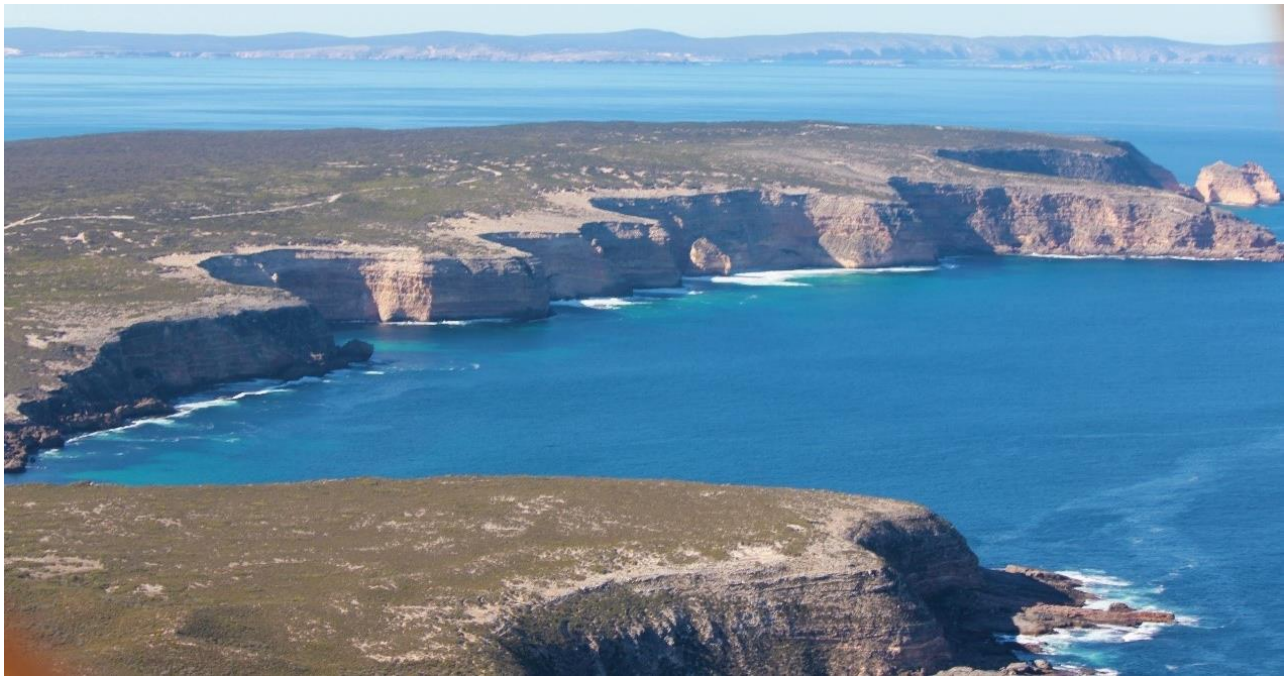
The risk of staff, contractors and visitors becoming trapped by bushfire is unlikely, however, a suitable provision for a Bushfire Shelter in Place (SIP) option is recommended. Building design and construction shall be in line with Ministerial Building Standards MBS 008 and other relevant legislation.

Dangerous Goods

It is recognised Southern Launch will be required to transport dangerous goods to and from the site and utilised excessively during launch operations.

Transport, management, and storage of all dangerous goods will be in accordance SA Government regulations.

Appropriate risk management, safety, and response procedures are detailed within the EMP.



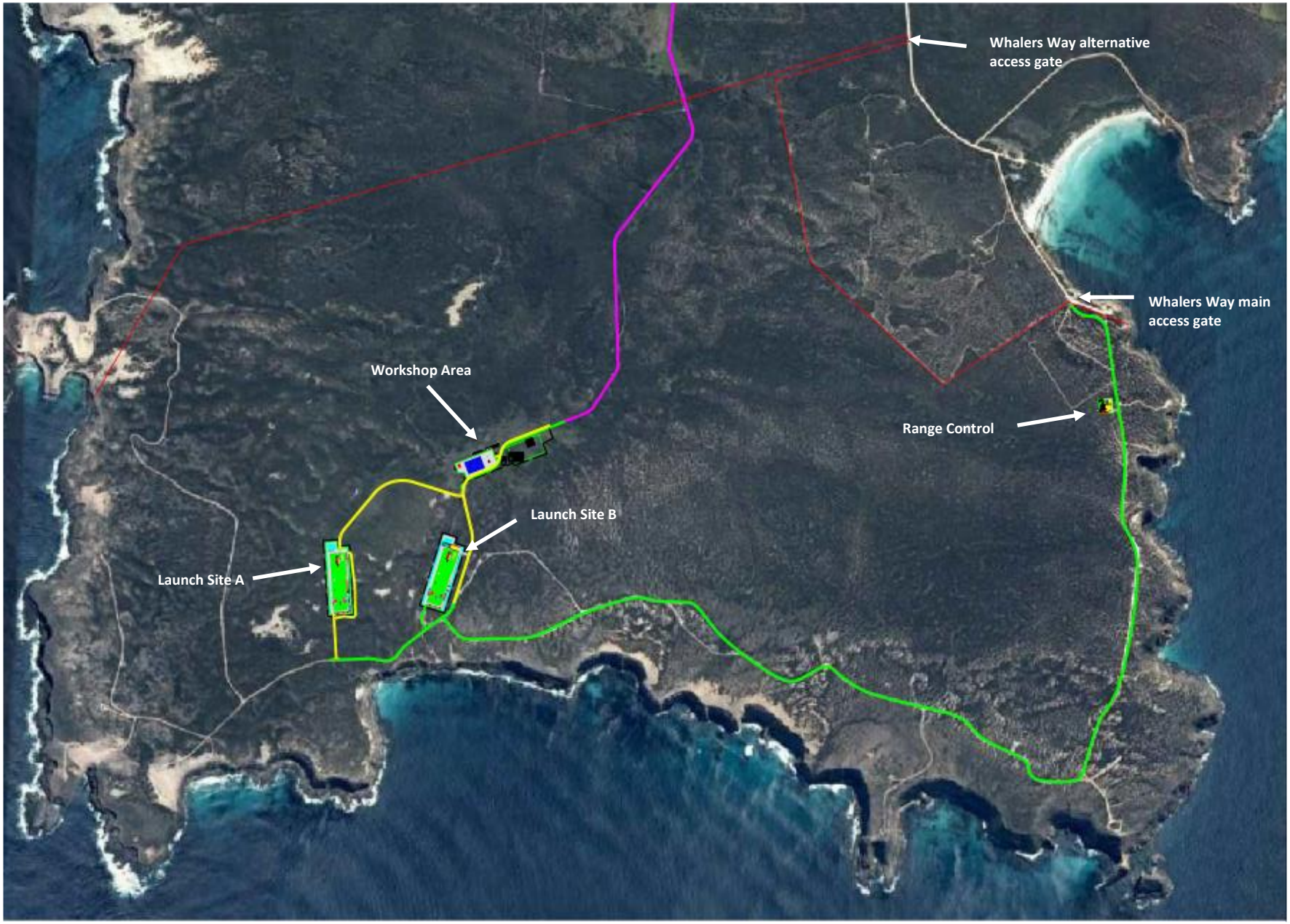


Figure 1 – Site Location, including Access, Range Control and Launch sites

7.3 Climate

The climate in South Australia is characterised by mild winters followed by hot and dry summers. The South Australian fire season typically occurs between the end of October and the start of May.

The CSIRO and Bureau of Meteorology (BOM) 'State of the Climate Report 2020' identified that "there has been an increase in extreme fire weather, and in the length of the fire season, across large parts of Australia since the 1950s, especially in southern Australia".

The changing climate is increasing the frequency of extreme fire weather events and the size, scale, ferocity and impact from bushfires. Such events pose a continuous challenge to agency fire suppression capacity and capability and an increased threat to life, property, and environmental assets.

Fire Weather

Summers are mild to warm with cool sea breezes keeping the temperatures generally below 30°C. On rare occasions, a severe blast of heat from the deserts to the north can cause several days of temperatures well over 40 °C.

High temperatures, hot dry northerly winds, and sudden changes to wind direction due to a cool change provide the greatest fire weather risk.

Winters in the Port Lincoln area are cool and cloudy, with frequent light drizzle, showers and temperatures between 16 °C and 26 °C.

Fire weather forecasts (provided by BOM) are provided for the Lower Eyre Peninsula. This area stretches from the southern Eyre Peninsula (Whalers Way) up to above Cummins to the north. Weather patterns and conditions across this area can vary significantly and often conditions on the coast can be milder than those in the north.

Data that has been collated by the BOM from weather stations closest to lease area over the past 30 years highlight the average number of days per year with the

- Fire Danger Rating (FDR) and
- Very High Fire Danger Index (FDI)

Average number of FDR Days per year				
High	Very High	Severe	Extreme	Catastrophic
34	22	5	1	0

Table 1 –Average Number of days per year with maximum FDR

Average number of Very High FDI days per year	
Very High	Days per year (22)
FDI 25-29	7
FDI 30-34	6
FDI 35-39	3
FDI 40-49	6

Table 2 -Average number of Very High FDI days per year

7.4 Fire Behaviour

Fire direction and rate of spread (expressed in km/hr), flame height, fire intensity and ultimately controllability by the fire agencies are determined by climatic and weather conditions, topography and available fuel in the area.

Days of higher fire risk are often typified by the passage of a cold front, which causes fires to spread rapidly and then change direction due to the wind change.

Fires can be expected to move quickly under the influence of strong, gusty north winds and can then move rapidly in a different direction when the subsequent south–westerly wind change arrives.

Fires that start under these conditions can reach a very high intensity, even in areas of relatively low fuel loads and can be difficult to control until the weather conditions abate.

Most of South Australia's catastrophic fires that have claimed lives and homes have been subject to this type of effect, with many fatalities resulting from people being trapped after the fire changed direction.

Fire History – Since 1931

There is no recorded fire history (bushfire or prescribed burn) for the area proposed at the launch sites or within the leased area.

It is however likely that there have been fires within adjacent farmland that has not been recorded on government or agency databases.

However there have been some significant bushfires in similar vegetation types throughout the lower Eyre peninsula, refer figure 2, Source - Fire Management Maps.

Fires escaping property

The risk of bushfire starting from an activity on Southern Launch leased land is always present. Bushfire mitigation recommendations made in this report complement existing Southern Launch site works plans and will focus activities on lowering the risk of bushfires escaping from the site.

A full analysis of the likelihood and consequence of bushfires originating from within and external to the Southern Launch leased land demonstrates that there is a similar risk of damage from bushfires originating from the surrounding landscape and entering the site.

The closest private dwellings are approximately 4 kilometres to the northeast of Launch Facility B. There is also the adjacent Fishery Bay Campground, and both are located outside of the boundaries of the leased land.

Whalers Way Campground is 2.5km to the northwest, within the launch complex.

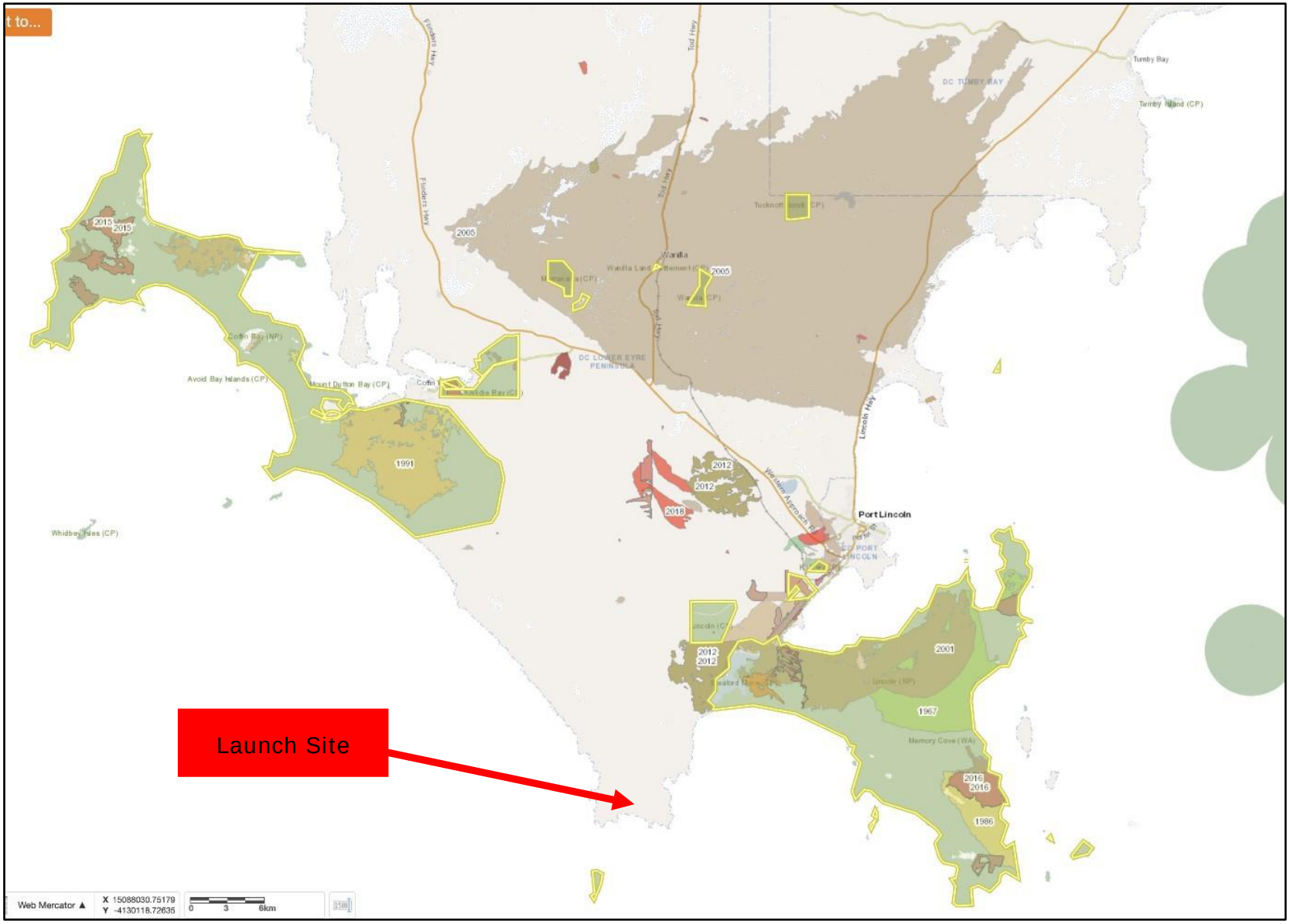


Figure 2 - Fire History Map since 1931Fire History Map since 1931

7.5 Vegetation Management

South Australia has three main vegetation types affecting the spread of bushfires: these are grass, mallee and woodland.

Grass fires are predominantly wind driven events and spread rapidly under the influence of strong winds. Grass fires burn at a lower intensity and flame height than forest fires and burn out quickly. Grass fires can often be quickly extinguished with water.

In contrast, woodland / forest fires have more fuel (leaf and bark litter on the ground, shrubs, grasses, trees etc) available for a fire to burn but travel slower. They can generate incredible amounts of heat energy and can even create their own weather under elevated fire weather conditions.

Fires in mallee vegetation can spread rapidly but often require high wind speeds to dramatically increase the rate of spread.

7.6 Access and Egress

Built infrastructure such as roads and tracks can also increase the speed of a fire response, allowing firefighters to suppress a fire safely and effectively before it reaches maximum intensity and flame height.

The site currently has adequate emergency vehicle access to both proposed launch sites and other proposed operational areas including the workshop and range control.

Access is via formed public roads (including sections of bitumen and hard base gravel) to the current entrance gate at Whalers Way and the proposed future entrance area.

Off road access is limited. The roads consist of an engineered gravel pavement susceptible to sand across the carriageway. Soils are mostly sandy with outcrops of limestone and granite.

Off road conditions dictate that a four-wheel drive may be necessary.

Southern Launch has identified all roads and fire access tracks in the area including potential future tracks and where required these will be upgraded and maintained to SA Government standards.

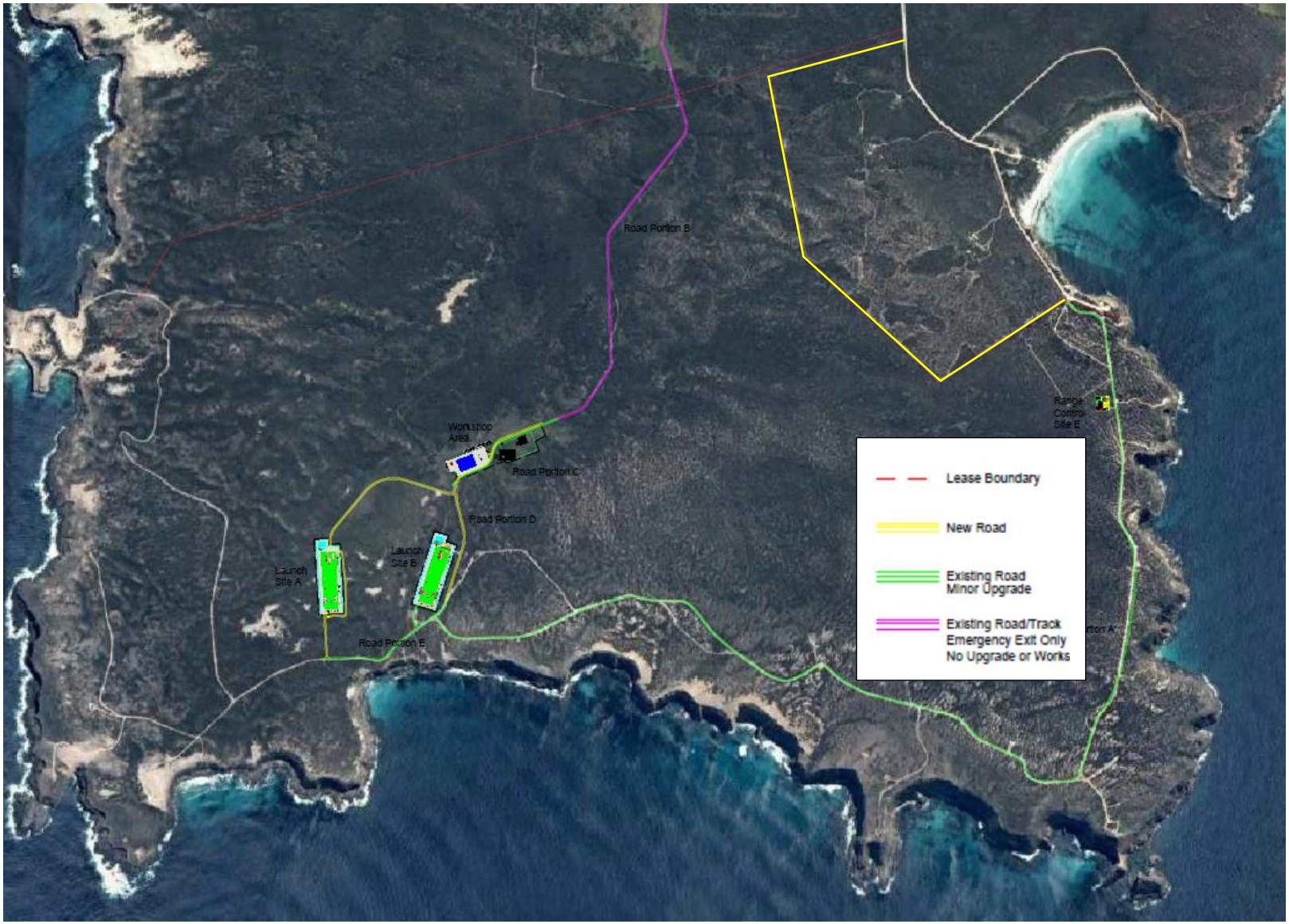


Figure 3 -Access and Egress tracks across the site

7.7 Water

The availability of water is critical to enable fires to be suppressed effectively. The agricultural and farming landscape to the north contains some farm dams that have varying degrees of capacity and are highly dependent on seasonal conditions.

There is limited available firefighting water within the lease area, Southern Launch has committed to increasing dedicated firefighting water supplies including static tanks (including earth dams) and mobile water resources including truck and smaller four-wheel drive capability

7.8 Response Capacity and Capability

Southern Launch recognises the important role that CFS volunteers play in the local community. Reliance on local CFS brigades is not part of the future management of the Southern Launch site from non-fire emergency related matters.

SACFS volunteers and staff are guided by the SACFS operational doctrine. The doctrine guides all aspects of prevention, preparedness, response and recovery to all emergencies. SACFS is the hazard leader for Bushfire and the support agency for all other emergencies.

Locally the Regional Operations Management Plan (ROMP) identifies local bushfire risks and defines priority response requirements for SACFS Groups and Brigades.

The Southern Launch lease area forms part of the Lower Eyre Peninsula CFS Group with the closet brigades being Lincoln, North Shields, Greenpatch and Coffin Bay (refer figure 4).

Response by CFS volunteers is dependent on the time of day, availability, fire location and other current incidents.

Brigades have combination of available resources including light four-wheel drive vehicles to bulk water carriers.

The Port Lincoln CFS brigade has a response time of approximately 45 minutes to the launch sites.

Aviation

There is contracted water bombing and observation aircraft available over the fire danger period based at Port Lincoln.

The Lease area is within the Lower Eyre Peninsula Primary Response Zone, which ensures that aviation resources are automatically dispatched to all reported fires. Availability and access to aviation assets is determined prior to the fire danger season via a "fire probability assessment".

The use of aircraft is a critical component for fire suppression, which can be especially effective to assist in slowing the initial spread of fires.

It should be noted however that as with all strategies, the use of aircraft does have limitations including:

- Unable to fly under extreme/catastrophic conditions if wind conditions are too strong.
- Unable to fly at night.

- Proximity of appropriate water sources affecting turnaround times
- General level of risk undertaking complex flying operations.
- Availability of aircraft during multiple incidents.

7.9 Visitor Management

Visitors, Southern Launch staff and contractors should seriously consider the risk of being on the leased property during days of significant fire danger.

Appropriate recommendations have been made through the BEP to adequately manage the risk to visitors during elevated fire weather conditions. This will include:

- A site induction on bushfire risk
- Managing and restricting entry to the site
- Communication planning
- The displaying of appropriate bushfire risk signage and fire weather information
    - o including catering for non-English speaking tourists unaware of bushfire risk
- Locking gates and the role of onsite security in restricting access
- Liaison with local CFS and tourism bodies of fire preparedness information

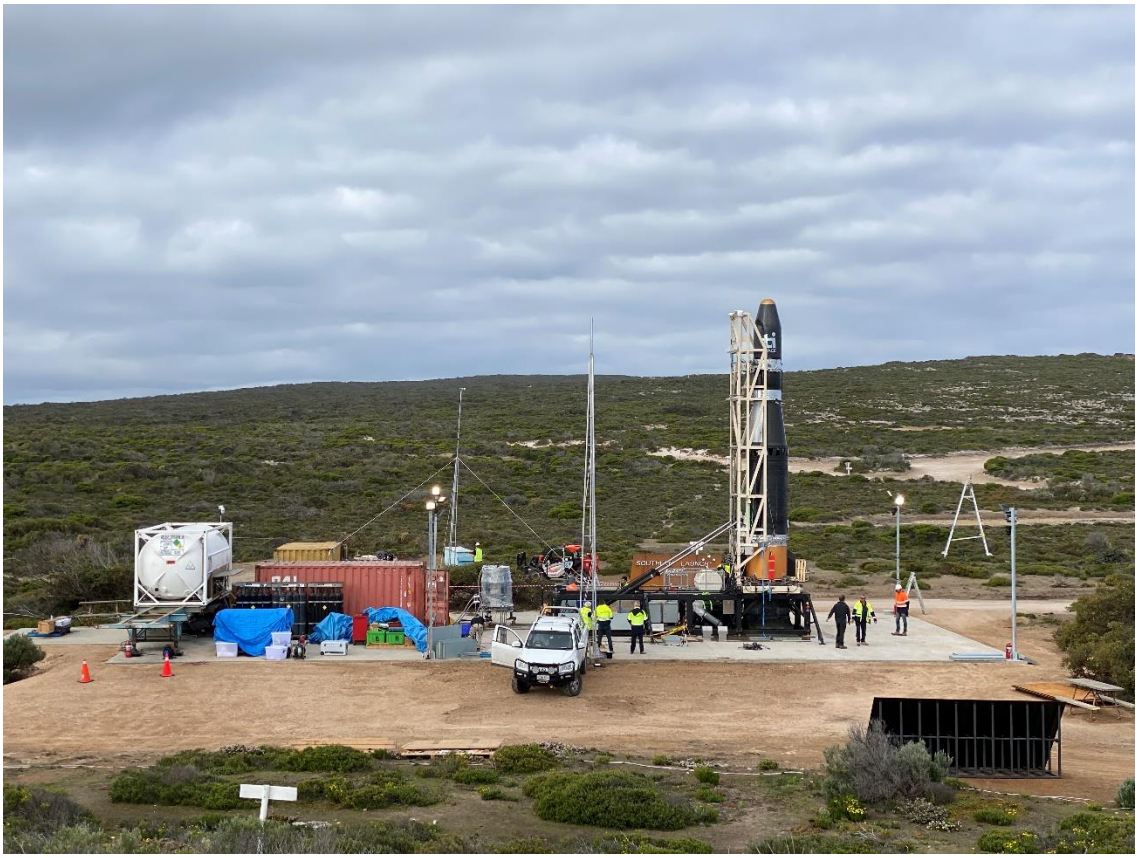


Figure 4 – SACFS CFS Brigade Locations

8. Bushfire Risk Assessment

South Australia is one of the most fire-prone areas in the world, with a history of catastrophic bushfires.

While bushfire is a significant risk facing South Australia, it is also a natural part of the environment and many plant species rely on fire to regenerate. A variety of causes can ignite a bushfire: some bushfires result from events that are natural, such as lightning, while others result from human activity.

The bushfire risk assessment process involves identifying, analysing, evaluating and treating the identified bushfire risks. The detailed bushfire risk assessment matrix is a function of the likelihood of an adverse event occurring, and the consequence of the event.

The overall risk assessment process requires a consistent approach, and the methodology has been developed and found in the AS/NZS ISO 31000:2009 as incorporated into the National Emergency Risk Assessment Guidelines (NERAG).

The bushfire risk assessment for Southern Launch must also consider if the proposed activities and mitigation strategies are likely to contribute to increasing the existing risks of a bushfire (either during its construction or operational phases) or inhibit any bushfire suppression operations carried out by Southern Launch or the combatting authorities.

The aim of the bushfire risk assessment is to assist Southern Launch understand the contributing factors associated with all operations (including its planned launch operations) from the site.

The objectives are to make recommendations to mitigate the bushfire risk to ensure Southern Launch achieve the priorities of protecting life, property and the environment.

The assessment included the following steps:

- A desktop assessment that considers bushfire history, external and internal fire management plans, risk indicators, bushfire modelling and other available information.
- Review of the existing site conditions involving a site visit and the collection of locality specific fuel load data.
- Assessments of aerial imagery.
- Analysis of available fire history.
- Analysis of the vegetation and its ability to be managed to reduce risk
- Assessment of the existing fire mitigation works in the area and their effectiveness.
- Conducting a bushfire risk assessment.
- Following the analysis, outline activities that will likely reduce bushfire risk.

The risk rating table (refer section 8.1) is used to combine likelihood and consequence to obtain a risk rating. The risk rating is used to aid decision making by determining which areas of the project are at the greatest risk of a fire starting and spreading from the Southern Launch leased land. Actions can be prioritised using this method to determine where risk mitigation works will occur.

8.1 Current Site Bushfire Risk Assessment

The proposed development site for Southern Launch is on the southern tip of the Eyre Peninsula, known as Whalers Way. The project site is approximately 1200 hectares of coastal vegetation with minimal vehicle access and infrastructure.

The project site is subject to a Heritage Agreement (pursuant to the South Australian Heritage Act, 1978) and under this agreement the nominated land has been dedicated for the conservation of native flora and fauna. This heritage agreement does not allow for specific activities to be undertaken to manage the vegetation and reduce the potential landscape bushfire risk and consequences.

Recreational and commercial tourism activities occur on the site permitted by agreements with the owner via the purchase of a visitor pass.

Table 3 summarises the bushfire risks for the current management and operational activities that occur on the project site.

Current site Bushfire risk assessment table

RISK TO	Impact	Likelihood	Justification	Consequence	Justification	Risk Rating
LIFE & PROPERTY						
Allotment 101 DP71437 Hundred of Sleaford On-site staff & contractors Assets and critical infrastructure Recreational tourists Fire agency (CFS, MFS & DEW) firefighters **Neighbours:** Dwellings and farms surrounding the site, particularly to the north and east of the site.	Loss of life /injury due to entrapment on the property in a major fire event. Loss of life /injury due to entrapment on roads and adjacent recreational sites in a major fire event. Destruction of critical assets Destruction of surrounding isolated dwellings and farms including loss of livelihood.	Likely	Fire behaviour could be unpredictable for direct attack suppression and may entrap firefighters. Access to the property in some locations is through private property or Crown land which may lead to confusion. Proximity of the adjacent dwellings. Minimal Bushfire mitigation work completed on surrounding properties. Heavy fuel loads and adjoining vegetated areas on private property with similar fuel accumulation characteristics. In the event of smoky conditions in the adjacent recreational area, people's sense of direction could be affected. Recreational users are not always with their vehicle and may be some time away from a safe mode of transport in the event of a fire. The general area of Port Lincoln, Whalers Way and the Eyre Peninsula is already bushfire prone and large areas are covered by the SA Government's Bushfire Hazard Overlay. Mobile phone reception is limited in most areas and alerts and warnings are likely to not be received. Use of combustible and flammable materials and liquids including propellant, lubricants, oils, etc. Lack of firefighting water in the surrounding landscape to assist with firefighting operations. Distance, time and access options to travel back to nominated Bushfire safer place or last resort refuge. Current Heritage agreement restricting vegetation management and bushfire prevention. General access to the site is unknown and not recorded.	Catastrophic	If entrapment occur there is potential for loss of life. Due to the landscape on and surrounding coastal mallee environment, bushfires will travel quickly, and people close to the bushfire may not receive an adequate warning to prepare.	Extreme

RISK TO	Impact	Likelihood	Justification	Consequence	Justification	Risk Rating
ENVIRONMENT						
Whole allotment and surrounding landscape.	Loss of whole allotment due to major fire event. Water quality and supply disruption occurs to surrounding communities. Large scale loss of dwellings and livelihood. Disruption to community connectivity, daily activities. Major impact on biodiversity and ecology in the area.	Likely	Elevated levels of bushfire fuel present in surrounding landscape, including private properties. History of bushfires starting from a variety of causes including farming operations and lightning. Fire activity during peak periods may overwhelm fire fighting agencies and ability to respond to new fires.	Major	Environmental impact, particularly in sensitive ecological areas, impact on fauna habitats. Local death & short-term displacement of species. Possible Impact on water quality and supply. Impact on community and community assets.	Extreme

Table 3 - Current Site Bushfire risk assessment table

8.2 Bushfire Risks During Construction and Operation

Existing land uses and human activity already pose a risk of bushfires for the site. The proposed development will introduce additional elements to the region that have, in theory, the potential to increase bushfire risk, however, many of these elements already exist or occur in the region from other industries or operations.

The implementation of appropriate mitigation strategies will depend on the design of suitable management practices, response procedures and effective communications between all stakeholders, particularly during the fire season.

Increased human activity during construction and operation of the project has the potential to increase ignition likelihood primarily by increasing the likelihood of accidental ignition in the area.

The following potential ignition sources and bushfire related hazards have been identified for the Southern Launch project:

- Mechanical (Rocket failure, wheel bearings, farming activities)
- Accidental (smoking, grinding welding)
- Lightning
- Deliberate ignition (arson).
- Restricted access and egress
- Bushfire surrounding the site in all directions.
- Extreme fire behaviour
- Direct flame contact on buildings
- Embers landing on the property.
- Inability to safely leave the property in the event of a bushfire or other emergency.
- Long unburnt vegetation with elevated levels of bushfire fuel.
- The use of heavy earthmoving machinery operating in rocky environment during construction.
- Increasing the potential for vehicles to drive through flammable vegetation.
- Increasing the volume of human activity and vehicles accessing the area.
- Storage and use of flammable fuels and materials.

The proposed development site is on naturally low fuels and reduced bushfire risk. The maintenance of existing and the construction of new roads to operational areas will increase access for emergency vehicles and reduce response times to reported bushfires.

Depending on the conditions a bushfire may become challenging to contain, however, if the recommendations within this plan are implemented, we consider there is no greater risks from bushfire during construction and operational activities to be more prevalent than any other existing general activity (e.g. farming, contracting or other construction).

8.3 Bushfire Risk Mitigation

The overwhelming desire of Southern Launch management is to implement preventative actions to mitigate the potential bushfire risk from a fire starting on their land and impacting the project area, the environmental assets, adjacent landowners and communities.

Measures to reduce the likelihood and consequence of bushfires include;

- Creation of sterile (no fuel) and low fuel areas around launch pad sites (exclusion and buffer zones) based on modelled launch trajectory, where an area of green grass will be managed, minimising the chance of ignition.
- Access to the site will be strictly managed, minimal number of people on site during launch operations
- Defined and managed visitor access areas.
- All staff contractors and visitors will be required to undertake a specific site induction identifying bushfire risk considerations and actions.
- Restricted access for tourism and recreational visitor management.
- Design and construction of an onsite Shelter in Place building.
- Upgrading of fire access and egress tracks.
- Landscape approach to bushfire mitigation activities
- Stakeholder engagement
- Vegetation Management

8.4 Qualitative Bushfire Risk Assessment

The qualitative bushfire risk assessment (table 4) considers the likelihood and consequence and combines the proposed mitigation strategies to define the residual risk rating.

Qualitative Bushfire Risk Assessment table

Risk to	Potential	Likelihood	Justification	Consequence	Risk Rating	Mitigation Strategies (Controls)	Revised Likelihood	Revised Consequence	Residual risk rating
LIFE AND PROPERTY	**DURING CONSTRUCTION AND OPERATION PHASE**								
On-site staff & contractors Emergency Services personnel Adjacent landowners Recreational Tourists Assets and infrastructure	**Accidental Ignition from** • Fire started by hot works • Fire started from general operations • earthworks while clearing dry vegetation on rocky ground • vehicle components contacting vegetation while driving off road • Lightning • Fires from adjacent properties • Motor Vehicle accident • Rocket exploding within confines of launch facility • Rocket exploding and landing on the leased area **Deliberate ignition from** • arson **Potential loss of life / injury from** • entrapment in open environment • entrapment in infrastructure including neighbouring dwellings • entrapment on roads adjacent recreational sites • Bushfire response operations	Likely	• Accidents happen • Fire behaviour could be unpredictable and may entrap firefighters. • Access in some locations is through private property or Crown land which may lead to confusion. • Proximity of the adjacent dwellings to the launch site. • Minimal Bushfire mitigation work completed on surrounding properties. • High fuel loads • In smoky conditions people's sense of direction could be affected. • Recreational users are not always with their vehicle and may be some time away from transport or safer place • Lease area is a bushfire prone area • Mobile phone reception is limited in most areas and alerts and warnings may not be received. • Use of combustible and flammable materials and liquids including propellant, lubricants, oils, etc. • Lack of separation currently between the works areas and existing vegetation. • Lack of firefighting water in the surrounding landscape to assist with firefighting operations. • Distance, time and access options to travel back to nominated Bushfire safer place or last resort refuge. • Large volume of flammable fuels and gases	Catastrophic	Extreme	• Appoint a Chief Bushfire Warden for the site as part of the Emergency Control Organisation (ECO) • Hot works management system undertaken by trained staff. • Works not authorised if FDI greater than 49. • No staff on site with FDI 74 or above • No Launch when FDI 49 or greater • Firefighting equipment onsite • Fire extinguishers on site, including all vehicles and earthmoving equipment • All staff and contractors must carry communication devices as per communications plan. • Southern Launch has fire suppression capacity including 4wd vehicles • Staff and contractors attend Basic Wildfire Awareness (BWA) training • Site induction includes advice on bushfire risks • Vehicles banned from driving off road • All staff involved in any bushfire suppression operations to be provided with the appropriate nationally accredited training. • Bushfire Emergency Plan • Appropriate vegetation management around launch site including sterile areas with no fuel • Appropriate vegetation management on property boundaries • Designated bushfire shelter on site • Installation of strategic Surveillance cameras • Dedicated fire water supplies onsite • Roads and tracks meet GAFMWG standards • Ongoing Liaison with stakeholders, neighbours, emergency services and all interested parties • Water deluge system at launch pad	Unlikely	Major	High

Risk to	Potential	Likelihood	Justification	Consequence	Risk Rating	Mitigation Strategies (Controls)	Revised Likelihood	Revised Consequence	Residual risk rating
LIFE AND PROPERTY	**DURING CONSTRUCTION AND OPERATION PHASE**								
	Potential bushfire impacts on • Southern Launch Assets and critical infrastructure • Adjacent landowners' dwellings and farms surrounding the Southern Launch site, particularly to the north and east of the site.					• Fuel and oxidiser bunds are protected by concrete and earth blast walls and tanks are located outside blast zone. • All staff will be outside exclusion zone during high-risk periods of launch preparation and launch. • Speed limit for vehicles on site will be 15 Km/h. • Vehicles will have radios and flashing yellow lights. • Annual BMOS audit			
ENVIRONMENT									
Large high intensity landscape bushfires over entire Southern Launch precinct (lease area) and surrounding landscape.	Loss of whole precinct due to major fire event. Water quality and supply disruption occurs to surrounding communities. Large scale loss of dwellings and livelihood. Disruption to community connectivity, daily activities. Major impact on biodiversity and ecology in the area.	Likely	• Elevated levels of bushfire fuel present in surrounding landscape, including private properties • History of bushfires starting from a variety of causes including farming operations and lightning. • Fire activity during peak periods may overwhelm fire fighting agencies and ability to respond to new fires.	Moderate	High	• Continue to liaise with all stakeholders across the southern peninsula and apply a tenure blind approach to bushfire mitigation and response. • Work with fire agencies, all surrounding land managers and private properties to ensure landscape risk is being appropriately managed. • Ensure that any future revegetation projects do not contribute to an increased bushfire risk to assets, infrastructure, or access. • Develop sound environmental management practices for future fire management, including post bushfire recovery actions. • Consider reducing the overall fuel hazard on the lease area • Maintain sterile areas and asset protection zones around critical infrastructure, assets and access tracks.	Unlikely	Moderate	Medium

Table 4 – Qualitative Bushfire Risk assessment table

9. Recommendations for Southern Launch to Reduce Bushfire Risk

1. All staff and contractors must carry basic firefighting equipment (including fire extinguisher) along with communications devices in all vehicles.

2. Invest in 4-wheel drive fire suppression capability to support bushfire risk mitigation during launch operations.

3. All staff that will be at the site during the fire danger period should be provided with basic bushfire awareness (BWA) training.

4. All staff involved in any initial attack bushfire suppression operations to be provided with the appropriate nationally accredited training.

5. Develop policies and procedures to appropriately manage bushfire risk to visitors, staff and contractors. Including site induction, bushfire response, actions on forecast high fire weather days, reported bushfire emergencies, visitor management and site closure.

6. Site induction to include site specific bushfire risk information.

7. Maintain a database of assets and a maintenance register.

8. Record the annual mitigation and preparedness actions through the implementation of the annual Bushfire Mitigation Operational Schedule (*BMOS).*

9. Review their legal liabilities regarding lease agreements, bushfire prevention requirements, suppression responsibilities and access to the lease area.

10. Southern Launch facilitate the opportunity for local CFS Brigades to undertake annual visits to become familiar with access and egress, access difficulties for larger appliances and areas restricted to smaller fire appliances.

11. Consider reducing the overall fuel hazard on the lease area, maintain sterile areas and asset protection zones around critical infrastructure, assets and access tracks.

12. Annually review and update the Bushfire Emergency Plan (BEP).

13. Provide a bushfire shelter in place location on the property for staff, contractors and visitors to shelter if threatened by a bushfire.

14. Implement a communication system that ensures that all staff, contractors and visitors can always be contacted and be notified of any emergency warnings and alerts.

15. Appoint a dedicated Chief Bushfire Warden and deputies as part of the Emergency Control Organisation (ECO) requirements.

16. Ensure a hot works management system (including permits) is implemented and includes consideration of the bushfire risk on the given day.

17. Consider the installation of surveillance cameras to assist with bushfire detection and site security.

18. Install dedicated static firefighting water supplies at appropriate locations across the site.

19. Advise the Bushfire Management Area Committee (BMAC) of bushfire mitigation actions being carried out on the lease area and update the Bushfire Management Area Plan (BMAP) as required.

20. Ensure all roads and access tracks through the site meet the current SA Government fire access track guidelines.

21. Continue to liaise with all stakeholders across the southern peninsula and apply a tenure blind approach to bushfire mitigation and response.

22. Work with fire agencies, all surrounding land managers and private properties to ensure landscape risk is being appropriately managed.

23. Ensure that any future revegetation projects do not contribute to an increased bushfire risk to assets, infrastructure, or access.

24. Develop sound environmental management practices for future fire management, including post bushfire recovery actions.

25. Improve emergency vehicle access around the perimeter boundary of the lease area.

Table 5 - Recommendations for Southern Launch to reduce Bushfire risk

10. Bushfire Prevention and Preparedness

Bushfire prevention and preparedness is a key factor in reducing the potential impacts from bushfires.

Prevention treatments and preparedness strategies must be managed all year round with a particular focus leading into and during the Fire Danger Period (FDP) and following any analysis of the potential bushfire risk.

10.1 Bushfire Mitigation Operational Schedule (BMOS)

The Bushfire Mitigation Operational Schedule (BMOS) is an operationally based annual audit document to record all activities to prepare for the fire season. It will be updated annually to reflect changes in the property and seasonal conditions.

This Schedule is in Appendix 15.1

10.2 Training

Employees are required to undertake site-specific training which includes instructions on site-based emergency procedures.

All persons in roles named in this plan will have received the necessary training required to fulfil their roles, and records of this training will be kept in the Southern Launch training files and databases.

Where required all training and assessment shall be provided by an external Registered Training Organisation and be nationally accredited.

The following training should be undertaken on a regular basis or as required:

- Bushfire Warden training and refresher in line with state requirements
- Induction programs should include knowledge of this procedure and the role of Chief Bushfire Warden and Deputy Building Wardens pre, during and post an emergency.
- Emergency Drills shall be conducted regularly, and all staff shall attend at least one emergency drill per season.
    - Evacuation Procedures
    - Sheltering in Place Procedures
- All staff to attend Basic Wildfire Awareness (BWA) training
- Southern Launch staff involved in any bushfire suppression operations must complete bushfire training to a minimum "Crew Leader Level" (units to be defined by the SACFS).

10.3 Equipment

Southern Launch has already identified the need to provide their own capability to undertake initial first attack firefighting as part of their operations. This will mitigate the reliance on CFS volunteers from neighbouring brigades and improve response times.

Bulk water is also to be made available, ideally from onsite dedicated fire water supplies and mobile a large tanker to support firefighting operations if required.

The site must have available equipment that is to be maintained and regularly tested prior to and during the fire danger period:

- Two "quick attack" fire units e.g. Toyota Landcruiser with 400l water capacity (trailers not recommended)
- One Fire truck, 4WD with minimum 4000l water capacity
- All hoses and fittings to comply with CFS standards
- All buildings and structures to comply with ministerial standards
- Static water supply for firefighting use (workshop, launch area and range control)
- All trained firefighting staff and contractors to be issued CFS compliant Personal Protective Clothing and Personal Protective Equipment

10.4 Fire Weather Forecast

The Bureau of Meteorology and the SACFS provide advice on forecast conditions that would make a fire unpredictable and difficult to control should a bushfire be ignited. This early advice is to assist the community plan for the predicted significant fire weather days.

There are several terms utilised when informing the community of the potential or current bushfire risk including

- Fire Danger Ratings and Fire Danger Index
- Total fire bans
- Bushfire Warnings and Current Incidents
- Bushfire Alert Levels

Fire weather forecasts can be available 4 days (up to 7 days) in advance, with Fire Danger Ratings routinely issued by 5pm daily during the fire season.

Fire Danger Ratings and Total Fire Ban information for days 2, 3 and 4 are preliminary forecasts and should be used as a guide only as these ratings may change based on both weather and non-weather-related factors.

Total Fire Bans are officially declared after 4pm the day prior.

10.5 Fire Danger Ratings & Warnings

To consider fire preparedness requirements, actions and to ensure timely advice to all staff, contractors and visitors, the Chief Bushfire Warden (or delegate) will review BOM 4-day and daily fire weather forecasts including.

- Fire Danger Ratings FDR
- Fire Danger Index FDI
- Lightening Activity Levels (LAL)

Term	Description
Fire Danger Ratings	Fire Danger Ratings provides an indication of how bad a bushfire would be if one started. For up-to-date Fire Danger Rating predictions visit; Fire Danger Ratings
Total Fire Bans	A Total Fire Ban is declared by SACFS on days when fires are likely to spread rapidly and could be difficult to control. There are restrictions on days of Total fire Ban's to prevent fires from starting. For up-to-date information on what activities you can do on fire ban days visit; Total fire bans - What can I do?
Bushfire Warnings	Bushfire Warnings provide information on a fire that has started and suggests things to do. For up-to-date warnings visit; SA Current Bushfire Warnings and Incidents.
Lightening Activity Levels (LAL)	Is a scale which describes lightning activity. LAL 1 No thunderstorms LAL 2 Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a 5-minute period. LAL 3 Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a 5-minute period. LAL 4 Scattered thunderstorms. Moderate rain is commonly produced Lightning is frequent, 11 to 15 cloud to ground strikes in a 5-minute period. LAL 5 Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud to ground strikes in a 5-minute period. LAL 6 Dry lightning (same as LAL 3 but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag Warning.

Table 6 – Fire Danger Ratings, Total fire ban and Bushfire warnings

Category	Fire Danger Index	
	Forest	Grassland
Catastrophic (Code Red)	100 +	150 +
Extreme	75–99	100–149
Severe	50–74	50–99
Very High	25–49	25–49
High	12–24	12–24
Low–Moderate	0–11	0–11

Figure 5 - Fire Danger Ratings and Fire Danger Index within South Australia

10.6 Bushfire Advice and Warning Messages

The SACFS provides information to support the community understand the current and predicted fire impact locations, predicted bushfire behaviour, possible impact areas, and recommended actions you should take.

Southern Launch ECO and staff are trained to implement an action plan in line with the SACFS Bushfire Advice and Warning Messages. Refer Section 16.6, tables 12, 13 and 14).

Bushfire Alert Level	Consideration	Action Plan
'ADVICE' 	**'Observe and review'** Facility operates with a heightened level of caution and Focused on a high level of diligence and alert Evacuation could be possible.	Further visitors not allowed to enter site, until threat has passed. Bushfire Shelter in Place location prepared for possible occupation.
WATCH' and ACT' 	**'Plan to shelter in place or evacuate'** A watch and act message is received reporting a fire that is a potential threat to the sites and public safety. Evacuation could be possible.	Move staff, contractors, and visitors to Bushfire Shelter in Place location. Prepare to move staff, contractors, and visitors from Bushfire Shelter in Place location to evacuation point.
'EMERGENCY WARNING' 	**'Evacuate or seek refuge'** An emergency warning message of an uncontrolled bushfire where the loss of life of threat to the sites is almost certain Evacuate early before danger is present	Evacuation is required. Plan to move staff, contractors, and visitors from Bushfire Shelter in Place location to evacuation point. If too late to evacuate seek refuge in Bushfire Shelter in Place location. Follow instructions of Emergency Services

Table 7 – Southern Launch Action plan for SACFS Bushfire Warning Messages.

11. Bushfire Emergency Control Organisation (ECO)

Any emergency requires effective management to ensure the priority is the safety of anyone who can be adversely affected.

The Bushfire ECO structure is based on the level of bushfire risk, complexity of the site and the number of staff and guests on the site at any one time.

The Bushfire ECO members have roles before, during and after emergencies including;

- Showing leadership
- organise and supervise the safe movement of staff, contractors and visitors
- assist emergency services responding to the bushfire
- communicate with everyone through the warden network.

All Bushfire ECO members are required to ensure the Chief Bushfire Warden is informed of the completion or non-completion of the nominated tasks.

It is the responsibility of the ECO to ensure that:

- Only one person is appointed as the Chief Bushfire Warden at any one time
- At least one other person has been trained to fill the Chief Bushfire Warden role.
- Staff on site are aware of their responsibilities and are available to assist with the management of and response to a bushfire emergency.

It is important to acknowledge the daily roles and functions of key staff but not confuse them with their emergency management roles during an emergency.

11.1 ECO Roles and responsibilities

PRE-Bushfire Emergency	
Title	Role
Chief Bushfire Warden	• Take control of all preparedness and response functions and ensure people are allocated other roles. • Liaise with Emergency Services, the Emergency Management Committee, and the Bushfire Management Area Committee. • Maintain a list of trained Deputy Building Wardens, First Aid Officers and trained staff. • Conduct induction training for new staff so that they are aware of their responsibilities under this plan. • Conduct regular exercises. • Ensure Building Wardens have appropriate identification available. • Ensure all staff are aware of their responsibilities during forecast high fire danger days • Ensure the appropriate Bushfire Emergency App is installed on their mobile phone (Alert SA, SA Fires, Australian Fires) and is set to receive alerts of fires in the local area. • Attend preseason meetings with DCLEP and SACFS Region 6 Staff and local Brigades to discuss any potential issues / concerns regarding bushfire preparedness and response. • Ensure Bushfire Emergency Plan is current and reviewed annually. • Ensure the annual Bushfire Management Operational Schedule (BMOS) is completed and signed.
Deputy Bushfire Warden	• Support the Chief Bushfire Warden in the delivery of their duties. • Carry out the preventative maintenance as per (BMOS) • Attend required training and Emergency Drills • Ensure the appropriate Bushfire Emergency App is installed on their mobile phone (Alert SA, SA Fires, Australian Fires) and is set to receive alerts of fires in the local area.
Building Fire Wardens	• Follow directions and support the Chief and Deputy Building Wardens in the delivery of their duties. • Carry out the preventative maintenance as per (BMOS) • Attend required training and Emergency Drills • Ensure the appropriate Bushfire Emergency App is installed on their mobile phone (Alert SA, SA Fires, Australian Fires) and is set to receive alerts of fires in the local area.
First Aid Officer	• Ensure the First Aid equipment is fully stocked and current. • Attend required training and Emergency Drills • Ensure the appropriate Bushfire Emergency App is installed on their mobile phone (Alert SA, SA Fires, Australian Fires) and is set to receive alerts of fires in the local area.

Table 8 - PRE Bushfire Emergency

DURING- Bushfire Emergency	
Title	Role

Chief Bushfire Warden	• Ascertain the nature of the bushfire emergency
	• Ensure that the emergency services, Deputy Bushfire Wardens and Building Wardens are notified of the bushfire emergency
	• Work with the ECO to determine the appropriate response (evacuate or shelter in place).
	• Initiate relevant response procedure providing leadership and direction.
	• Ensure the emergency services are aware of the
	  • Emergency Location
	  • the number of occupants
	  • if sheltering in place or evacuation is occurring and
	  • any other relevant information.
	• Ensure any site visitors are kept fully informed and aware of the bushfire.
	• Brief emergency services personnel upon arrival.
	• Follow directions of Emergency Services.
	• Monitor Advice - Reduced Threat Messages

Deputy Bushfire Warden	• Upon being notified of the bushfire emergency, immediately report to the Chief Bushfire Warden to receive direction. • Commence implementing the Bushfire Emergency Plan procedures (Evacuate or shelter in place) • Provide accurate and timely advice to Building Wardens • Report completion of allocated tasks to the Chief Bushfire Warden. • Monitor Advice - Reduced Threat Messages
Building Wardens	• Follow directions and support the Chief and Deputy Bushfire Wardens in the delivery of their duties. • Maintain control of the relevant area and keep visitors informed of the bushfire emergency. • Ensure the orderly and safe flow of people during evacuation or sheltering in place. • Provide direction and guidance to visitors to the Bushfire Shelter in place building or evacuation point. • Report completion of allocated tasks to the Deputy or Chief Bushfire Warden. • Monitor Advice - Reduced Threat Messages
First Aid Officer	• Upon being notified of the bushfire emergency, immediately report to the Building Warden. • Respond to any first aid emergencies and provide support as required emergency services arrive. • Call 000 if urgent Medial Attention required. • Report completion of allocated tasks to the Building Warden. • Notify the Chief Bushfire Warden of any reportable incidents.

Table 9 - DURING Bushfire Emergency

POST Bushfire Emergency	
Title	Role
Chief Bushfire Warden	• When the emergency has been declared safe by the emergency services, inform the Deputy Bushfire and Building Wardens as required. • Ensure liaison with emergency services has occurred to advise the safest route from the facility. • Organise a debrief with the ECO members and where appropriate with emergency service organisation representative/s. • Monitor Advice - Reduced Threat Messages
Deputy Building Wardens	• Seek direction from the Chief Bushfire Warden. • In the event of shelter in place occurring, support the orderly departure from the facility. • Participate in any post emergency debrief actions. • Monitor Advice - Reduced Threat Messages
Building Wardens	• Seek directions from the Chief or Deputy Building Wardens • If shelter in place was undertaken o assess bushfire situation post fire front o assess if safe to move from shelter in place o facilitate the orderly evacuation of the shelter in place o liaise with emergency services and coordinate evacuation from Southern Launch site • Monitor and provide support if required. • Participate in any post emergency debrief actions. • Monitor Advice - Reduced Threat Messages
First Aid Officer	• Seek direction from the Chief Bushfire Warden. • Monitor and provide support if required. • Participate in any post emergency debrief actions.

Table 10 - POST Bushfire Emergency

11.2 ECO Reporting Structure

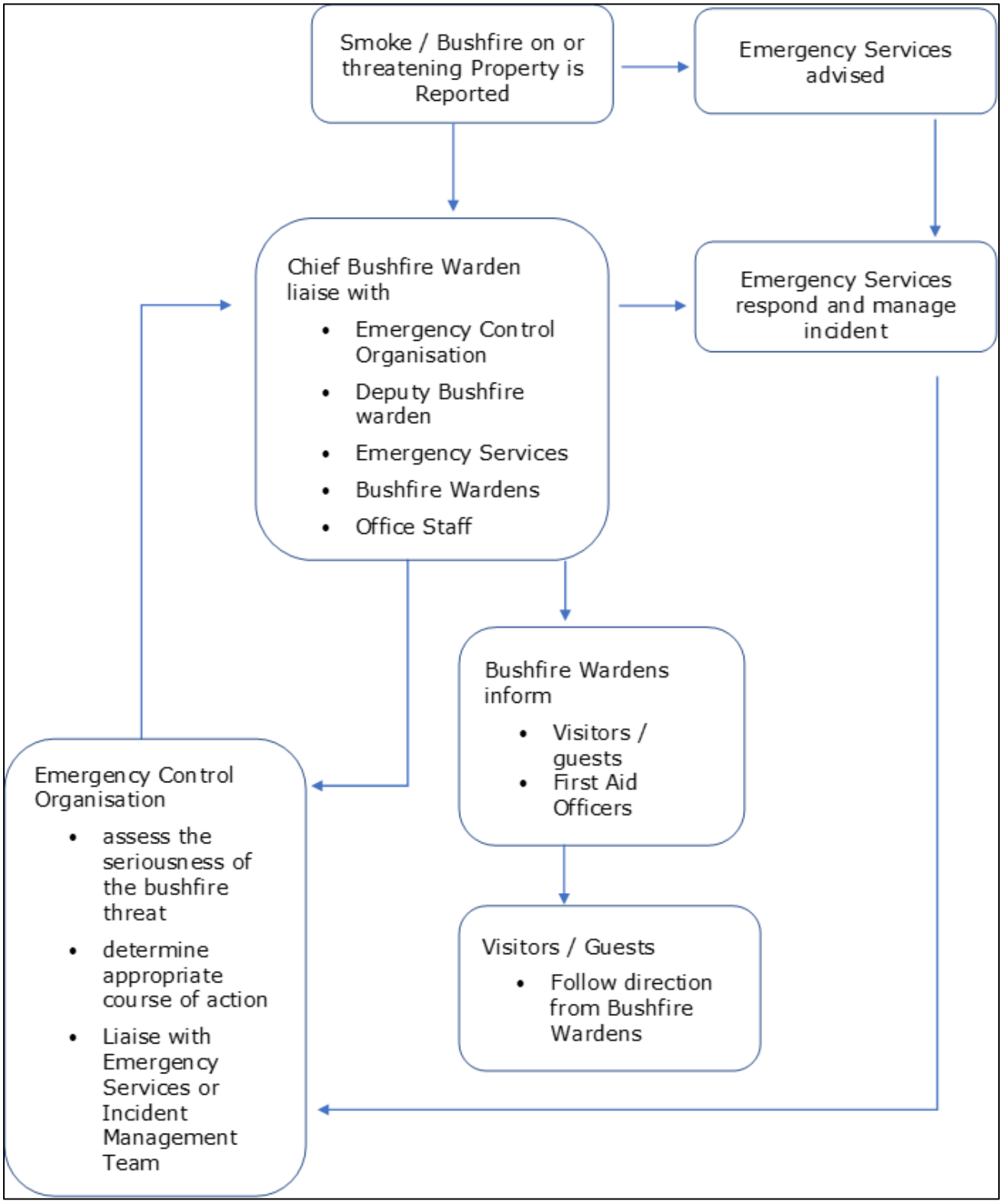


Figure 6 - Bushfire ECO reporting structure

12. Bushfire Response

The Chief Bushfire Warden during a Bushfire emergency or forecast fire weather conditions at the site has a range of options to determine the most appropriate method of keeping staff, contractors, and visitors safe from any potential danger.

The decision should always be based on a risk assessment that determines:

- The likely threat to life or threat of injury
- Staying is a greater risk than leaving
- You can leave safely in a timely manner

The following points are to assist the Chief Bushfire Warden to determine the most effective action during a bushfire emergency:

- Assessment of the Bushfire location and predicted impacts
- The local fire weather conditions
- The time expected before impact on the bushfire Shelter in Place location or egress route before everyone can be safely evacuated to the bushfire safer place
- The seriousness of the threat to human safety and evacuating occupants
- Available resources to evacuate all staff and guests
- Travel time to Evacuation point and Safer Place
- Safest travel routes
- Ability to liaise with and receive advice from emergency services

12.1 Primary Response

The Primary Action in response to forecast fire weather conditions or a reported bushfire for all sites is to evacuate all staff and guests.

Evacuation is the process of moving people from where they are at risk to another location that is an appropriate distance (following a route that is the quickest and safest) away from the effects of a bushfire to a safer location.

Leaving early is critical to ensuring occupants are not on the property when the bushfire danger becomes elevated and will ensure staff and visitors are safe and free from the risk of death, injury, or harm.

If in doubt, always choose the conservative approach that improves the survivability of the visitors.

Evacuation advice and direction will be provided by the Chief Bushfire Warden and communicated by the onsite building wardens to all staff and visitors.

If the primary action to evacuate is no longer a safe option, there will be an alternative procedure to ensure the safety of staff and guests.

12.2 Secondary Response

The Secondary Action in response to forecast fire weather conditions or a reported bushfire is where staff and guests are not able to safely evacuate and must shelter in place.

Sheltering in place is the process of moving people to a specific (a Bushfire Shelter in place building) that has been appropriately constructed to Australian Standards to support the expected number of people and withstand the effects of bushfire.

The Chief Bushfire Warden will direct staff and guests to the Shelter in Place building (range control) where they will remain inside as the fire front passes.

12.3 Bushfire Evacuation

A Bushfire Emergency Warning from SACFS may require immediate evacuation on the day with little or no warning and limited preparation time. There should be no expectation that emergency services will be available to support any evacuation activities.

Evacuation from the property to a bushfire safer place or last resort refuge will require driving through other high bushfire risk areas, the access routes must be considered based on known fire location or predicted fire spread.

IMMEDIATE FULL EVACUATION is	• this measure will be used to remove all personnel and occupants from the site to a designated Bushfire Safer Place.
PRE-WARNED EVACUATION is	• this measure follows reliable information that prompts a decision to possibly undertake a controlled and managed evacuation.
SHELTER IN PLACE (NO EVACUATION) is	• This should be seen as a last resort • Only utilised if leaving the property during a bushfire or when the approaching bushfire is too close, and it is considered unsafe • Not enough time to safely move all staff, contractors, and visitors from the site to a safe area.

12.4 Evacuation or shelter in place decision matrix

The Evacuation / shelter in Place decision matrix is based on the initial report of a small developing fire (not yet completely established and burning at is maximum forward rate of spread). The estimated initial forward rate of spread (FROS), prior to a wind change, used is 4.5km / hour, based on an FDR of Extreme, with and FDI of 90. There is greater potential for higher FROS in adverse fire weather conditions.

Forecast Fire weather conditions (FDR) and (FDI)	Action required by the Chief Bushfire Warden for forecast FDR for the Whalers Way site next working day		Distance of reported fire (North or West of site, Shelter in Place Building, or egress/evacuation route)		
			< 10km	10 – 20km	>20km
Catastrophic FDI 100+	ACTION	Act to close site, notify CFS of closure	Site Closed	Site Closed	Site Closed
Extreme FDI 75-99		Act to close site, notify CFS of closure	Site Closed	Site Closed	Site Closed
Severe FDI 50-74		Site open to essential operations only Possible Evacuation in the event of a fire may be required – prepare now and inspect Shelter in Place Building	Shelter in place	Immediate Full Evacuation	Possible Evacuation
Very High 25-49		Site Open Possible Evacuation in the event of a fire may be required – prepare now and check Shelter in Place Building	Possible Evacuation	Possible Evacuation	Possible Evacuation

Table 11 - Evacuation or shelter in place decision matrix

12.5 Southern Launch Actions for Fire Danger Ratings

Fire Danger Rating	Fire Danger Index (FDI)	Action for Southern Launch
CATASTROPHIC	100+	SITE CLOSED: NO LAUNCH Fire danger rating is issued by BOM for the following day. Evacuation to be completed the day prior.
EXTREME	75-99	SITE CLOSED: NO LAUNCH Fire danger rating is issued by BOM for the following day. Evacuation to be completed the day prior.
SEVERE	50-74	SITE PART CLOSED: NO LAUNCH (Only essential operational staff to be on site) Action to be completed the day prior or the morning of forecast fire conditions. Chief Bushfire or Deputy Bushfire Warden will: • Monitor the Alert SA app, ABC Radio, SACFS website • Check any recent thunderstorm activity or lightning strikes in the area in the previous 24-48 hours. • Share all relevant information to Building Wardens • Determine actions to shelter in place or evacuate • Advise CFS duty officer of Number of personnel on site, location and decided actions. • Inform any contractors of fire plan and evacuation procedures. • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Undertake preparations for potential evacuation including prepositioning of dedicated vehicles • Follow advice from Emergency Services Building Wardens will: • Always remain in contact with the Deputy or Chief Building Wardens and Office Staff • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Inform all staff on site that a day of Total Fire Ban has been declared. • Advise all staff that no naked flames, smoking, or hot works are permitted. • Prepare / check shelter in place building for possible occupation by personnel, including checking of operation of all fire defence systems and emergency supply equipment including power supply systems and generators, and fire hose reels. • Prepare to be evacuated as required All staff and visitors will: • Follow the direction of Building warden or emergency services

Fire Danger Rating	Fire Danger Index (FDI)	Action for Southern Launch
VERY HIGH	25-49	SITE OPEN: Launch operations subject to FDI assessment as per Grain Harvest COP Action to be completed the morning of forecast fire conditions. Chief Bushfire or Deputy Bushfire Warden will: • Check any recent thunderstorm activity or lightning strikes in the area in the previous 24-48 hours. • Undertake risk assessment to determine day activities • Advise CFS duty officer of Number of staff, location and decided actions. • Inform any contractors of fire plan and evacuation procedures. • Undertake scheduled welfare checks at 0900, 1200, and 1500 • Follow advice from Emergency Services Building Wardens will: • Participate in risk assessment to determine day activities • Monitor the Alert SA app, ABC Radio, SACFS website • Always remain in contact with the Deputy or Chief Building Wardens and Office Staff • Undertake scheduled welfare checks at 0900, 1200, 1500 • Inform all staff and visitors of risk assessment decision • Advise staff and visitors that no naked flames, smoking, or hot works are permitted. • Prepare to be evacuated as required All staff and visitors will: Follow the direction of Building warden or emergency services
HIGH	12-24	OPEN: Normal bushfire plan procedures apply.
LOW – MODERATE	0-11	OPEN: Normal bushfire plan procedures apply

Table 12 - Summary of SACFS Fire Danger Ratings and Actions for Southern Launch

12.6 Southern Launch Actions for Bushfire Advice and Warning messages

Bushfire Advice	
Title	Role
Chief Bushfire Deputy Bushfire Warden	• Monitor the Alert SA app, ABC Radio, SACFS website • In addition to CFS advice (polygon), monitor bushfires and incidents to the north of the Site. • If reported fire is 10 to 20km to the North or West of the Bushfire Shelter in Place location or the evacuation egress routes, consider the preferred option to shelter in place or evacuate • Share all relevant information to Building Wardens • Determine actions to shelter in place or evacuate • Advise CFS duty officer of Number of staff, contractors and visitors, location and decided actions. • Inform any contractors of fire plan and evacuation procedures. • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Undertake preparations for potential evacuation including prepositioning of dedicated vehicles • Liaise with and follow advice from Emergency Services
Building Wardens	• Monitor the Alert SA app, ABC Radio, SACFS website • Always remain in contact with the Deputy or Chief Building Wardens and Office Staff • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Prepare to be evacuated as required • Prepare / check Bushfire Safer Place location for possible occupation by staff, contractors, and visitors, including checking of operation of all fire defence systems and emergency supply equipment including power supply systems and generators and fire hose reels. • Liaise with staff, contractors, and visitors regarding conditions and directions as directed by the Chief Bushfire Warden • Report on outside conditions and location of guests to Chief Bushfire Warden
All staff	• Monitor the Alert SA app, ABC Radio, SACFS website • Monitor Emergency Alert Messages • Follow the direction of Building warden or emergency services
Contractors & Visitors	• Monitor the Alert SA app, ABC Radio, SACFS website • Monitor Emergency Alert Messages • Follow the direction of Building warden or emergency services

Table 13 - Southern Launch actions for Bushfire Advice Message

Bushfire Watch and Act	
Title	Role
Chief Bushfire Deputy Bushfire Warden	• Monitor the Alert SA app, ABC Radio, SACFS website • In addition to CFS advice (polygon), monitor bushfires and incidents to the north of the Site. • If reported fire is 10 to 20km to the North or West of the Bushfire Shelter in Place location or the evacuation egress routes, consider the preferred option to shelter in place or evacuate • Share all relevant information to Building Wardens • Determine actions to shelter in place or evacuate • Advise CFS duty officer of Number of staff, contractors and visitors, location and decided actions. • Inform any contractors of fire plan and evacuation procedures. • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Undertake preparations for potential evacuation including prepositioning of dedicated vehicles • Liaise with and follow advice from Emergency Services
Building Wardens	• Monitor the Alert SA app, ABC Radio, SACFS website • Always remain in contact with the Deputy or Chief Building Wardens and Office Staff • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Prepare to be evacuated or shelter in place as required • Prepare / check Bushfire Shelter in Place location for possible occupation by staff, contractors, and visitors, including checking of operation of all fire defence systems and emergency supply equipment including power supply systems and generators, and fire hose reels. • Liaise with staff, contractors and visitors regarding conditions and directions as directed by the Chief Bushfire Warden • Report on outside conditions and location of guests to Chief Bushfire Warden
All staff	• Monitor the Alert SA app, ABC Radio, SACFS website • Monitor Emergency Alert Messages • Follow the direction of Building warden or emergency services
Contractors & Visitors	• Monitor the Alert SA app, ABC Radio, SACFS website • Monitor Emergency Alert Messages • Follow the direction of Building warden or emergency services

Table 14 - Southern Launch actions for Bushfire Watch and Act Message

Bushfire Emergency Warning	
Title	Role
Chief Bushfire Deputy Bushfire Warden	• Monitor the Alert SA app, ABC Radio, SACFS website • In addition to CFS advice (polygon), monitor bushfires and incidents to the north of the Site. • If reported fire is 10 to 20km to the North or West of the Bushfire Shelter in Place location or the evacuation egress routes confirm the preferred option to shelter in place • Share all relevant information to Building Wardens • Advise CFS duty officer of Shelter in Place plans • Advise CFS duty officer when safely sheltered in place • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Liaise with and follow advice from Emergency Services
Building Wardens	• Monitor the Alert SA app, ABC Radio, SACFS website • Always remain in contact with the Deputy or Chief Building Wardens and Office Staff • Prepare to shelter in place • Shelter in place • Undertake scheduled welfare checks at 0900, 1200, 1500 and 1800 • Support / comfort visitors and contractors during sheltering in place • Report to Chief Bushfire Warden when safely sheltering.
All staff	• Monitor the Alert SA app, ABC Radio, SACFS website • Monitor Emergency Alert Messages • Follow the direction of Building warden or emergency services
Contractors & Visitors	• Monitor the Alert SA app, ABC Radio, SACFS website • Monitor Emergency Alert Messages • Follow the direction of Building warden or emergency services

Table 15 - Southern Launch actions for Bushfire Emergency Warning Message

13. Recovery

After the fire has passed all staff, contractors, and visitors are to remain in the Bushfire Safer place until the Chief Bushfire Warden has liaised with the emergency services to confirm the fire area has been declared as safe before any person is allowed to renter.

The Chief Bushfire Warden will advise Emergency services that staff, and guests are re-entering the site.

Building Wardens will support and assess all staff, guests and vehicles for injury or damage, all structural assets to be checked by qualified personnel, all injuries to be referred to seek medical attention and damage to be appropriately recorded.

If staff and guests stayed in the bushfire shelter, once the fire front has passed, the Bushfire Warden will assess any existing hazards (including where appropriate extinguish embers and small fires outside) and check it's safe to move from the Bushfire Shelter in place building.

The Building Warden in consultation with the Chief Bushfire Warden and Emergency services will coordinate post fire evacuation from Bushfire Shelter in place building. It is noted that this may take some time.

The Chief Bushfire Warden will arrange a suitable time with staff to have a debrief that includes the questions;

- What was planned?
- What Happened?
- What can we do better next time?

The Chief Bushfire Warden will assess the impacts from the bushfire and enact the Business Continuity Plan as required.

14. Conclusion

The Southern Launch Whalers Way site is being constructed in an environment that is well known and understood for being bushfire prone.

This risk assessment has dealt with bushfire risk holistically. This includes the risk of fire occurring on site as part of Southern Launch's operations and the risk of fire entering the area from the surrounding landscape.

The single greatest threat to the buildings/infrastructure on site and the surrounding private and public land, particularly on the northern side of the Southern Launch site is the amount, configuration and arrangement of bushfire fuel present and its ability to spread fire rapidly across the site under adverse fire weather conditions.

Significant resources are being applied to the development of mitigation actions to reduce bushfire risk, and this includes the recognition of dedicated Southern Launch fire resources during launch activities occurring in the Fire Danger season.

The ECO is responsible for the development, maintenance and exercising of this Bushfire Emergency Plan and all operations conducted within the site, this includes management of specific bushfire related activities including:

1. Communications planning
2. Ensure safe areas and managing exclusion zones
3. Evacuation and emergency response planning
4. Fire suppression capability and capacity
5. Nominating dedicated Bushfire Fire Wardens
6. Fire weather monitoring
7. Key prevention and preparedness actions
8. Fire training and emergency response activities

Bushfire does not adhere to property boundaries, and it is evident that a similar bushfire risk exists on land managed outside of the Southern Launch leased site.

Bushfire mitigation works undertaken on the site such as implementing asset protection zones around key infrastructure, improved vehicle access, vegetation management, dedicated fire resources and training will help to reduce the overall bushfire risk, the subsequent impact on surrounding communities and the environment.

15. Appendices

15.1 Example Bushfire Mitigation Operational Schedule (BMOS)

ANNUAL BUSHFIRE MITIGATION OPERATIONAL SCHEDULE					
Location: Whalers Way Southern Launch Site	**Date:**				**Approved by:**
Mitigation Task	**Annual timing**	**Date Completed**	**Task ID**	**Responsible Owner**	**Comments**
Vegetation Management					
Vegetation Management Zone works around Range Control and Operations buildings completed to achieve the approved Bushfire Attack Level (BAL) as per AS3959-2018.	Sep-Dec		1		
Vegetation adjacent to all access tracks is cleared to minimise encroachment	Sep-Dec		2		
Grass areas adjacent to launch pads irrigated and maintained	Sep-Dec		3		
Site preparation for fire danger season includes general ground maintenance e.g. grass mowed, dead vegetation removed, leaf litter removed and vegetation encroachment on buildings mitigated	Sep-Dec		4		
Health Safety and Welfare					
All staff familiar with policies, procedures and their responsibilities before, during and after a bushfire emergency	Sep-Dec		5		Refer BEP
Policy and Procedures					
Emergency Management Plan reviewed, updated and approved by CEO	Sep-Dec		6		
Bushfire Emergency Plan reviewed, updated and approved by CEO	Sep-Dec		7		
All staff, contractors and visitors familiar with policy for closure on forecast Severe, Extreme and Catastrophic Fire Danger Days	Sep-Dec		8		
Southern Launch has a nominated Shelter in Place building (Range Control)	Sep-Dec		9		
Planning					
Daily fire danger rating is distributed and publicised across the site for staff, contractors and vistors during the FDP	Sep-Dec		10		
Advise the Bushfire Management Area Committee (BMAC) of bushfire mitigation actions being carried out on the lease area and update the Bushfire Management Area Plan (BMAP) as required.					
Training					
Staff completed training in Bushfire and Emergency Management as per their role and responsibilities	Sep-Dec		11		
Staff attended annual bushfire preparedness meeting and emergency response drill	Sep-Dec		12		
Managers attended introductory Incident Management training	Sep-Dec		13		
Designated staff involved in any initial attack bushfire suppression operations to be provided with the appropriate nationally accredited training.	Sep-Dec		14		
All staff have attended Basic Wildfire Awareness (BWA) course	Sep-Dec		15		
Plant and Equipment					
All bushfire fighting equipment tested, fire water tanks full and operational. Fire extinguishers, fire hose reels, and hand tools serviceable	Sep-Dec		16		
All bushfire fighting communications and warning systems are tested and operational e.g. alarms, PA, radios, SMS groups, other systems	Sep-Dec		17		
Access and Egress					
CFS Fire fighting appliances have defined emergency access and egress areas including turn around areas	Sep-Dec		18		
Inspect Southern Launch access roads and tracks (drainage, surface conditions and vegetation) identify and implement maintenance as required	Sep-Dec		19		
Infrastructure					
Inspect gates to ensure locks are in place and functioning	Sep-Dec		20		
Clear gutters, roof surfaces/valleys, external decks and verandas clear to ensure they are free of leaf litter/dead plant material accumulation	Sep-Dec		21		
External building components should be free of combustible material and are to be painted and sealed, window and external vent screens serviceable	Sep-Dec		22		
Excessive amounts of flammable and combustible fuels / gases and other items removed from being located externally to buildings e.g. gas bottles, paint, solvents and chemicals	Sep-Dec		23		

15.2 Site Layout Launch Site A Emergency Management and Evacuation Plan Map

EXAMPLE ONLY

Final layout will be shown with approved detailed designs.

All fire infrastructure will be designed to appropriate Industry and legislative requirements

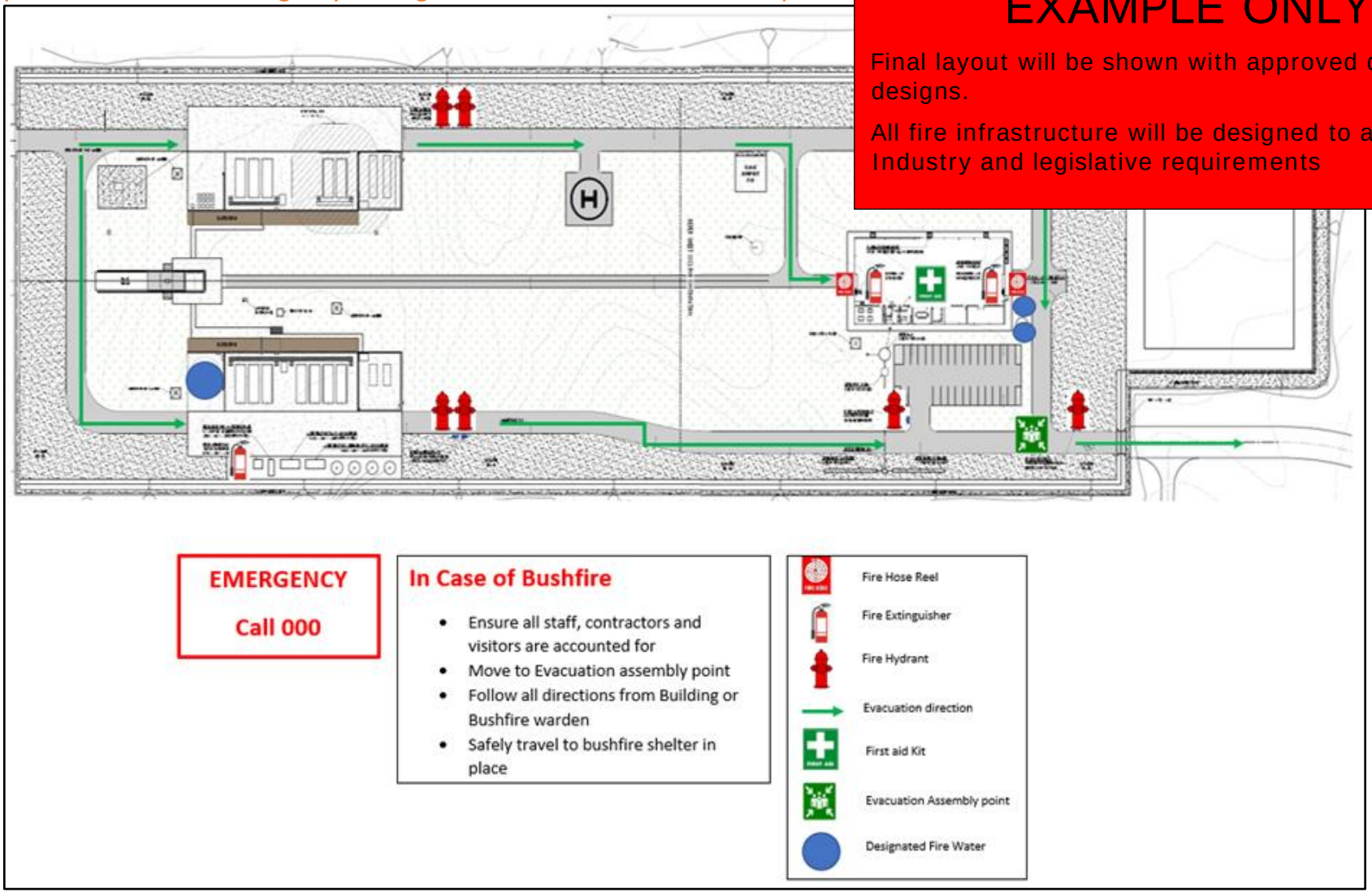


Figure 7 – Launch Site A Emergency Management and Evacuation Plan

15.3 Site Layout Launch Site B Emergency Management and Evacuation Plan Map

EXAMPLE ONLY

Final layout will be shown with approved detailed designs.

All fire infrastructure will be designed to appropriate Industry and legislative requirements

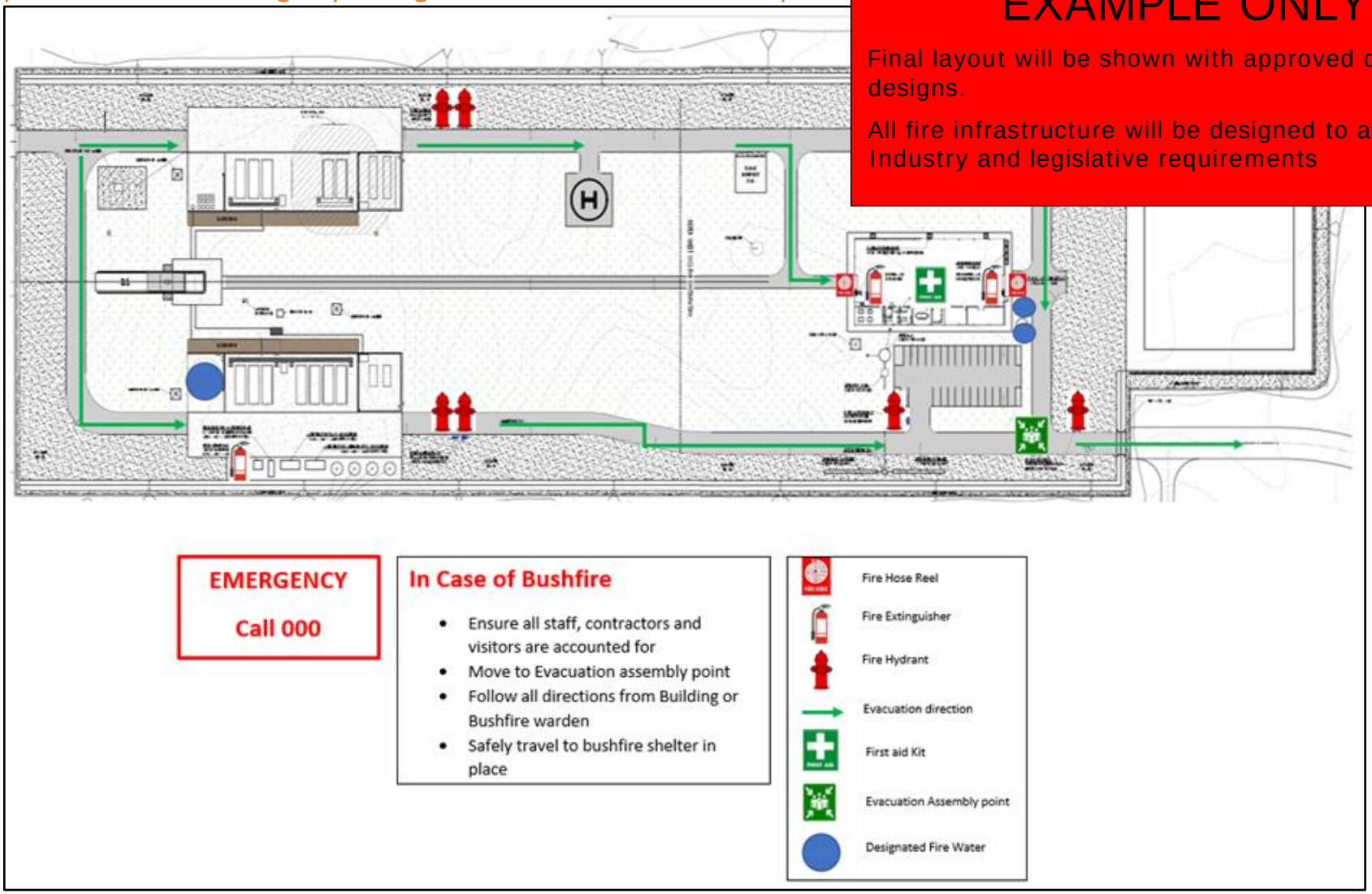


Figure 8 - Launch Site B Emergency Management and Evacuation Plan

15.4 Site Layout Range Control Emergency Management and Evacuation Plan Map

EXAMPLE ONLY

Final layout will be shown with approved detailed designs.

All fire infrastructure will be designed to appropriate Industry and legislative requirements

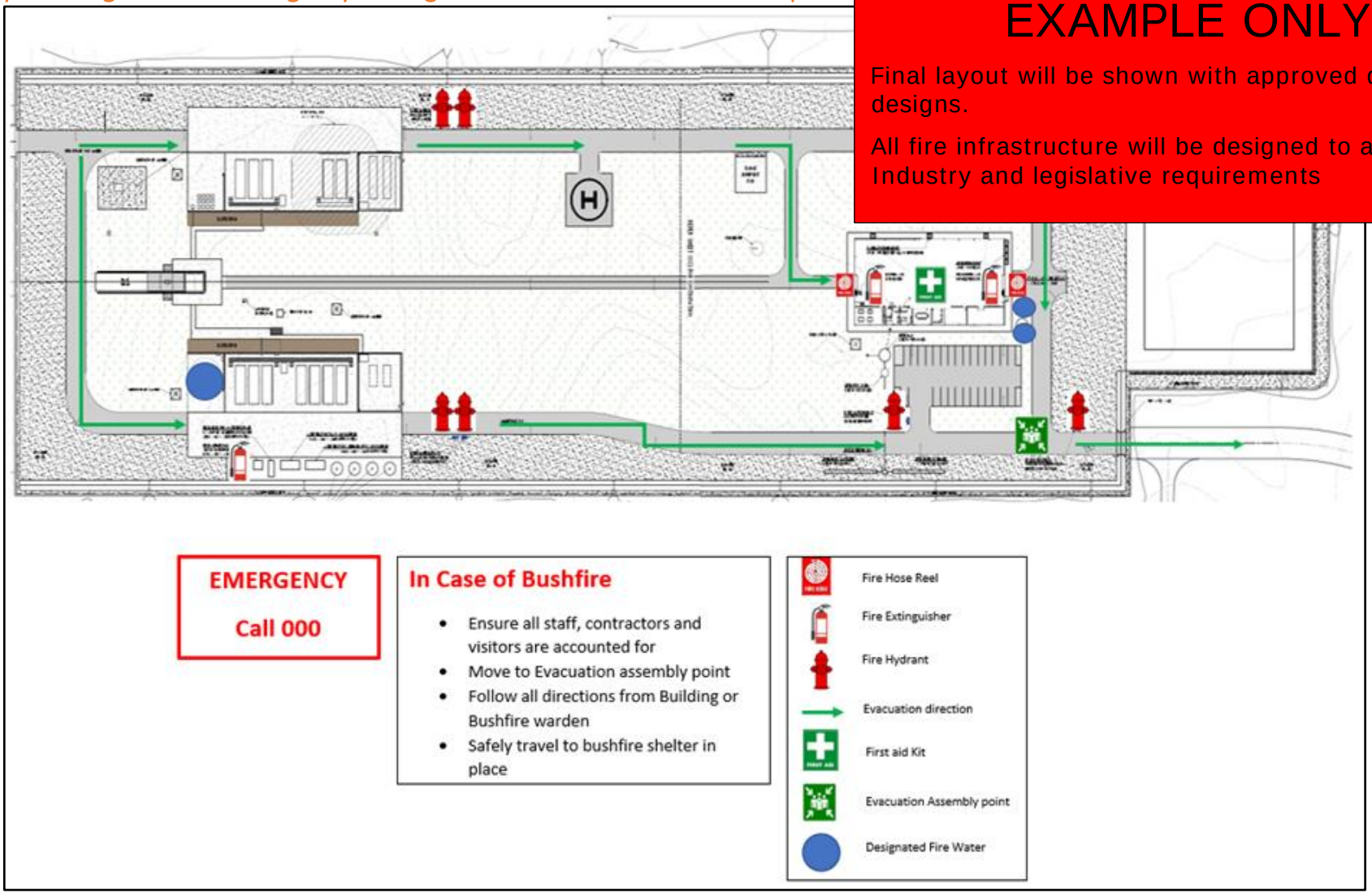


Figure 9 – Range Control Emergency Management and Evacuation Plan

15.5 Site Layout Workshop Emergency Management and Evacuation Plan Map

EXAMPLE ONLY

Final layout will be shown with approved detailed designs.

All fire infrastructure will be designed to appropriate Industry and legislative requirements

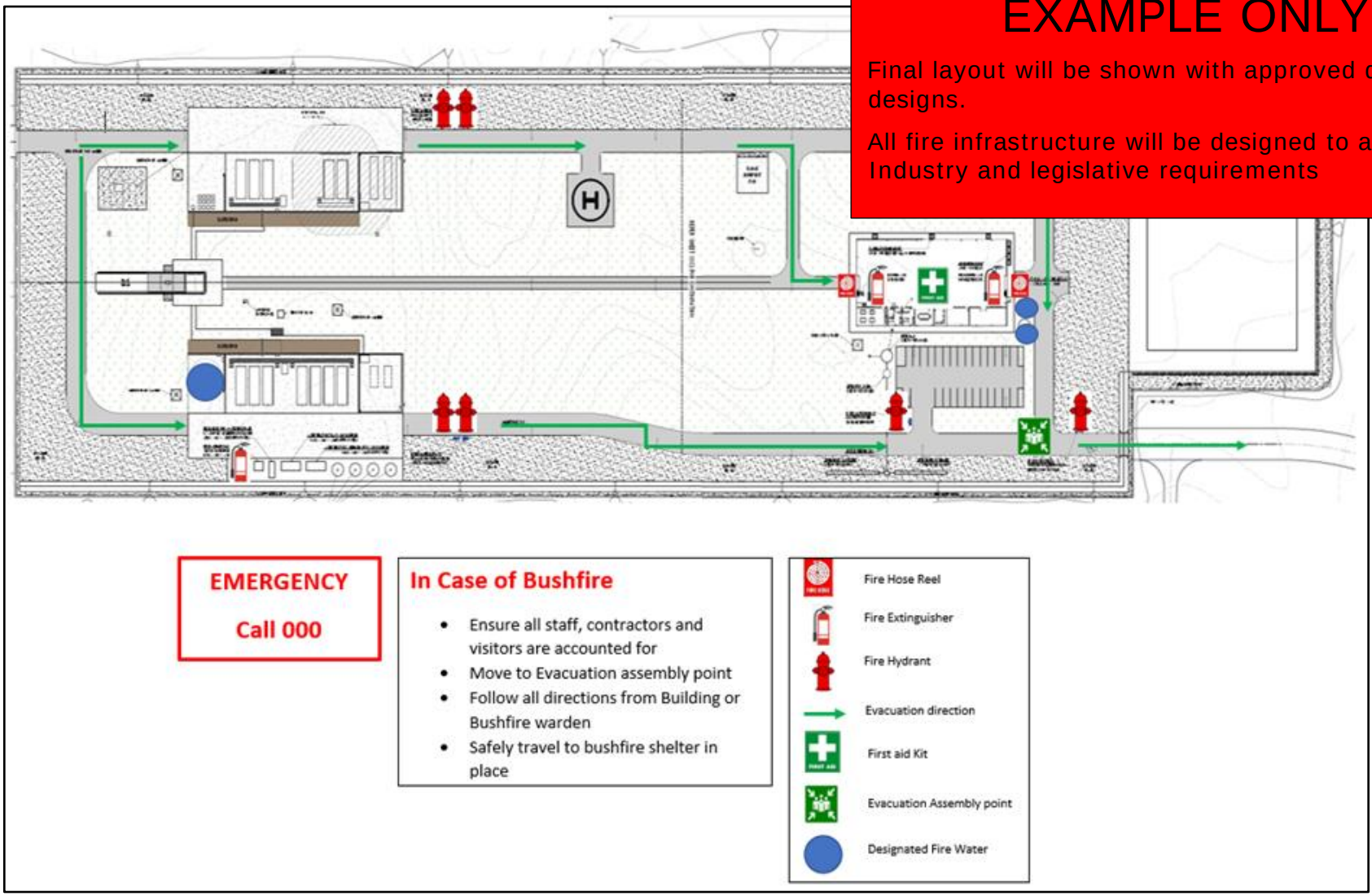


Figure 10 - Workshop Emergency Management and Evacuation Plan

15.5 Emergency Management and Evacuation Plan access and egress Map to Shelter in Place

Figure 11 - Emergency Management and Evacuation Plan access and egress Map to Shelter in Place

15.6 Lower Eyre Peninsula Last Resort Refuges and Bushfire Safer Places

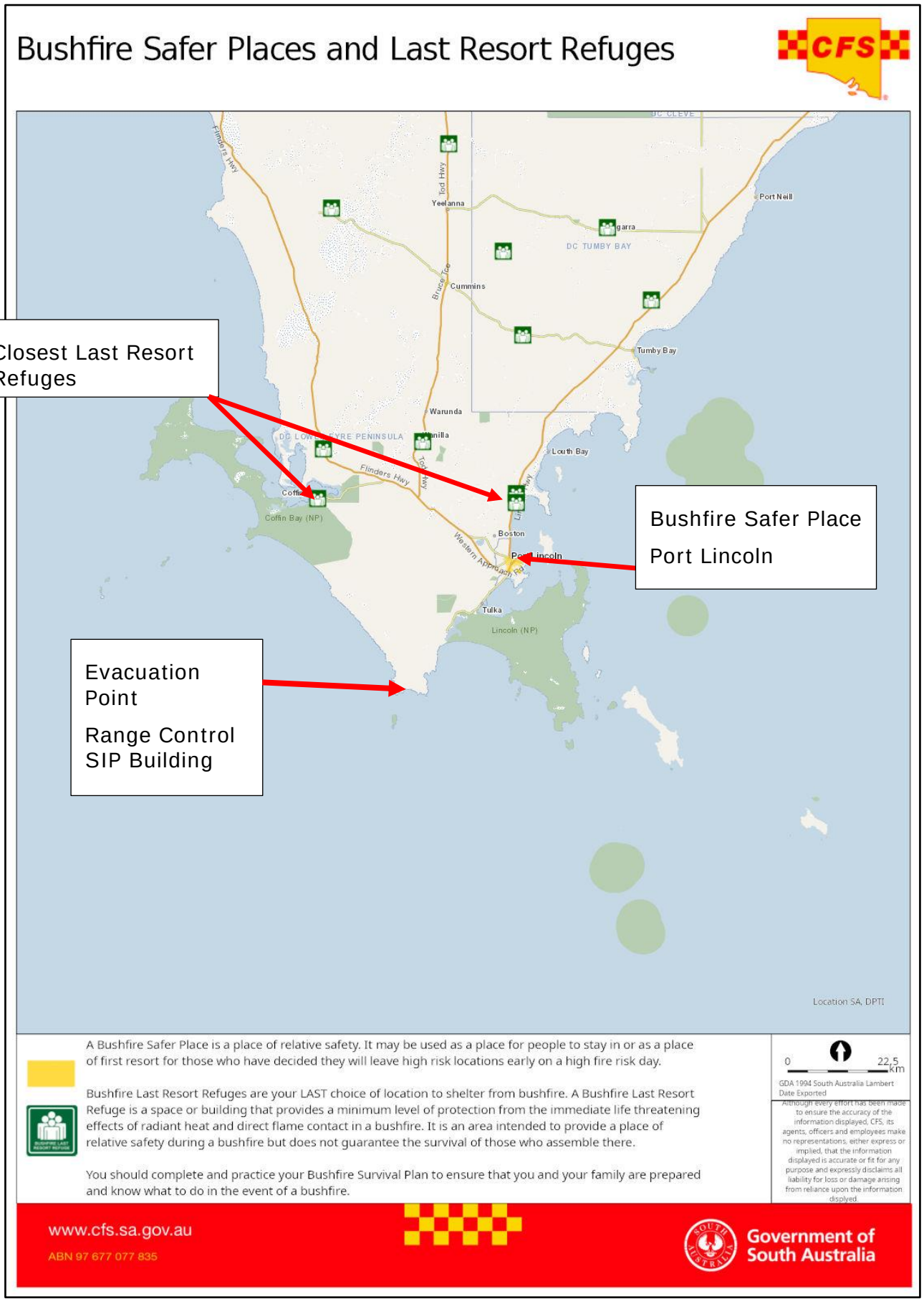


Figure 12 - Lower Eyre Peninsula BSP and LRR

15.7 Evacuation Point egress options to Bushfire Safer Place

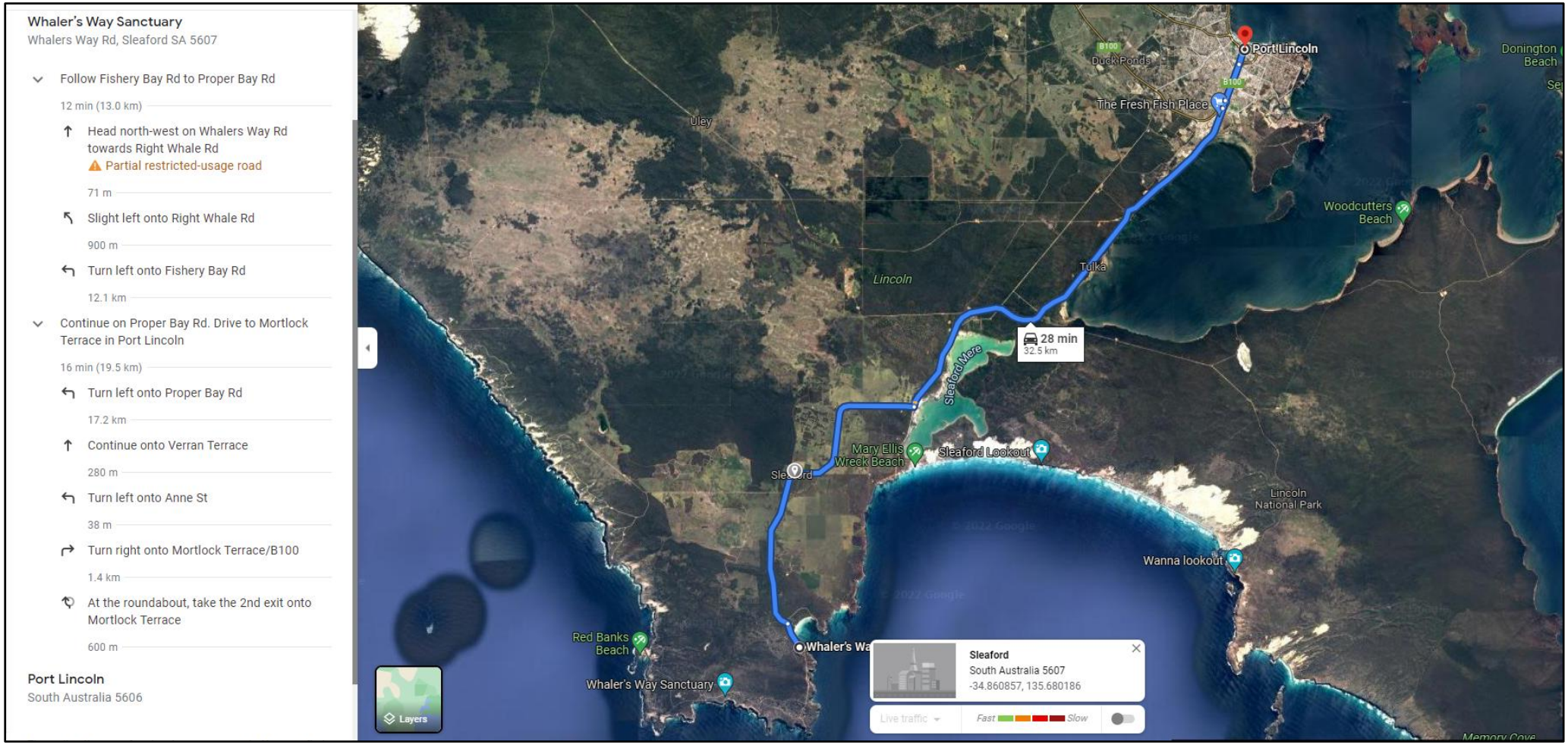


Figure 13 - Evacuation point egress options to Bushfire safer Place

15.8 Bushfire Shelter in Place Procedures

Stage	*Trigger*	*Action*
Preparation of the bushfire Shelter in Place Building	*Prior to the declaration of the Fire Danger Season (October / November)*	*Undertake all preparedness actions in the Bushfire Management Operational Schedule (BMOS) for the site.*
Preparation prior to the fire front	• *Fire within 10km (N, W or E of Bushfire Shelter in place building, evacuation egress or evacuation point)* • *FDI 50 or above* • *Ember attack landing on or in the immediate vicinity of the Bushfire Shelter in place building.*	• *Follow the direction of the Bushfire warden* • *Move to the Bushfire Shelter in place building* • *Put on personal protective clothing* • *Wait outside the refuge for as long as possible (prior to the impact of fire front)* • *Account for all people* • *Possibly wet down the surrounding vegetation* • *Remain calm* • *Advise emergency services you have moved to refuge.*
Response	• *Embers attacking the Bushfire shelter in place building* • *Intense radiant heat, thick smoke and fire* • *Imminent fire front impact*	• *Move inside the Bushfire Shelter in place building* • *Close and secure all doors, windows and vents.* • *Advise emergency services you have moved into refuge.* • *Remain in the Bushfire shelter in place building until fire front has passed* • *Remain calm*
Recovery	• *Fire front has passed*	• *Open Bushfire shelter in place building door* • *Assess outside conditions* • *If safe to do so move out of Bushfire shelter in place building to evacuation point* • *If safe to do so extinguish any burning material adjacent Bushfire shelter in place building* • *Assess welfare of all* • *Attend to any medical requirements* • *Advise emergency services of situation* • *Await advice for evacuation to safe place*

Table 16 - Shelter in place Procedures

15.8 Southern Launch Bushfire Emergency Management and Evacuation Plan

Southern Launch Bushfire Emergency Management and Evacuation Plan	
Primary Action	Evacuate the site
Secondary Action	Shelter in place
Key Site Contact	Bushfire Warden TBA by Southern Launch
Infrastructure on site	Launch Sites Workshop (Includes BAL rated SIP Building) Range Control (Includes BAL rated SIP Building)
Number of staff and Guests	Max 40
Roles and responsibilities	Chief Bushfire Warden oversees the site and managing all staff and guests
Emergency Contacts	Emergency Services - 000 SACFS Hotline - 1300 362 361 SACFS Incident Information https://www.cfs.sa.gov.au/warnings-and-incidents/ SACFS Regional Operations - 08 8682 4266

Evacuation or Shelter in Place procedures

Evacuation from the site will be determined by the ECO in conjunction with the Chief Bushfire Warden and based on the Evacuation or Shelter in Place decision Matrix.

IMMEDIATE FULL EVACUATION

- Extreme or Catastrophic forecast conditions (SITE CLOSED)

PRE-WARNED (Possible) EVACUATION

- Advice from emergency services
- Severe forecast conditions (FDI 50 or above) and Fire greater than 20 km away or;
- FDI 50 or below and fire within 20km

SHELTER IN PLACE (NO EVACUATION)

- Advice from emergency services
- Severe forecast conditions (FDI 50 or above) and Fire within 10km

Designated Emergency Assembly (Evacuation) point

STAGE 1 – Bushfire Assembly Area (Launch Site A, B and Range Control)
STAGE 2 – Bushfire Evacuation point (Range Control)
STAGE 3 – Bushfire Safer Place Port Lincoln

Transport and Travel Requirements	
Number and type of Vehicles and trips required (To travel from Launch site to Evacuation point)	2 vehicles
Travel time requirements (To travel from Launch Site to Evacuation point)	20 minutes
Travel time requirements (To travel from Evacuation point to Safer Place)	1 Hour
Number of Vehicles required (To travel from Evacuation point to Bushfire Safer Place or place of last resort)	2 buses 1 trip
Person organising transport	Fire Warden

Table 17 - Southern Launch Bushfire Emergency Management and Evacuation Plan

15.9 Chief Bushfire Warden Evacuation Checklist

Task		Yes/No
Equipment Check	Torch	
	Reflective vest	
	Notepad and pen	
	Mobile phone	
	Important Contact Numbers list	
	Staff and Guest list	
Risk assessments	Have you checked CFS Bushfire Messages	
	Have you assessed options to evacuate or shelter in place	
	Have you considered time required to evacuate from refuge to safer place	
Coordination	Have you prepositioned vehicles or arranged appropriate transport from Bushfire Shelter in place building to evacuation point?	
	Have you prepositioned vehicles or arranged appropriate transport from evacuation point to bushfire safer place?	
	Have you confirmed safest egress routes?	
Notification	Have you been notified to evacuate or shelter in place	
	Have you advised all staff, guests, Chief Bushfire Warden and Emergency Services the decision to evacuate or shelter in place?	
	Have you advised all staff and guests to assemble at the Bushfire Shelter in place building	
	Have you notified Chief Bushfire Warden that all staff and guests are accounted for at the Bushfire Shelter in place building.	
	Have you advised all staff and guests to assemble at the Evacuation point	
	Have you notified Chief Bushfire Warden that all staff and guests are accounted for at the evacuation point.	
	Have you advised all staff and guests to assemble at the Bushfire safer Place	
	Have you notified Chief Bushfire Warden that all staff and guests are accounted for at the bushfire safer place and evacuation is complete.	

Table 18 - Bushfire Warden Evacuation checklist

J

WAX VISUAL AMENITY

RESPONSE TO PUBLIC SUBMSSION

Project No:	20OLF
Project:	ORBITAL LAUNCH FACILITY
Subject:	RESPONSE TO PUBLIC SUBMISSIONS
Date:	5 APRIL 2022
To:	SOUTHERN LAUNCH
Attention:	ANDREW CURRAN
From:	WARWICK KEATES

As part of the EIS process for the Whalers Way Orbital Launch Complex, 261 public submissions were received. Of these, seven (7) were explicitly concerned with landscape character and visual impact. These include submission numbers 3 (Lothian), 42 (Berret and petition), 68 (Hockaday), 128 (Gorvel), 153 (Menz), 159 Hayes and 168 Rayson.

The following statement provides additional information and comment in relation to several subject areas. These include;

1. Protection and preservation of the natural landscape
2. High quality of the existing landscape of Whalers Way
3. Meeting of the Development Plan objectives
4. Mitigation opportunities to reduce the visual impacts

In response to the public responses and ongoing assessment of the project, Area A has been relocated 900m northeast away from the coastline of Wahlers Way. This adjustment to the siting of development Area A has been considered as part of the visual assessment response.

1. Protection and preservation of the natural landscape

All seven respondents expressed the need to protect and preserve the natural landscape and the potentially unacceptable impacts of the proposed development.

The Landscape Character and Probable Visual Effect Assessment (LCPVEA) acknowledge that there will be visual effects on the existing landscape character of the Whalers Way locality. However, the separated development footprints associated with the Orbital Launch Complex will fragment the visual effect of the overall development. Combined with the low raised built form and the existing screening provided by local ridgelines, the visual effect of the Whalers Way Orbital Launch Complex is described as slight to moderate.

The scale of the development and the specific siting reduce the potential visual impacts. Each site has been selected to offer increased levels of screening and visual mitigation. The original siting was situated on an inclines plateau facing north away from the coastal edge towards the modified rural landscapes. The revised location of Area A will position the launch facility further to the northeast, away from the south-facing coastal edge of the locality and the western coast line. While the revised Ares A is elevated , it is surrounded by local ridgelines that provide screening to the west and fragmented screening to the north, south and east, mitigating the overall visual effect of the launch site, particularly to the south.

Area B is surrounded by the local landforms that restrict views to the broader landscape. In addition, a local ridgeline to the south restricts visual impacts on the coastal cliffs. Area D is set will back from the coastline and is located in a low lying basin, visually separating it from the broader locality.

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While there will be specific changes to the existing landscape character, the overall natural character of the locality will remain. Notably, there will be limited impacts on the visually sensitive and scenic coastal edge. The contained visibility of the proposed development is illustrated by the Zone of Theoretical Visual Influence (ZTVI) mapping (Figures 2 to 6.

While the visual impacts will increase during launch periods, the duration and temporary nature of the visual effect does not alter the slight to moderate visual impacts assessment of the proposed development.

Furthermore, the ZTVI mapping illustrates that there will be no impacts on Theakstone Crevasses due to the relative position of the crevasses, the landform screening to the west of revised Area A. In addition, the visual impacts on Wanna Cliff Lookout and Winter Hill Lookout will be negligible given the separation distances and landform screening. In addition, the eastern escarpment of the Whalers Way locality already contains several buildings and infrastructure elements, which create visual impacts across the natural landscape character of the area.

2. High quality of the existing landscape of Whalers Way

The LCPVEA recognises the high landscape value of the Whalers Way coastline. While the Coastal Viewscapes of South Australia report, undertaken by Dr Lothian, rates the coastline as having a value of 8.25, this value relates to the coastline and coastal edge. The landscape assessment considered the broader locality, including the landscape character of inland areas. This results in a lower landscape value and the corresponding visual effects.

Given the contained ZTVI, the screening provided by local ridgelines and the fragment development form associated with the Whalers Way Orbital Launch Complex, it remains my opinion that the probable visual effect will be slight to moderate.

3. Meeting of the Development Plan objectives

The LCPVEA provided a review of the Lower Eyre Peninsula Council Development Plan (consolidated 12 July 2018) concerning potential visual impacts.

Several public submissions highlighted the Zone requirements, with specific reference to potential visual impacts. As discussed in the assessment report, the objectives for the zone aim to facilitate development that contributes to the desired character of the zone while enhancing and conserving the natural features of the coast, including visual amenity and landforms.

The desired character statement indicates certain development may occur within the zone but must be undertaken in a way that does not dominate the area's natural elements. As previously stated, the fragmented development form and ridgeline screening mitigate the impact effect of the Whalers Way Orbital Launch Complex.

The revised Area A and Area B will consist of buildings with a maximum height of 10-metres and water towers with lattice towers up to 22.5-metres above the surrounding ground level. These buildings and associated infrastructures will be constructed with colours and materials to mitigate some of the visual impacts on the surrounding landscape. The bunding and potential revegetation across the sites will further reduce the potential impacts of the buildings. In addition, the retention of existing vegetation where possible will provide additional screening and mitigate the visual impact of the water towers over greater distances. The visual contained character Area D means that there is little visual impacts on the broader landscape.

The 30-metre launch towers will be visible from surrounding areas. When these structures are raised for launches, they will be visible within two defined view corridors; from offshore waters to the south and north towards the agricultural land of the peninsula. However, the temporary nature of these infrastructure elements assists in minimising potential visual effects.

Given the scale of the development and the visibility demonstrated by the revised ZTVI mapping, the impact on the landscape of the locality is not dominant, and the potential visual and landscape impacts of the Whalers Way Orbital Launch Complex in the coastal landscape will be minimised.

An assessment of revised Area A, and the ZTVI mapping Illustrates a compact visual effect is produced across the central coastal basin of the locality. The adjacent ridelines and vegetation cover provide distinct viewsheds to the east and west. The revised location in combination with the underlying topography mitigates the potential visual effects of the proposed development. This is especially when compared with the orginal Area A proposal.

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4. Mitigation opportunities to reduce the visual impacts

Several of the respondents provided suggestions for potential visual mitigation. These included relocating the sites away from the coastal edge, reducing building heights, and increasing the amount of retractable infrastructure to limit visual impacts outside of the launch periods.

The revised Area A has been relocated north east and away from the coastal edge of Whalers Way. Figures 2 and 4 illustrate the reduced visual impacts on the coastline and the screening that is provided to the west. The north easterly inclined plateaux on which revised Area A is located limits the potential visual effects on the wider location with the local ridgelines screen removing potential impacts on Fisheries Bay and Red Banks Beach

Given the existing ridgelines and landforms containing Areas B and D, no modification is proposed for these areas. The contained nature of Areas B and D is illustrated in the ZTVI mapping.

Having reviewed the public submissions, I can confirm that Whalers Way Orbital Launch Complex is likely to create a range of slight to moderate visual impacts within a contained landscape context. The revised Area A, coupled with other mitigation measures, indicate that the degree of visual effect on the existing landscape will be minimised.

Warwick Keates
BA (Hons), Grad Dip LA, CMLI, AAILA, Registered Landscape Architect

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Figure 1

Landscape Character Map

Red Banks

Red Banks Beach

Fishery Bay

White Lookout

D

E

A

B

Grosper Bay

Cowrie Beach

Cape Carnot

Black Lookout

Cape Wiles

- Roads
- Contour (5m)
- Cadastral Land Parcels
- Coastal Basin
- Northern Escarpment
- Eastern Coastal Escarpment
- Undulating Coastal Plateau
- Coastal Headland
- Coastal Ridgeline
- Low Coastal Edge
- Local Ridgelines
- Viewscapes (surrounding context)
- Site Boundary

0 1000m

Figure 2

ZTVI Map
Revised Area A

(30 metre mast)
(1 metre digital terrain model)

- Roads
- Contour (5m)
- Visible
- Site Boundary

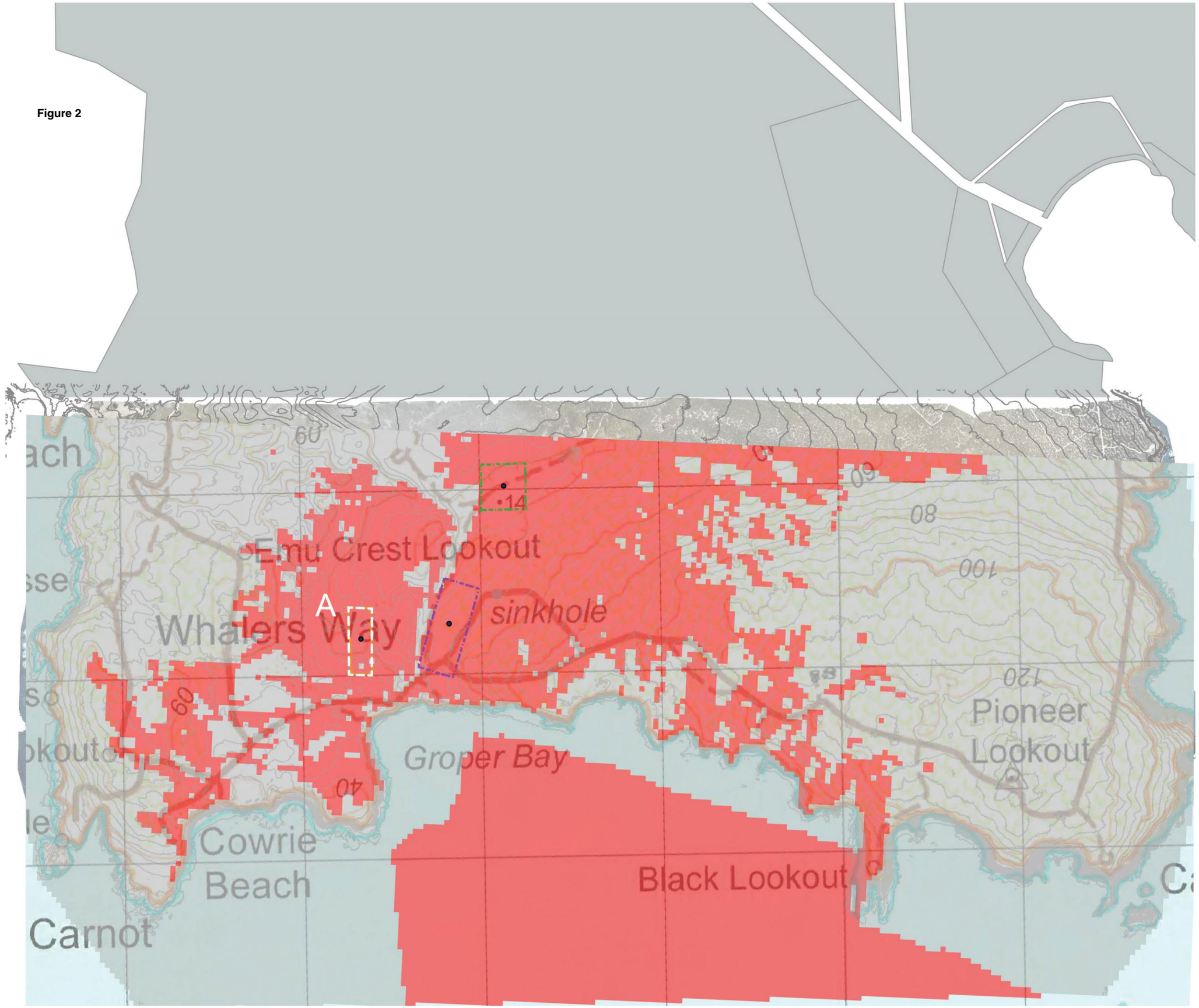

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Figure 3

ZTVI Map
Area A

(30 metre mast)
(1 metre digital terrain model)

- Roads
- Contour (5m)
- Visible
- Site Boundary

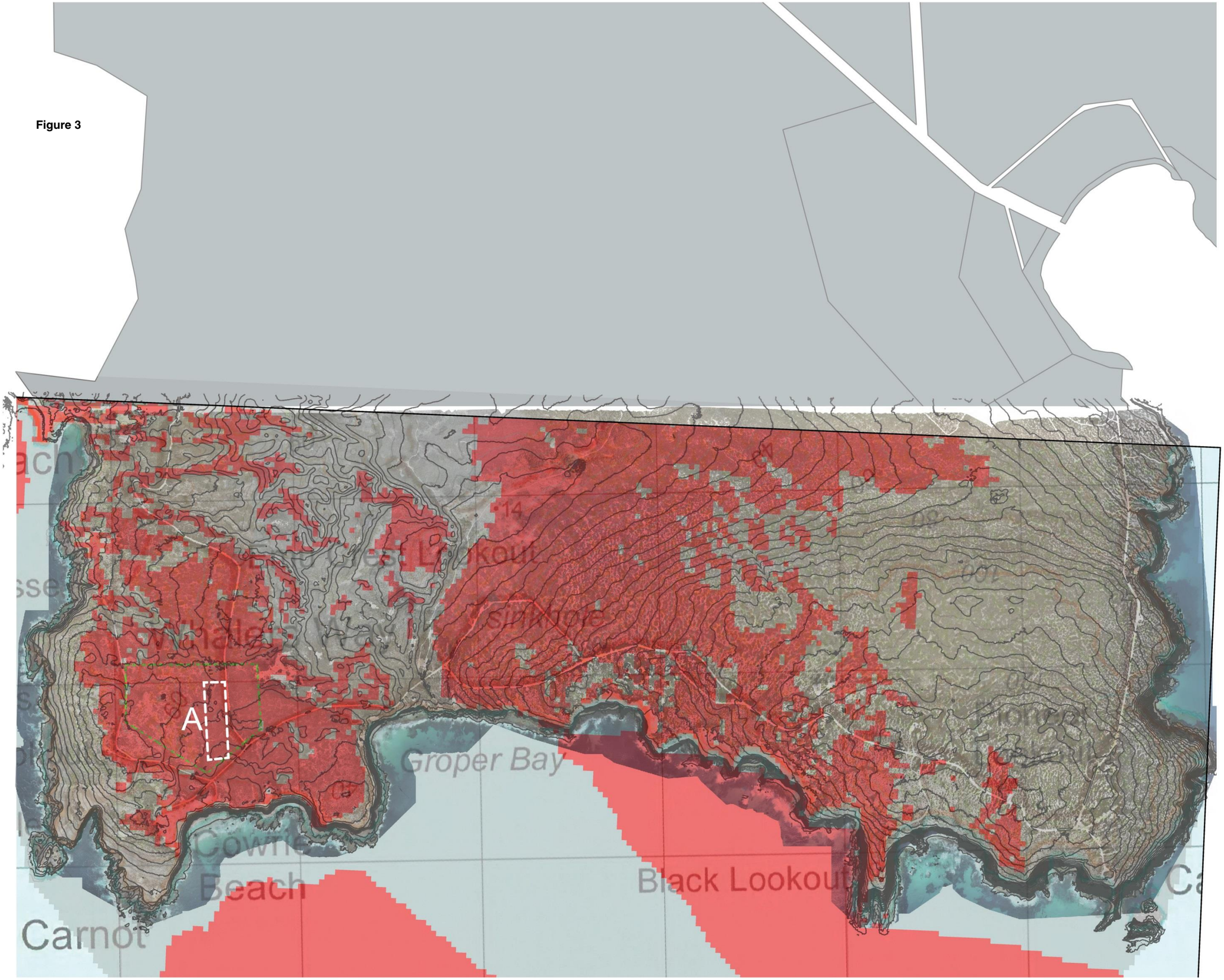

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Figure 4

ZTVI Map
Revised Area A

(10 metre mast)
(1 metre digital terrain model)

- Roads
- Contour (5m)
- Visible
- Site Boundary

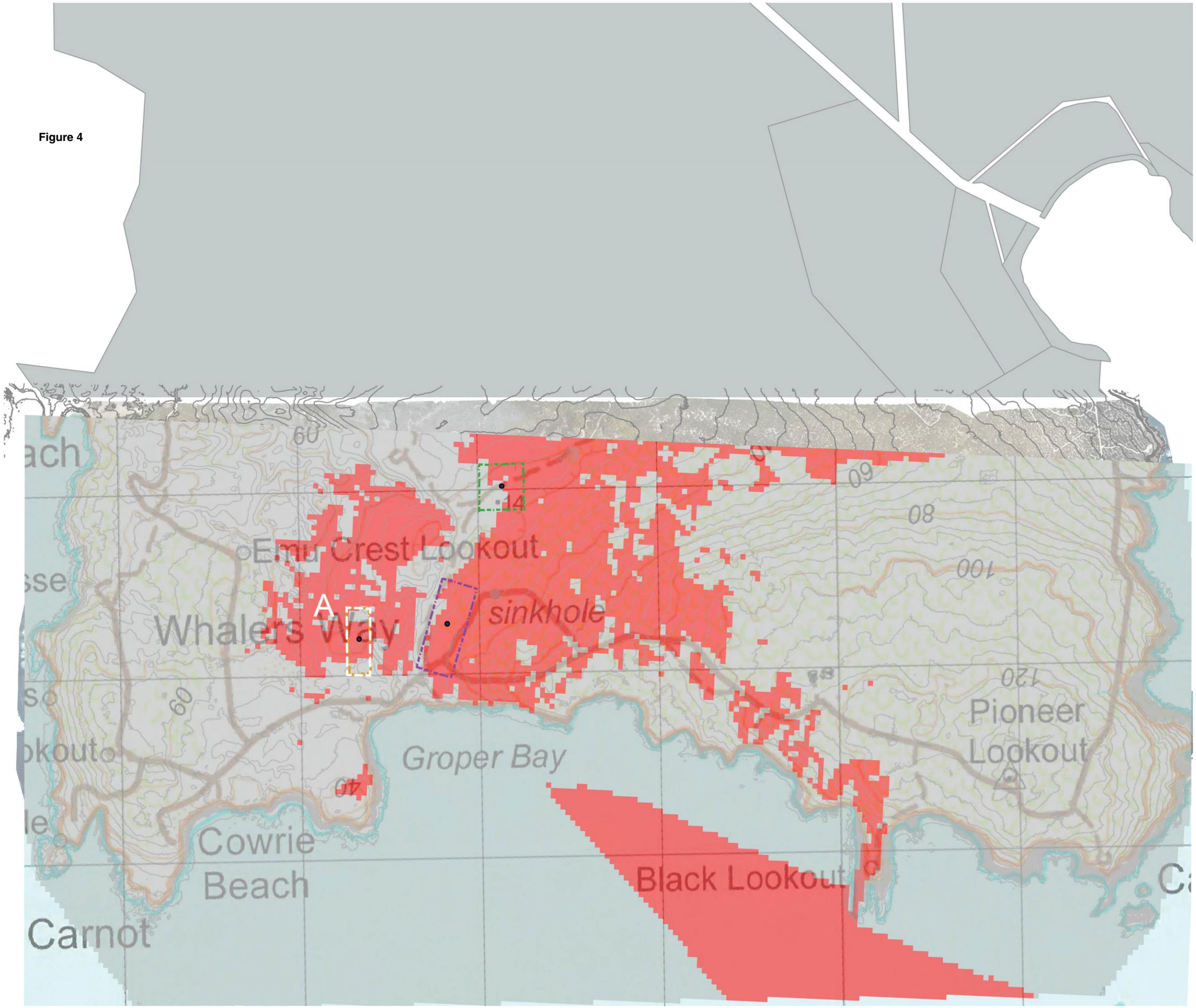

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Figure 5

ZTVI Map
Revised Area A and Areas B & D

(10 metre mast)
(1 metre digital terrain model)

- Roads
- Contour (5m)
- Visible
- Site Boundary

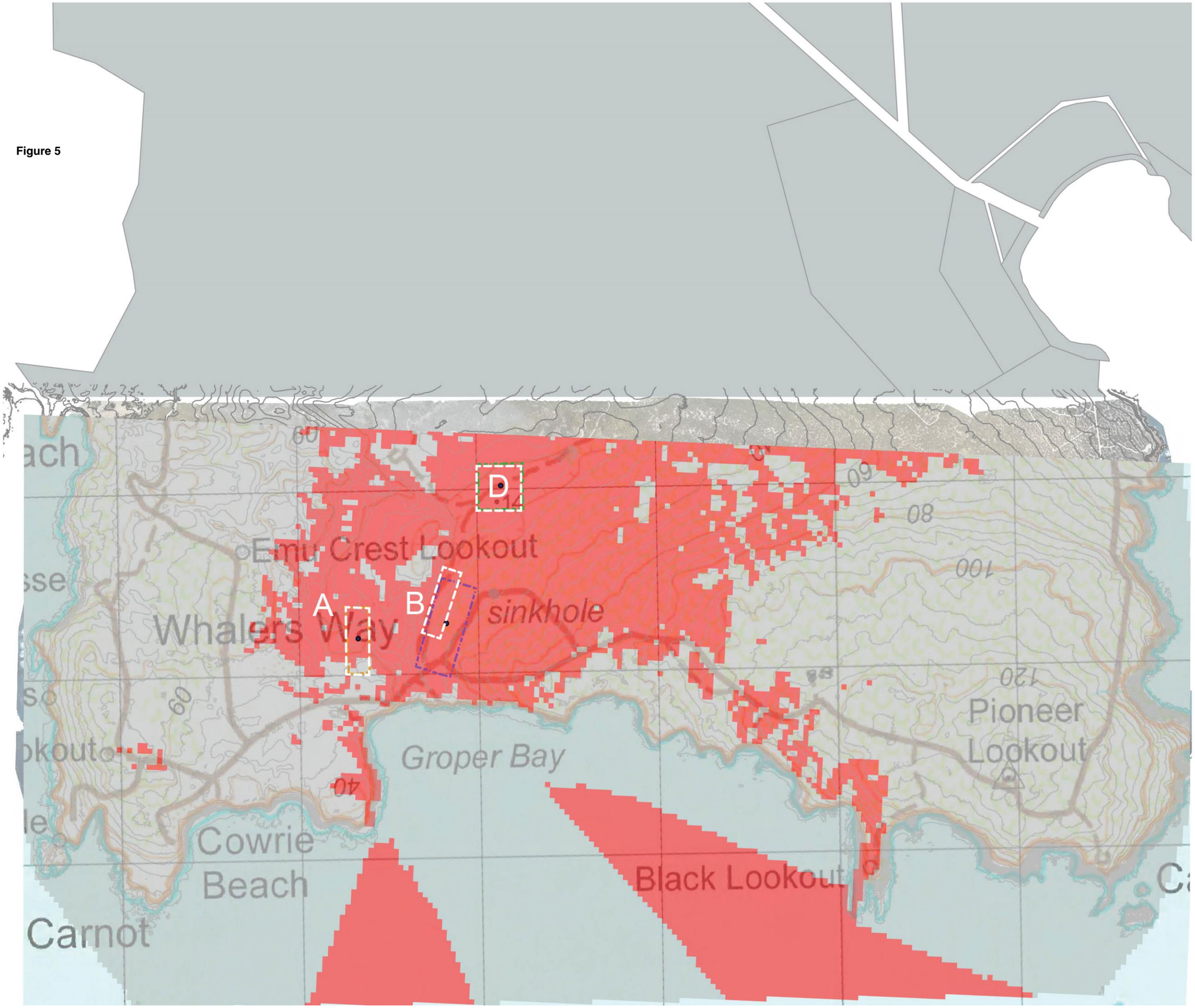

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Figure 6

ZTVI Map
Area A, B & D

(10 metre mast)
(1 metre digital terrain model)

Roads

Contour (5m)

Visible

Site Boundary

A

B

D

Groper Bay

Cowrie Beach

Carnot

Black Lookout

0 1000m

K SLR AIR QUALITY

25 February 2022

640.30035-L02-v0.1-20220224.docx

Southern Launch
Level 8, 70 Pirie Street
Adelaide SA 5000

Attention: Andrew Curran

Dear Andrew

Whalers Way Orbital Launch Complex
Engine Test Air Quality Assessment Update

Introduction

For a number of reasons, a new location has been proposed for Launch Site A. The new location is approximately 800 m northeast of the Launch Site A location as previously assessed for engine testing activities in the air quality assessment report[1].

This letter report provides an air quality assessment update for engine tests at the new Launch Site A location.

Assessment Update

In the 2020 air quality assessment report prepared by SLR, the dispersion modelling was based on launch test emissions from Launch Site B, which is the closest launch site to the nearest sensitive receptors[2], which are residences approximately 3.5 km to the northeast of the operations. This captured worst case conditions for the launch operations. The air quality assessment also modelled emissions from engine tests at Launch Site A, which is now proposed to be relocated. The distance to the nearest receptor from Launch Site A (as first proposed) was approximately 4.7 km. The distance to the nearest receptor from the new location is approximately 3.8 km.

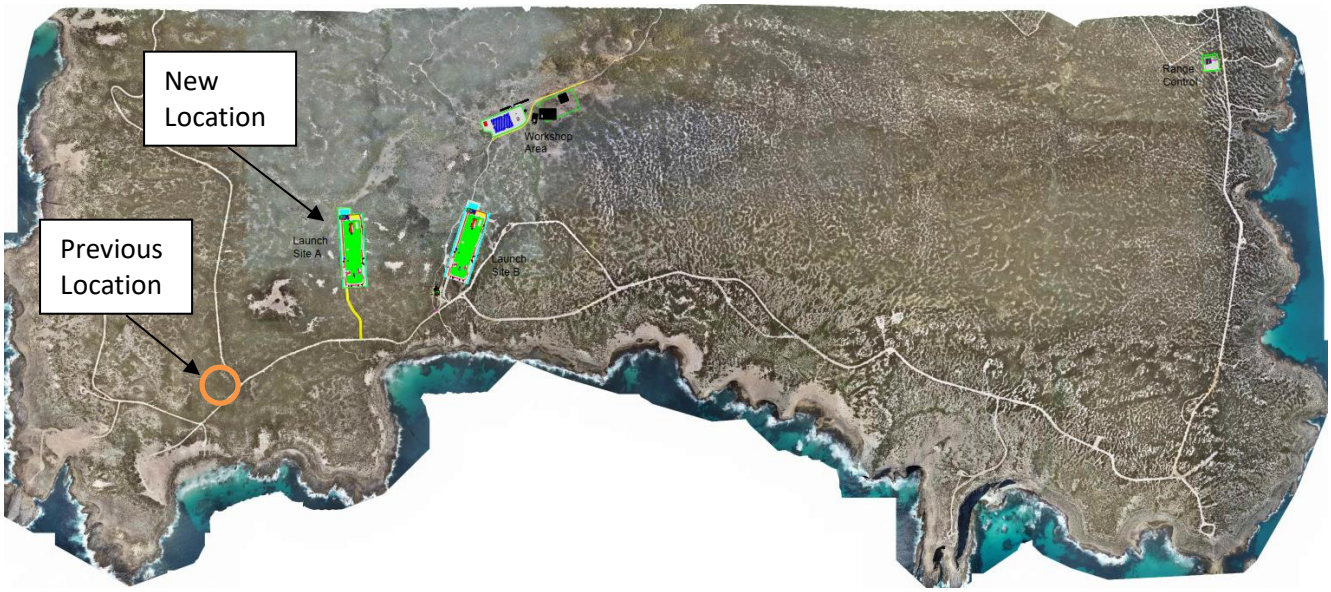
In consideration of the reduced separation distance to the nearest sensitive receptors for the engine test operations, the dispersion modelling has been updated with the engine test emissions (as previously estimated and modelled) occurring at the new Launch Site A location.

The emissions data are presented in Table 7 of the assessment report (see attached). As previously modelled, the engine tests were assumed to occur every second hour of the year (total of 4,380 engine tests assessed). With capacity planned for only a small number of engine tests (compared to the planned 36 launches per year), the assessment can be considered as conservative assessment of ground level concentration impacts.

The new Launch Site A location is shown in **Figure 1**.

[1] SLR, Whalers Way Orbital Launch Complex Air Quality Impact Assessment, August 2020.
[2] See results figures for location of R1, R2 and R3.

Figure 1 New Location Launch Site A (west of Launch Site B)



Results

The results from the updated dispersion modelling are presented in **Figure 2**, **Figure 3** and **Figure 4** and show that based on the assumptions of engine tests occurring every second hour of the year (all times of day) the Air EPP assessment criteria for CO, NO_2 and $PM_{2.5}$ are marginally exceeded at the location of Receptor 2.

To provide additional details on the peak predicted ground level concentrations, the top ten predicted ground level concentrations at Receptor 2 are presented in **Table 1,** demonstrating that that the Air EPP criteria for CO and NO_2 are only predicted to be exceeded for one engine test event out of the 4,380 modelled emission events**.** The particulate matter (PM) emissions modelled as $PM_{2.5}$ show that the emission contribution to the 24 hour average concentration has the potential to exceed the $PM_{2.5}$ Air EPP criterion of 25 µg/m^3 (when including a background concentration of 7 µg/m^3) on 9 occasions out of the 4,380 modelled engine test emission events.

To investigate the times of day that the peak ground level concentrations are predicted to occur, the hours contributing to the top 50 predicted ground level concentrations at Receptor 2 were reviewed. This showed that peak impacts are predicted for early morning, evening and overnight conditions but not for daytime hours (8 am to 4 pm) with better dispersion.

Figure 2 Maximum Ground Level Concentrations CO for Engine Tests at New Site A Location

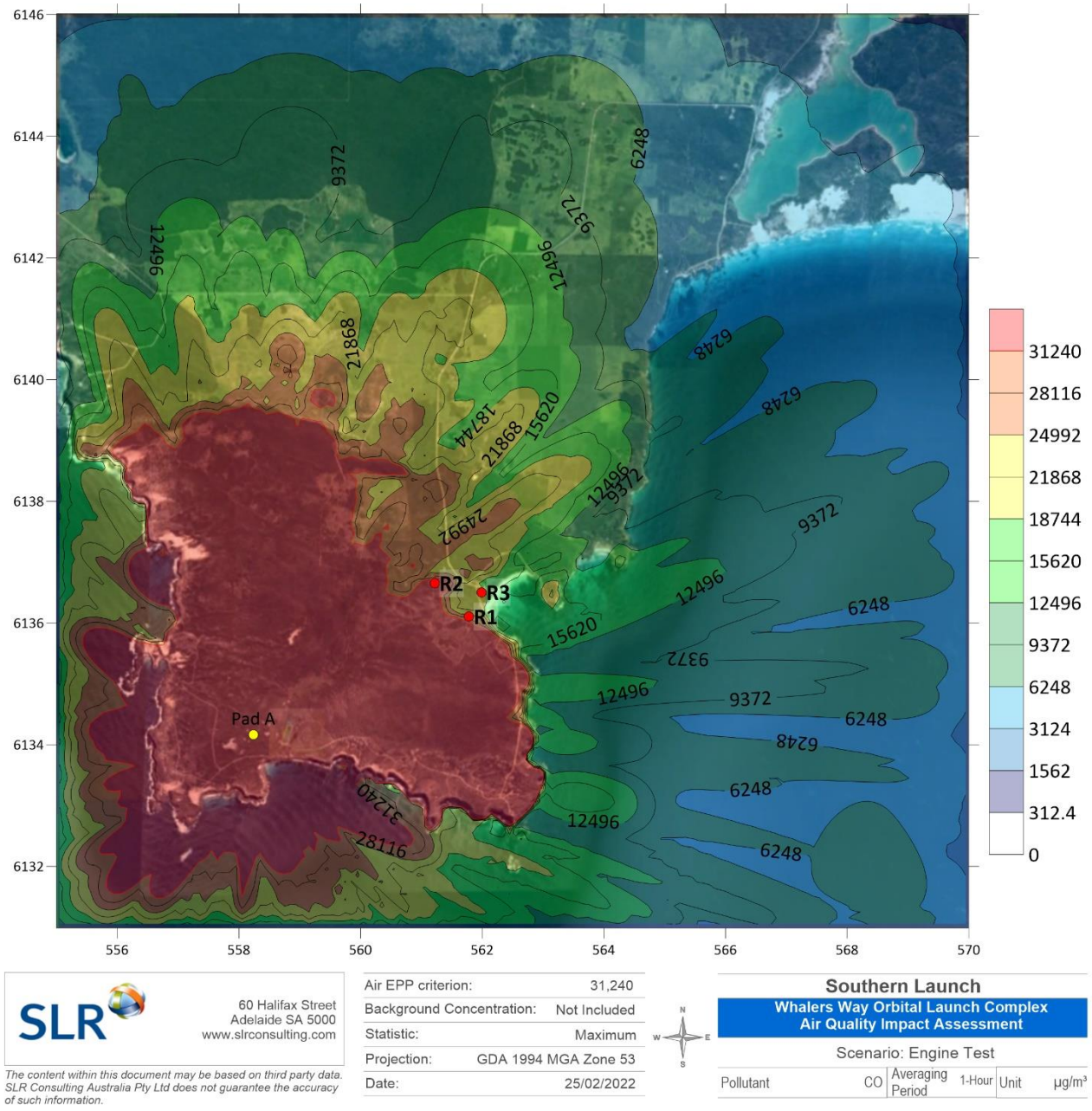


Figure 3 Maximum Ground Level Concentrations NO_2 for Engine Tests at New Site A Location

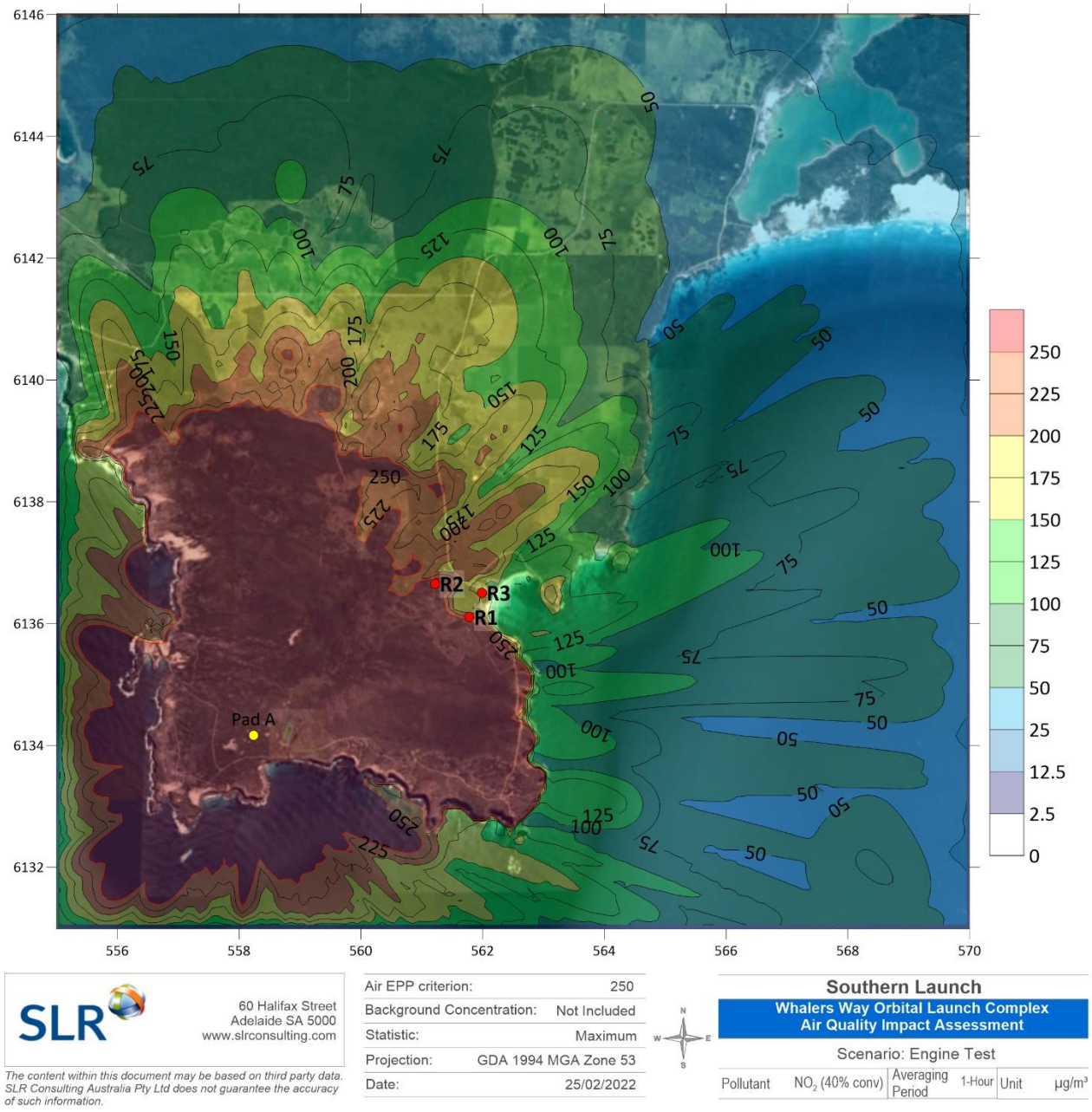


Figure 4 Maximum Ground Level Concentrations $PM_{2.5}$ for Engine Tests at New Site A Location

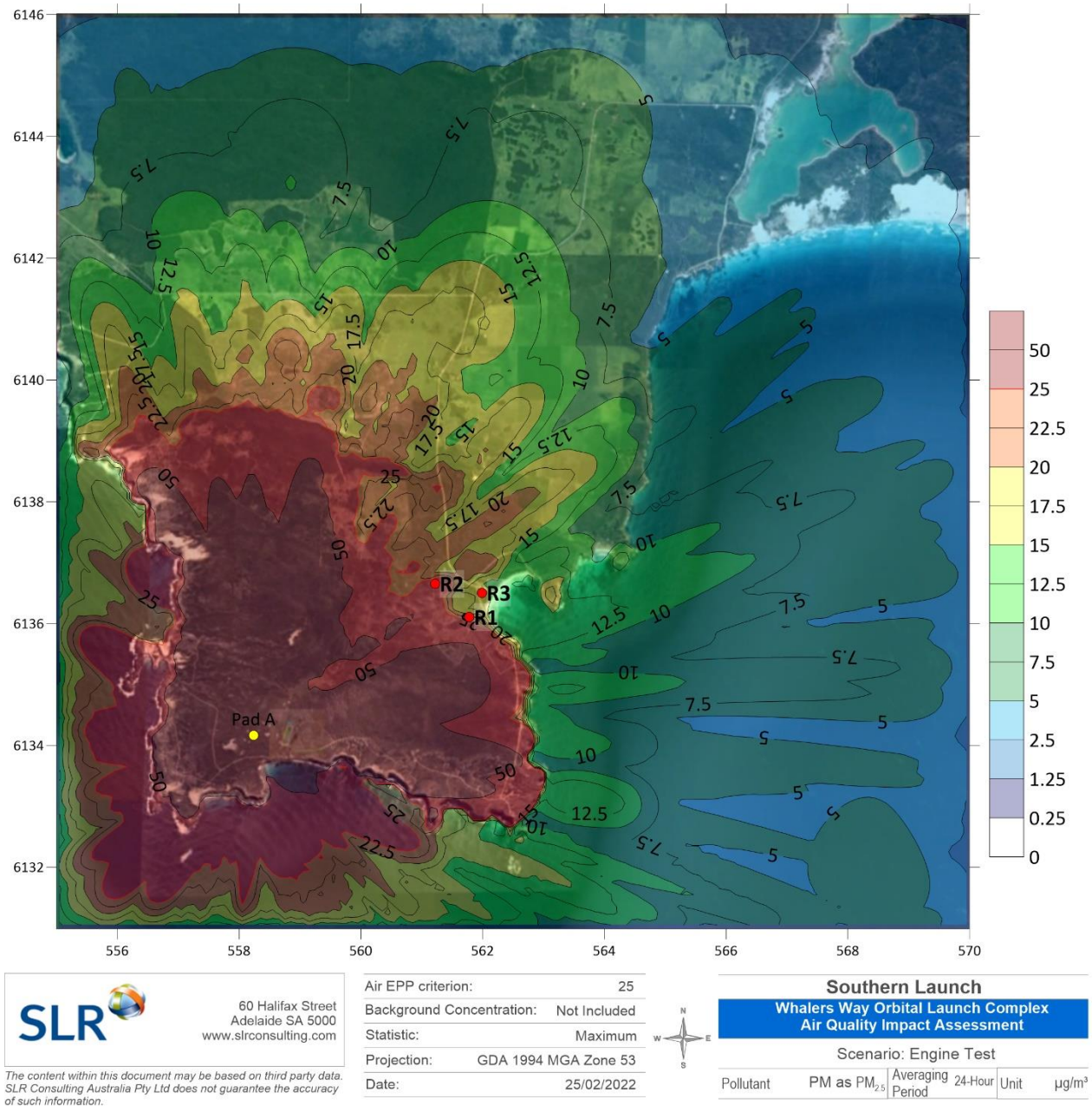


Table 1 Top 10 Predicted Ground Level Concentrations at Receptor 2 (Background Excluded)

Rank	1-hour CO ($\mu g/m^3$)	1-hour NO_2 [assuming 40% NO_2:NO_X Conversion] ($\mu g/m^3$)	24 Hour PM as $PM_{2.5}$ ($\mu g/m^3$)
Highest	**39,395**	**339**	**33**
2nd Highest	28,761	247	**24**
3rd Highest	27,324	235	**23**
4th Highest	25,053	215	**21**
5th Highest	24,314	209	**20**
6th Highest	23,913	206	**20**
7th Highest	21,837	188	**18**
8th Highest	21,608	186	**18**
9th Highest	20,853	179	**18**
10th Highest	18,687	161	16

Conclusions

The dispersion modelling of engine tests at the new Launch Site A location shows marginal exceedances for the modelled emissions of CO, NO_2 and PM as $PM_{2.5}$. The modelling assumed engine tests occurring every second hour of the assessment year with total of 4,380 engine tests. At this stage it is only envisaged that a smaller number of engine tests (compared to the planned 36 launches per year) may be performed each year.

In consideration of the smaller number of engine tests proposed, the results can be regarded as conservative. The likelihood of an engine test occurring in worst dispersion conditions with wind direction towards the nearest sensitive receptors is considered low and hence the risk of air quality exposure is also low. Nevertheless, air quality management actions that can be considered to reduce the exposure potential include:

- Performing engine tests in daytime conditions only (avoiding overnight conditions).
- Avoiding performing engine tests in wind directions towards the nearest receptors (southwesterly wind direction) in light wind conditions.

Yours sincerely

Johan Meline
Principal - Air Quality
CAQP, MIEAust
0431 516 449

Checked/
Authorised by: KL

WHALERS WAY ORBITAL LAUNCH COMPLEX

Air Quality Impact Assessment

Prepared for:

Southern Launch
Level 8, 70 Pirie Street
ADELAIDE SA 5000

SLR Ref: 640.30035-R01
Version No: -v1.1
August 2020

PREPARED BY

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Southern Launch (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
640.30035-R01-v1.1	27 August 2020	Johan Meline	Judith Cox	Graeme Starke
640.30035-R01-v1.0	22 July 2020	Johan Meline	Judith Cox	Graeme Starke

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APPENDICES

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:

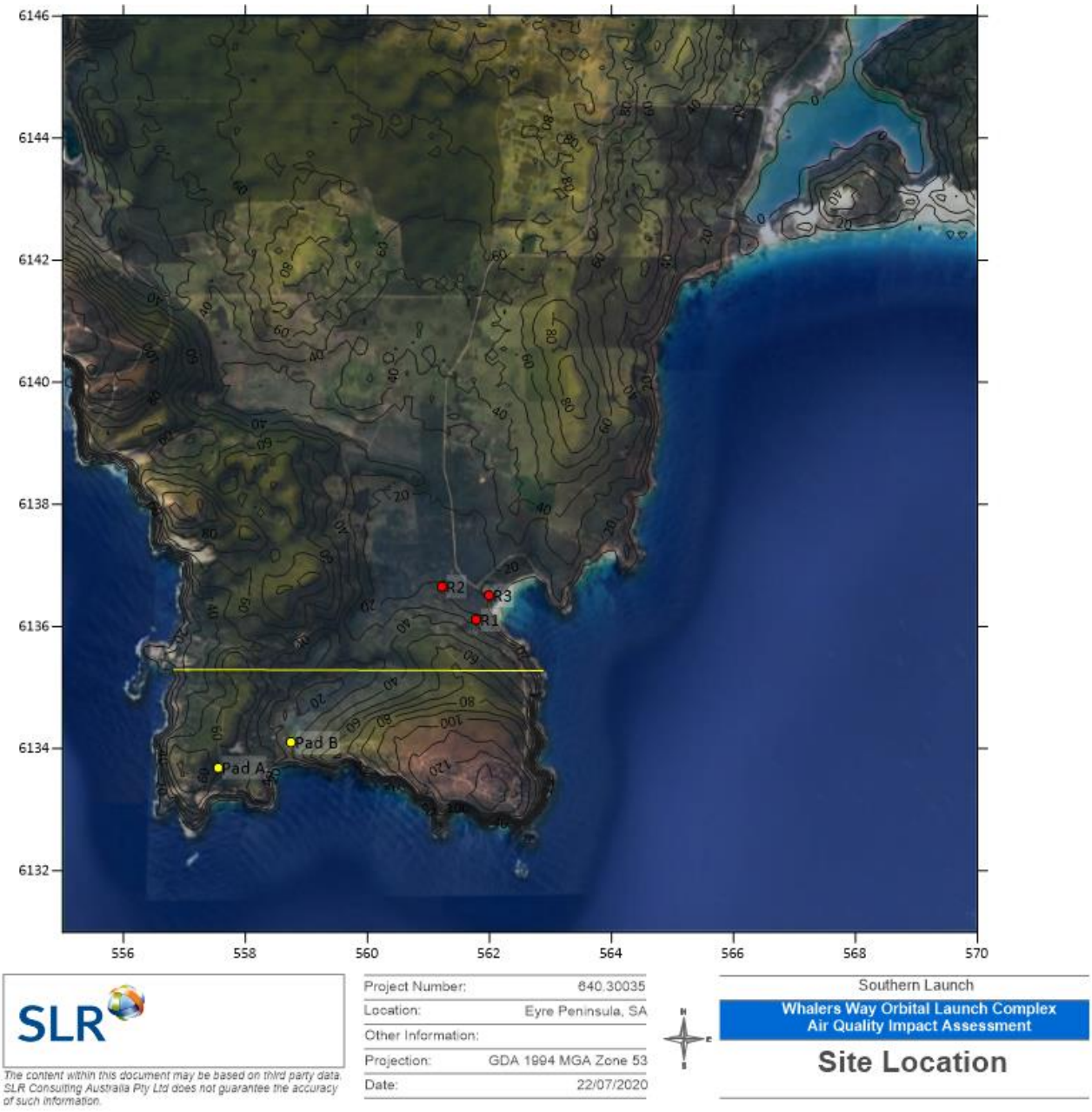
- Develop Launch Site B as Stage 1 for a range of launch vehicles sizes from micro to larger conventional (less than 10 tonnes to approximately 50 tonnes).
- Develop Launch Site A as Stage 2 for larger launch vehicles (greater than 30 tonnes to up to over 100 tonnes).

The location of the launch pads and nearest sensitive receptors are shown in **Figure 1**. The nearest sensitive receptors are located to the northwest at a distance of approximately 3.5 km from Launch Site B (Pad B) and 4.7 km from Launch Site A (Pad A).

For this air quality assessment emissions were estimated for dispersion modelling on a worst-case basis for the proposed operations considering the size of rockets and type of fuels. This included emissions from launches from Launch Site B (located closest to the nearest receptors) and rocket engine tests at the engine test facility located at Launch Site A for all times of day (24/7 operations).

Overall, the assessment considers worst-case impacts from the proposed operations which will include very short duration emission events on an infrequent basis. The emissions contributing to ground level concentrations are estimated to only last for up to 30 seconds for each launch. Discussion on the contribution to ground level concentrations from the vertical emissions profile from the launches is provided in the results. Details on the assessment methodology and how the rocket launches were modelled is provided in the assessment methodology section.

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

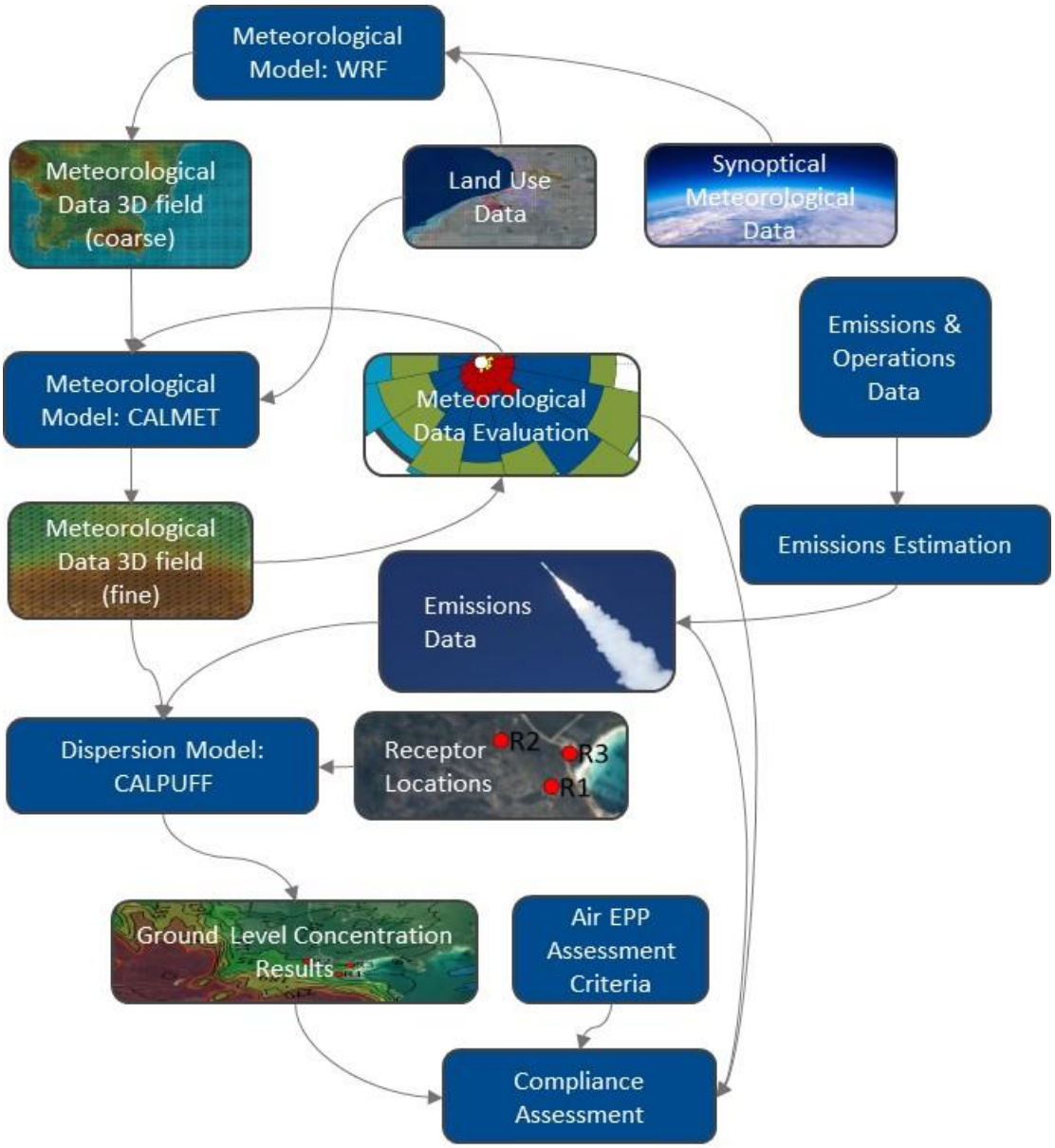


2 Assessment Methodology

2.1 Introduction

An overview of the air quality impact assessment dispersion modelling methodology is provided in **Figure 2**. Additional detail on each of the key aspects is detailed in the following sections.

Figure 2 Air Quality Assessment Dispersion Modelling Methodology Overview



2.2 Selection of Model Year, Meteorological Model and Dispersion Model

The year 2009 was selected for the dispersion modelling, being the standard year for assessment requested by the South Australian Environment Protection Authority (EPA).

Air quality assessment of rocket launches is not a typical application for dispersion modelling. In considering the elevation of the points of emission as the launch vehicles gains altitude, the meteorological model WRF was used for the best development of upper air data.

For the dispersion modelling CALPUFF was used. CALPUFF is the best choice model considering the project location and that sub-hourly emissions steps were required to characterise the short duration emission events for the assessment.

2.3 Processing of Meteorological Data

For the processing of the meteorological data required for the dispersion modelling (12 months of hourly timestep data) the weather research and forecasting model (WRF) was used to provide site representative data for the CALMET model for processing of the fine scale three-dimensional wind field data for the dispersion modelling.

- A description of the WRF model is available in the model description technical notes (NCAR, 2019).
- A description of the CALMET/CALPUFF model is available in the CALPUFF manual (SRC, 2011).

A summary of the meteorological model domain details is provided in **Table 1**.

Evaluation of the processed meteorological data is provided in **Appendix A** and shows typical near coastal windy conditions favourable for dispersion. Also, from an exposure point of view, the nearest sensitive receptors are not located downwind in any prevailing wind direction.

Table 1 WRF and CALMET Modelling Domain Details

Model and domain settings	Details
WRF	
4 nested grids	1,823 km x 1,829 km 153 km x 153 km 69 km x 69 km 26 km x 26 km Inner domain centre point: E: 559,619 N: 6,135,493
CALMET	
Domain size	15 km x 15 km
Receptor grid	100 m resolution
Domain origin	Southwest corner: E: 555,000 N: 6,131,000
Initial guess field	3D output from WRF
Further details on model settings can be provided as required.	

2.4 Dispersion Model

CALPUFF was used for the dispersion modelling. CALPUFF is widely used in Australia and is capable model for a range of applications and conditions such as larger scale modelling assessments and complex meteorological/terrain settings such as near coastal areas with land/sea interactions on dispersion.

A summary of the meteorological model domain details and model settings are provided in **Table 2**.

Table 2 CALPUFF Domain Details and Model Settings

Item	Details
Domain details	Same computational grid size and resolution as for CALMET.
Receptor details	In addition to the gridded domain receptors, three discrete receptors were included to account for assessment of ground level concentrations at the nearest sensitive receptor locations: **R1:** E: 561,779 N: 6,136,105 **R2:** E: 561,216 N: 6,136,652 **R3:** E: 561,988 N: 6,136,505
Modelling time step	Sub-hourly as 60 s.
Emissions data	Variable external emissions files.
Further details on model settings can be provided as required.	

2.5 Emissions Estimation

The air quality related emissions of significance for the proposed orbital launch complex are from the rocket launches and engine tests. It is understood that there may be up to 36 launches per year when the facility is fully developed and a smaller number of engine tests, mostly smaller in scale. Considering this, emissions were estimated for two emissions scenarios:

- Rocket launch
- Engine test

The duration of each emission event is very short considering the speed at which rockets accelerate and gain altitude. Typically, orbital launch vehicle rockets are launched with three stage burns (three stage motors).

For assessment of air quality in relation to implications for ground level concentrations it is only the portion of engine exhausts that are emitted below the mixing height that has the potential to be mixed to ground level.

As such, emissions were estimated for the portion of emissions from the Stage 1 burn up to an altitude of 3,000 m (which is the upper level of mixing height as typically set in CALPUFF). The duration to reach 3,000 m altitude for the launch vehicles that are being considered is approximately 30 seconds. Typically, the Stage 1 engine burn lasts for about 2.5 minutes.

With the shortest time step in CALPUFF being 60 seconds the duration of the emission events for the two scenarios were set to:

- Rocket launch – 1 minute
- Engine test – 3 minutes

From a literature review for references to emissions data for orbital launch facilities it appears that facilities are typically located in fairly remote areas without nearby receptors. Due to remoteness there is typically recognition that air quality impacts are unlikely to affect receptors. Given this, assessments are typically more qualitative than quantitative and the level of detail available on rocket engine exhaust launch emissions are limited. Also, in relation to emissions data for the emissions estimation for the assessment there will be a range of rockets launched at the facility and all details regarding all potential rockets and fuels are not available at this stage.

Considering the level of detail available for both rocket engine exhaust emissions in general, and the rockets that may be launched from the proposed orbital launch complex, the emissions estimation was focused on potential worst-case emissions of each pollutant.

The emission rates for each pollutant depend on the size of the rocket (engine capacity) and the rocket fuel type. In essence there are two types for rocket fuels: liquid fuels and solid fuels.

From a review of rocket engine exhaust emissions data. the following pollutants were identified as relevant to include in the assessment to cover both liquid and solid fuel emissions:

- Carbon monoxide (CO) – combustion product from liquid RP1 (kerosene) fuel.
- Nitrogen oxides as nitrogen dioxide (NO_2) – combustion product from liquid RP1 (kerosene) fuel.
- Hydrogen chloride (HCl) – emitted from certain solid fuel engines.
- Particulate matter (PM) as for combustion emissions assumed to be fine particulate matter ($PM_{2.5}$) – emitted as part of all combustion however worst-case emissions are from solid fuels.

Due to operational circumstances, a rocket could be launched at any time of day. As such, it was conservatively assumed that emissions would occur all times of day.

However, also considering that the emissions only occur for a very short duration, that there will be no consecutive launches within short time periods and that the emission rates are very high (compared to standard dispersion modelling applications), variable emissions files were set up including a rocket launch/engine test every second hour of the year for each scenario. As such the modelling includes assessment of a total of 4,380 launch events and 4,380 engine tests. The annual total of proposed launches is 36 and the number of engine tests will be very few and mostly much smaller scale than assumed.

By allowing for the emission events of one and three minutes in duration occurring every second hour, it is expected that there will be no cumulative impacts to ground level concentration from consecutive launches (which will not occur)[1] while still allowing for assessment of all time of day conditions.

Details on the emissions calculations are provided in **Section 3**.

[1] The distance to the nearest receptors for Launch Site B is approximately 3,500 m. Travel distance of ambient air at 0.5 m/s with a persistent wind direction over 2 hours is 3.6 km.

Other emissions from site that have been identified are from smaller generators for powering of the facility buildings and operations. Onsite power generation may be a temporary arrangement until grid power is connected at a later stage in the site development. Alternatively, it is also understood that a solar panel/battery option is being considered for the site. The generator emissions are not large scale and not significant for assessment.

There will also be some dust emissions from site for the site construction activities. This is however expected to be managed as for conventional civil construction requirements and the scale of the activities will not have a nuisance impact on the nearest receptors considering the distances to receptors from the facility site areas.

2.6 Evaluation of Ground Level Concentrations and Assessment Criteria

For the evaluation of air quality impacts, and the assessment of compliance for the proposed operations, the predicted maximum ground level concentrations were assessed against the South Australian Air Quality Environment Protection Policy (Air EPP) ground level concentration assessment criteria as presented in **Table 3**.

As discussed above, while the emission rates from the activities are high, the duration of each emission event is less than a minute for a launch, and only up to a few minutes for an engine test. With a total of 36 launches planned per year, the duration between launches is expected to be in the range of several days to a couple of weeks. Considering this, assessment is most relevant against the short term 1 hour and 3 minute averaging period assessment criteria as listed in the Air EPP.

For the evaluation against the $PM_{2.5}$ 24 hour criterion the maximum hourly concentration as contribution to a 24 hour average was considered.

For this assessment which considers very short term duration emission events, background concentrations have not been included specifically in the results evaluation. Focus of the results presentation was on demonstrating the predicted resulting maximum incremental ground level concentrations. Given the location of the launch complex there is not expected to be any background concentrations of significance for CO, NO_2 or HCl. For context to the $PM_{2.5}$ predicted concentrations the $PM_{2.5}$ background concentration was considered in the results discussion.

Table 3 Air EPP Maximum Ground Level Concentration Assessment Criteria (SA, 2016)

Pollutant	Classification	Averaging time	Maximum ground level concentration	Comment
CO	Toxicity	1 hour	31,240 µg/m³	
		8 hours	11,250 µg/m³	Not relevant to include considering short term duration of emission events.
NO_2	Toxicity	1 hour	250 µg/m³	
		12 months	60 µg/m³	Not relevant to include considering short term duration of emission events.
HCl	Toxicity	3 minutes	270 µg/m³	
$PM_{2.5}$	Toxicity	24 hours	25 µg/m³	Contribution to 24 hour average calculated from maximum predicted ground level concentration.
		12 months	8 µg/m³	Not relevant to include considering short term duration of emission events.

3 Emissions Data

As discussed in **Section 2.5,** emissions were estimated for scenarios covering worst-case emissions from launch and engine test events. A summary of the emissions calculations and source characteristics are provided below.

Full details on the rocket information and data cannot be provided due commercial agreements between Southern Launch and the clients they have early agreements with.

As discussed previously, the emissions data available for the proposed rocket types, and also for air quality assessments of rocket launch facilities in general, is very limited. As such emission rates were estimated based on available emissions data and scaled based on exhaust and fuel consumption rates. Also as discussed in the emissions estimation section, emissions up to 3,000 m were included.

The emissions estimation was based on a conservative selection of emissions data. A summary on relevant data and references are provided in **Table 4** and **Table 5**.

The worst-case emissions estimation for the engine test was based on a full Stage 1 burn of the liquid fuel 58 t rocket engine, since large scale solid fuel engines are never tested at locations other than the development facility.

Table 4 Emission Rate Calculations Based on Liquid Fuel

Scenario	Pollutant	Launch vehicle mass (including fuel) (t)	Fuel consumption rate (kg/s)	Pollutant exhaust mass fraction/ mass	Time to 3,000 m (s)	Emission rate (kg/s)	Emissions to reach 3,000 m (kg)	Time for Stage 1 burn (s)	Emissions for Stage 1 burn (kg)
Launch Engine test	CO	58 [a]	420 [a]	24.76% [b]	27	104.0	2816.5	100	10,399.2
Launch Engine test	NO_x as 100% NO_2			2.313 lb/s		2.2 [d]	60.5		223.5
Engine test	PM			0.5 % [b]		2.1	NA		210.0

[a] Source: Southern Launch
[b] Source: (Federal Aviation Administration, 2020) Table 4.1 at engine exit before after burn in exhaust plume[2]
[c] Source: (Federal Aviation Administration, 2020) Table 4.1
[d] Calculated as scaled on engine exhaust/fuel consumption rates and converted to 100% NO_2 from 100% NO

Table 5 Emission Rate Calculations Based on Solid Fuel

Scenario	Pollutant	Launch vehicle mass (including fuel) (t)	Fuel consumption rate (kg/s)	Pollutant exhaust mass fraction	Time to 3,000 m (s)	Emission rate (kg/s)	Emissions to reach 3,000 m (kg)
Launch	HCL	41 [a]	338 [a]	21.4% [b]	24	72.3	1,705.2
Launch	PM			28.4% [b]		95.9	2,263.0

[a] Source: Southern Launch
[b] Source: (D. Schuch, 2017) Table 1

Emission rates were calculated for the duration of travel to 3,000 m, and were then divided between the levels for the dispersion model sources as presented in **Table 6** (launch scenario) and **Table 7** (engine test scenario).

One volume source was included for each layer of the meteorological cell data layers. By characterising the emissions sources as a volume sources it was conservatively assumed that the exhaust plume was of ambient temperature and that there was no buoyancy for the exhaust plumes.

Emissions were set in one variable emissions file for each scenario to occur for one minute every second hour for the launch scenario and for three minutes every second hour for the engine test scenario.

[2] Emissions for both CO and PM are listed zero in the mixed exhaust (after afterburn).

Table 6 Emissions Data for Launch Scenario

CALMET layers	Elevation of source (m)	Sigma y (m)	Sigma z (m)	CO emission rate (g/s)	NO_2 emission rate (g/s)	HCl emission rate (g/s)	PM emission rate (g/s)
2000 to 3000 m	2,500 m	5	250	15,647	336	9,473	12,572
1200 to 2000 m	1,600 m	5	200	12,518	269	7,579	10,058
640 to 1200 m	920 m	5	140	8,763	188	5,305	7,040
320 to 640 m	480 m	5	80	5,007	108	3,031	4,023
160 to 320 m	240 m	5	40	2,504	54	1,516	2,012
80 to 160 m	120 m	5	20	1,252	27	758	1,006
40 to 80 m	60 m	5	10	626	13	379	503
20 to 40 m	30 m	5	5	313	7	189	251
0 to 20 m	10 m	5	5	313	7	189	251
Total emissions (g/s)				46,942	1,009	28,420	37,716
Total emissions over 60 s (kg)				2,816.5	60.5	1,750.2	2,263.0
Source location	Pad B: E: 558.744, N: 6134.099						

Table 7 Emissions Data for Engine Test Scenario

	Elevation of source (m)	Sigma y (m)	Sigma z (m)	CO emission rate (g/s)	NO_2 emission rate (g/s)	PM emission rate (g/s)
Engine test emission rates	10	15	5	57,773	1,242	1,167
Total emissions over 180 s (kg)				10,399.2	223.5	210.0
Source location	Pad A: E: 557.542, N: 6133.686					

4 Results

4.1 Introduction

The results for the two assessment scenarios are presented below and include:

- Contour plots for predicted maximum ground level concentrations for launches in **Figure 3** to **Figure 6** and are discussed in **Section 4.2**.
- Contour plots for predicted maximum ground level concentrations for engine tests in **Figure 7** to **Figure 9** and are discussed in **Section 4.3**.
- Maximum ground level concentrations and top ten predicted ground level concentrations for launches and engine tests in **Table 8** and **Table 10**.
- An analysis of elevated source contribution to ground level concentrations is provided in **Table 9**.

All contour plots show the incremental ground level concentrations due to the operations (excluding background concentrations).

The contour plots are included with a colour shading based on the percentage of the assessment criteria to simplify the review of the results plots and to make it easier to compare between scenarios and pollutants. The fields are provided in 10% segments, also including segments for 5% and 1% levels of the Air EPP as a minimum of the assessment criteria. The Air EPP assessment criteria are shown as red contours.

4.2 Launch Scenario

The results for the launch scenario show the following:

- The CO result show low levels of maximum predicted ground level concentrations at the nearest receptors (less than 1% of the Air EPP assessment criterion).
- The NO_2 emissions were conservatively estimated assuming 100% conversion of NO_x to NO_2 and show low levels of maximum predicted ground level concentrations at the nearest receptors (approximately 1% of the Air EPP assessment criterion).
- The HCl results show predicted maximum ground level concentrations in the order of approximately 40% of the Air EPP assessment criterion at the nearest receptors.
- PM results, as assessed against the $PM_{2.5}$ assessment criterion show a maximum 1 hour average ground level concentration of 84.1 µg/m^3 which translates to a 24 hour average contribution of 3.5 µg/m^3. This is approximately 14 % of the 25 µg/m^3 Air EPP criterion. If including a background concentration of a similar value to the 70th percentile for $PM_{2.5}$ as measured in Port Augusta of around 7 µg/m^3 there is still significant margin before an exceedance of Air EPP criterion.
- The results in **Table 9** show that there is no contribution to the top thirty ground level concentrations from the sources in the modelling above 1,200 m. The highest ground level concentrations are predicted in stable conditions with low wind speeds and low mixing heights. On the occasions with contribution from higher elevation sources this is typically in conditions with higher mixing heights and more unstable conditions achieving vertical mixing. Overall. it is the stable low wind speed and low mixing height conditions that contribute to the highest ground level concentrations. **Table 9** is presented with conditional formatting colour coding for overview visualisation of the data contribution.

This shows that while the emission rates for the rocket launches are very high the emission events only occur for a very short durations and that is only the portion of the lower levels of emissions during launch (up to around 1,200 m) that contribute to ground level concentrations. Emissions above 1,200 m which make up the greater part of the launch emissions are not mixed to ground level and are dispersed in upper air layers.

Figure 3 Results for CO for Launch Scenario

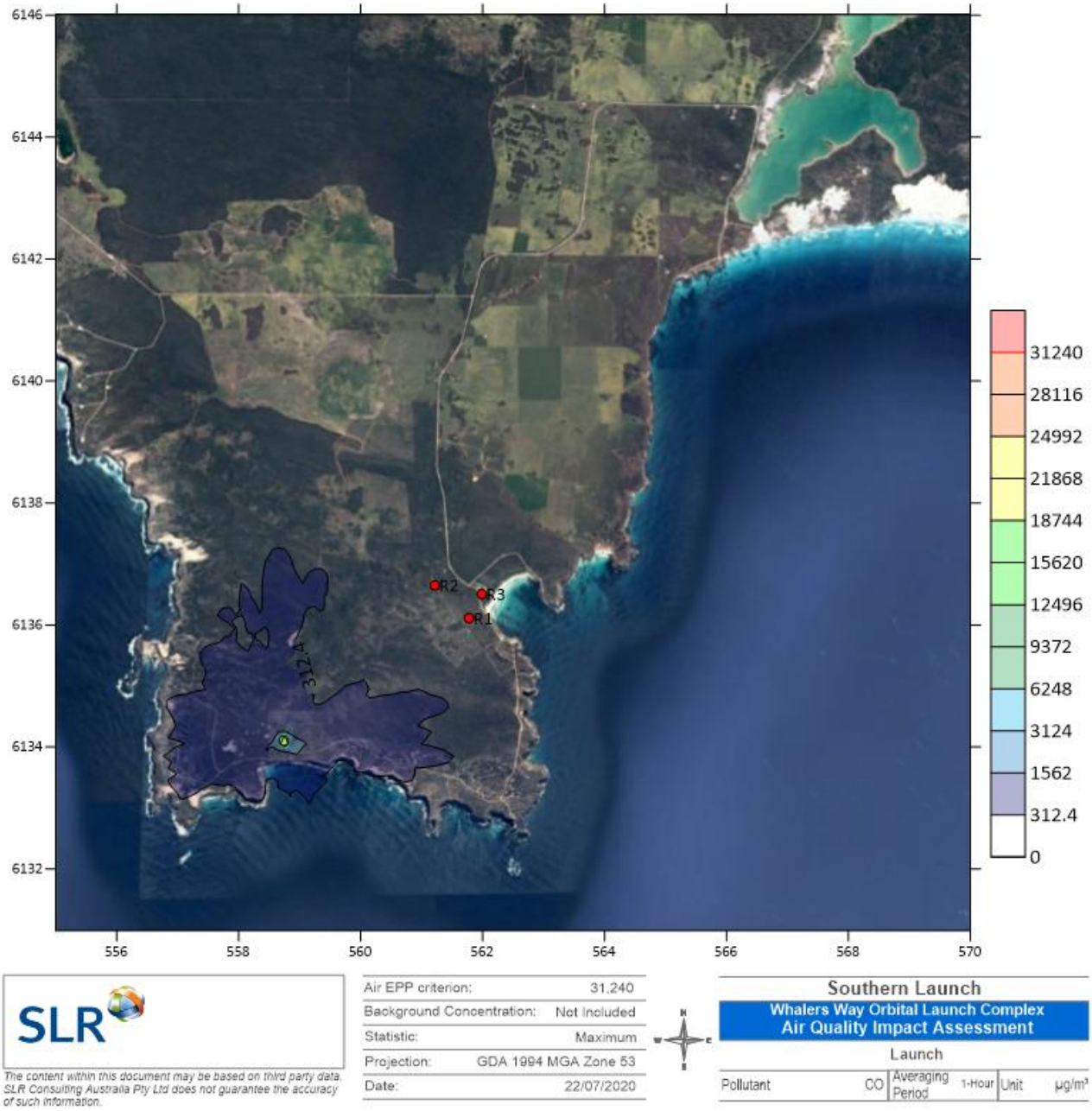


Figure 4 Results for NO_2 for Launch Scenario

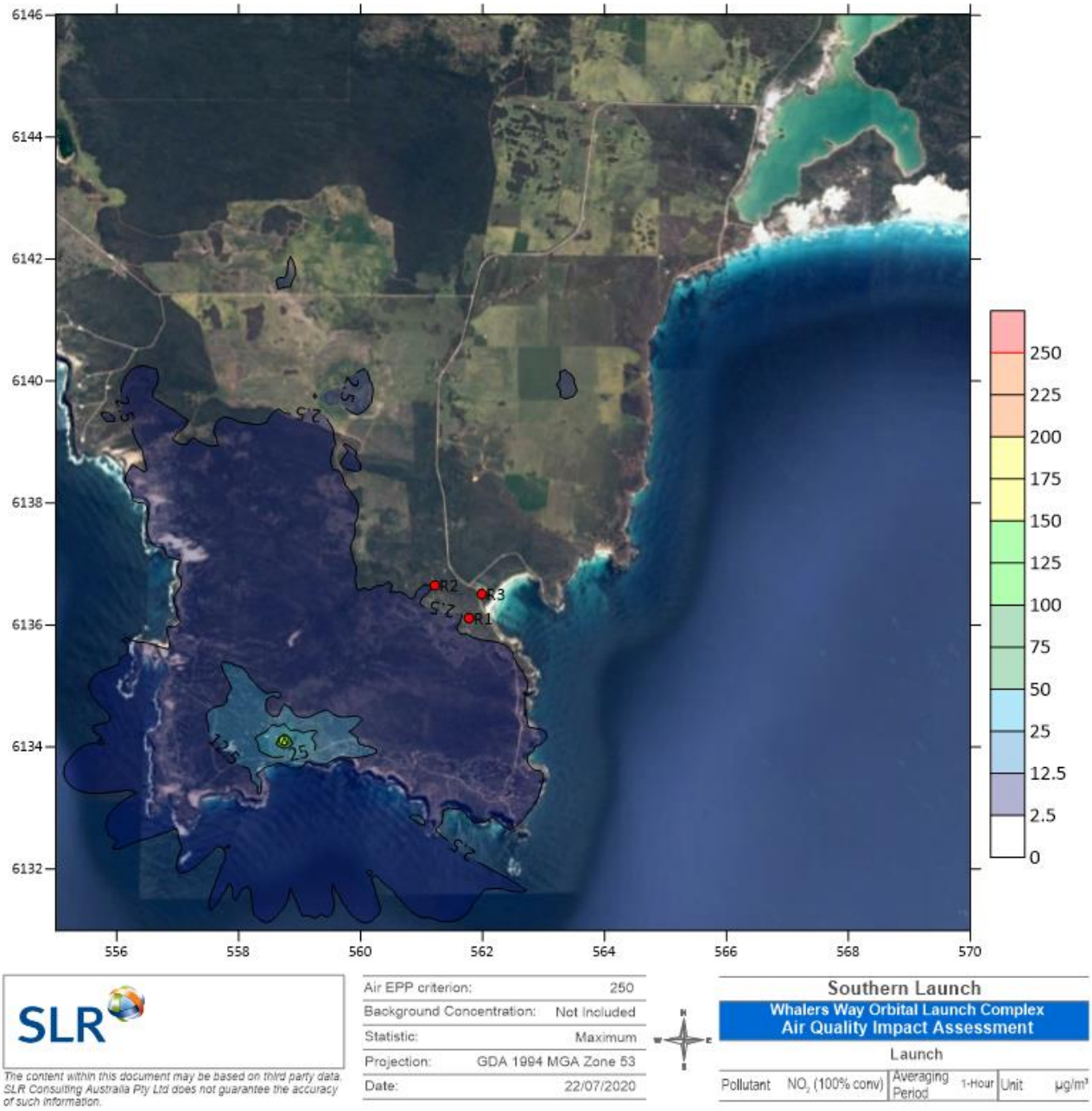
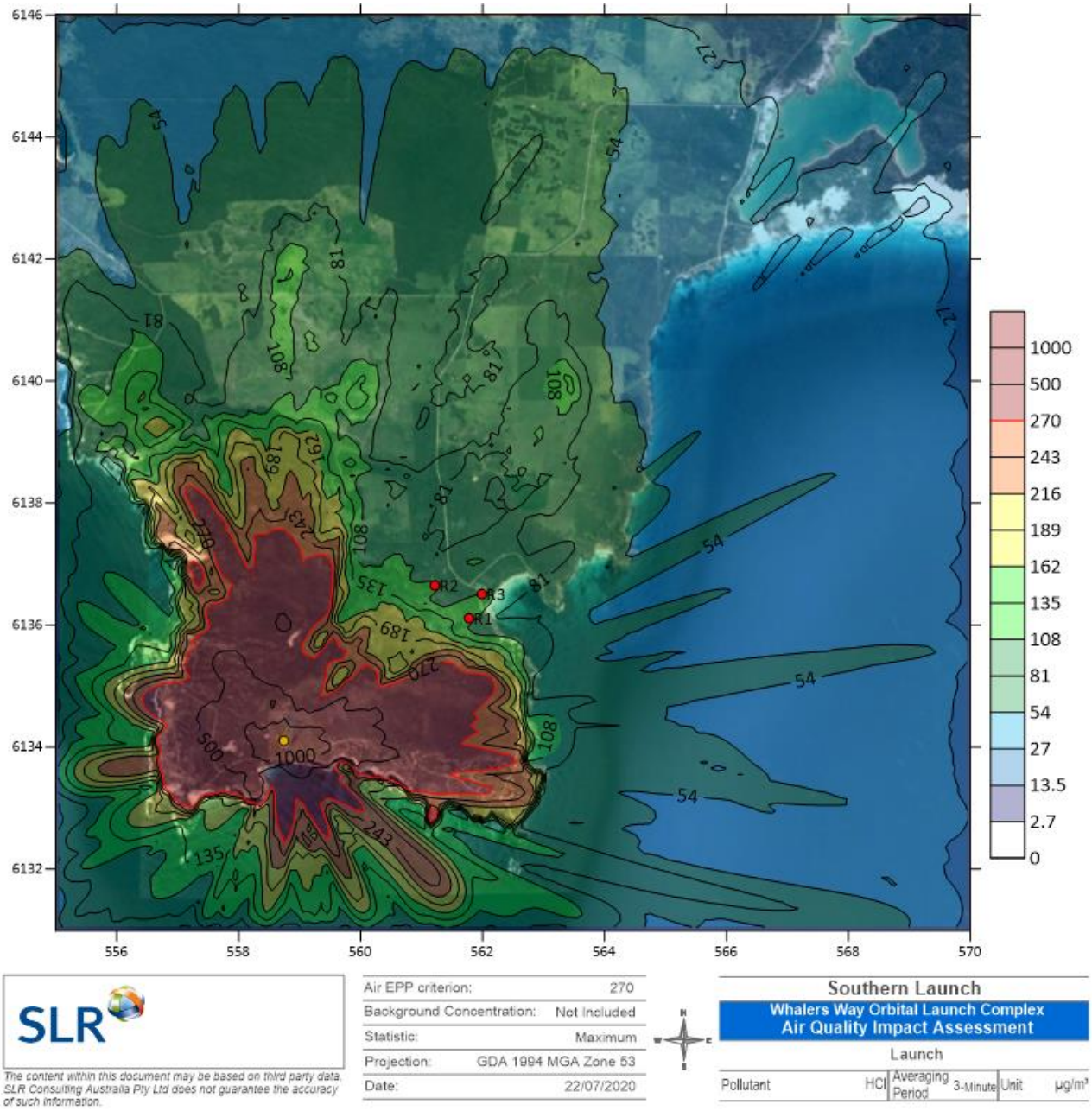


Figure 5 Results for HCl for Launch Scenario



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Air EPP criterion:	270
Background Concentration:	Not Included
Statistic:	Maximum
Projection:	GDA 1994 MGA Zone 53
Date:	22/07/2020

Southern Launch
Whalers Way Orbital Launch Complex
Air Quality Impact Assessment
Launch

Pollutant	HCl	Averaging Period	3-Minute	Unit	µg/m³

Figure 6 Results for $PM_{2.5}$ for Launch Scenario

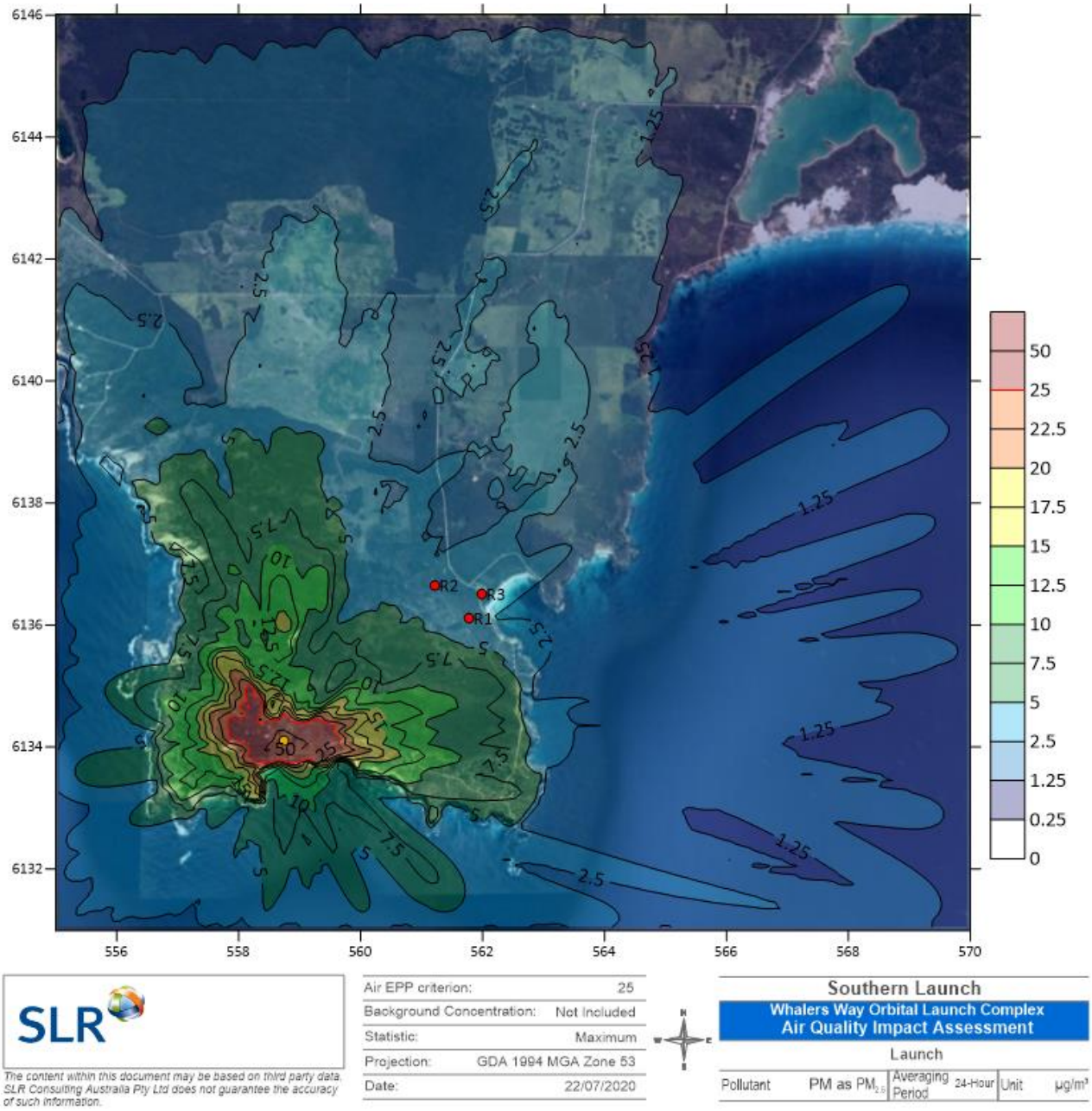


Table 8 Top 10 Ground Level Concentrations for R2 and Meteorological Conditions for Launch Scenario

Rank	Date stamp	Maximum GLC 1 hr avg except for HCl 3 min avg (µg/m³)	Wind speed (m/s)	Wind direction (°)	Stability class	Mixing height (m)
CO	Air EPP Assessment Criteria: 31,240 (µg/m³)					
Maximum	2009/05/02 17:00	104.9	1.8	218	F	61
2nd highest	2009/07/23 03:00	96.0	1.6	194	F	70
3rd highest	2009/05/26 07:00	93.6	2.6	219	D	72
4th highest	2009/12/11 19:00	88.5	3.3	224	F	118
5nd highest	2009/11/27 05:00	87.7	1.7	213	C	130
6rd highest	2009/12/12 01:00	86.6	3.1	224	F	110
7th highest	2009/12/19 03:00	86.2	4.0	222	E	164
8nd highest	2009/03/16 05:00	84.0	4.3	223	E	203
9rd highest	2009/05/02 15:00	84.0	2.3	228	C	530
10th highest	2009/11/23 19:00	82.0	2.7	226	F	70
HCl	Air EPP Assessment Criteria: 270 (µg/m³)					
Maximum	2009/05/02 17:00	115.2	1.8	218	F	61
2nd highest	2009/07/23 03:00	105.5	1.6	194	F	70
3rd highest	2009/05/26 07:00	102.8	2.6	219	D	72
4th highest	2009/12/11 19:00	97.2	3.3	224	F	118
5nd highest	2009/11/27 05:00	96.5	1.7	213	C	130
6rd highest	2009/12/12 01:00	95.2	3.1	224	F	110
7th highest	2009/12/19 03:00	94.8	4.0	222	E	164
8nd highest	2009/05/02 15:00	92.5	2.3	228	C	530
9rd highest	2009/03/16 05:00	92.4	4.3	223	E	203
10th highest	2009/11/23 19:00	90.1	2.7	226	F	70
NO_2 (as 100% of NOx) Air EPP Assessment Criteria: 250 (µg/m³)						
Maximum	2009/05/02 17:00	2.3	1.8	218	F	61
2nd highest	2009/07/23 03:00	2.1	1.6	194	F	70
3rd highest	2009/05/26 07:00	2.1	2.6	219	D	72
4th highest	2009/12/11 19:00	2.0	3.3	224	F	118
5nd highest	2009/12/12 01:00	1.9	3.1	224	F	110
6rd highest	2009/12/19 03:00	1.9	4.0	222	E	164
7th highest	2009/11/27 05:00	1.9	1.7	213	C	130
8nd highest	2009/03/16 05:00	1.8	4.3	223	E	203
9rd highest	2009/11/23 19:00	1.8	2.7	226	F	70
10th highest	2009/05/02 15:00	1.8	2.3	228	C	530
$PM_{2.5}$						

Rank	Date stamp	Maximum GLC 1 hr avg except for HCl 3 min avg ($\mu g/m^3$)	Wind speed (m/s)	Wind direction (°)	Stability class	Mixing height (m)
Maximum	2009/05/02 17:00	84.1	1.8	218	F	61
2nd highest	2009/07/23 03:00	77.0	1.6	194	F	70
3rd highest	2009/05/26 07:00	75.0	2.6	219	D	72
4th highest	2009/12/11 19:00	71.0	3.3	224	F	118
5nd highest	2009/11/27 05:00	70.4	1.7	213	C	130
6rd highest	2009/12/12 01:00	69.5	3.1	224	F	110
7th highest	2009/12/19 03:00	69.2	4.0	222	E	164
8nd highest	2009/05/02 15:00	67.5	2.3	228	C	530
9rd highest	2009/03/16 05:00	67.4	4.3	223	E	203
10th highest	2009/11/23 19:00	65.7	2.7	226	F	70

Table 9 Top 30 Ground Level Concentrations and Percentage Contributions from Elevated Sources for R2 and Meteorological Conditions for Launch Scenario

Date and Time Stamp	Max GLC CO (µg/m³)	% Contribution to Ground Level Concentration (GLC) From Each Layer								Wsp (m/s)	Stab Class	MxHt (m)
		0 to 20 m	20 to 40 m	40 to 80 m	80 to 160 m	160 to 320 m	320 to 640 m	640 to 1,200 m	1,200 to 2,000 m	2,000 to 3,000 m			
2009/05/02 17:00	104.9	95.8%	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0%	0%	1.8	F	61
2009/07/23 03:00	96.0	46.8%	40.5%	12.6%	0.0%	0%	0%	0%	0%	0%	1.6	F	70
2009/05/26 07:00	93.6	79.1%	20.9%	0.0%	0%	0%	0%	0%	0%	0%	2.6	D	72
2009/12/11 19:00	88.5	57.8%	41.1%	1.0%	0.0%	0.0%	0.0%	0.0%	0%	0%	3.3	F	118
2009/11/27 05:00	87.7	21.1%	21.2%	53.8%	3.9%	0.0%	0.0%	0.0%	0%	0%	1.7	C	130
2009/12/12 01:00	86.6	63.3%	36.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0%	0%	3.1	F	110
2009/12/19 03:00	86.2	47.0%	36.6%	16.4%	0.0%	0.0%	0.0%	0.0%	0%	0%	4.0	E	164
2009/03/16 05:00	84.0	42.2%	36.3%	21.6%	0.0%	0.0%	0.0%	0.0%	0%	0%	4.3	E	203
2009/05/02 15:00	84.0	7.2%	6.0%	10.2%	19.1%	31.0%	26.5%	0.0%	0%	0%	2.3	C	530
2009/11/23 19:00	82.0	86.4%	13.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0%	0%	2.7	F	70
2009/03/15 05:00	80.1	39.0%	35.6%	25.4%	0.0%	0.0%	0.0%	0%	0%	0%	4.5	E	216
2009/05/26 05:00	77.8	72.0%	28.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%	0%	3.0	F	95
2009/11/23 17:00	77.6	9.3%	8.1%	13.1%	22.9%	31.3%	15.4%	0%	0%	0%	2.5	D	520
2009/05/02 19:00	74.2	73.5%	26.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0%	0%	1.6	F	57
2009/04/05 05:00	72.7	34.5%	36.0%	29.0%	0.6%	0.0%	0.0%	0%	0%	0%	5.3	E	280
2009/04/17 19:00	68.7	97.3%	2.7%	0.0%	0.0%	0.0%	0%	0%	0%	0%	1.7	F	57
2009/05/03 15:00	66.6	6.0%	4.8%	9.0%	17.7%	29.2%	33.2%	0%	0%	0%	2.4	C	541
2009/09/16 19:00	66.5	31.9%	32.3%	34.3%	1.5%	0.0%	0.0%	0%	0%	0%	5.6	D	313
2009/04/29 15:00	63.7	7.8%	6.8%	12.7%	23.9%	32.6%	16.2%	0%	0%	0%	4.0	C	574
2009/03/06 07:00	62.4	9.0%	7.6%	13.5%	27.0%	35.0%	7.9%	0%	0%	0%	2.8	C	573
2009/04/03 05:00	60.7	27.3%	25.7%	42.6%	4.3%	0.0%	0.0%	0%	0%	0%	6.2	D	354
2009/12/18 03:00	59.6	48.0%	50.5%	1.5%	0.0%	0.0%	0.0%	0%	0%	0%	3.4	E	122
2009/12/04 23:00	58.8	47.8%	32.4%	19.8%	0.0%	0.0%	0.0%	0%	0%	0%	3.9	E	167
2009/09/07 05:00	58.7	90.6%	9.4%	0.0%	0.0%	0.0%	0.0%	0%	0%	0%	2.4	F	68
2009/08/10 03:00	58.5	27.8%	23.6%	46.7%	1.9%	0.0%	0.0%	0%	0%	0%	5.7	D	302
2009/12/11 23:00	58.4	50.4%	49.3%	0.3%	0.0%	0.0%	0.0%	0%	0%	0%	3.1	F	110
2009/05/13 03:00	57.3	38.1%	43.5%	18.2%	0.2%	0.0%	0.0%	0%	0%	0%	5.0	E	252
2009/03/14 01:00	55.4	26.9%	27.0%	39.2%	7.0%	0.0%	0%	0%	0%	0%	6.7	D	394
2009/05/16 11:00	54.4	8.7%	8.1%	15.2%	28.1%	33.0%	6.9%	0%	0%	0%	4.8	D	488
2009/03/24 17:00	53.1	76.0%	24.0%	0%	0%	0%	0%	0%	0%	0%	1.4	C	53

4.3 Engine Test Scenario

The results for the engine test scenario show the following:

- The results for CO for the engine test scenario with a full Stage 1 burn and much higher emissions at ground level than for the launch scenario shows, as expected, much increased ground level concentrations of CO. The predicted concentrations are however still within compliance at the nearest receptors.
- Similarly to the CO results for the engine test the NO_2 ground level concentrations are also much increased compared to the launch scenario. However, instead of assuming 100% conversion of NO_x to NO_2 (as common for screening assessments) a conversion of 40% was applied for this scenario. The 40% conversion was referenced to (Jansen et al, 1988) for a distance of approximately 5 km in summer conditions. The predicted concentrations are still within compliance at the nearest receptors.
- For PM the contribution to 24 hour average shows a similar margin to the $PM_{2.5}$ Air EPP assessment criterion as CO and NO_2 for the engine test. If including a 70^{th} percentile background concentration similar to what has been recorded in Port Augusta in recent years of around 7 µg/m^3 **Table 10** shows that only the maximum predicted hourly concentration would contribute to an exceedance.

The results for the engine test assuming a full Stage 1 burn at ground level for a 58 t rocket with liquid fuel within compliance for CO and NO_2 and marginally over for one day for PM as assessed against Air EPP $PM_{2.5}$ criteria. Considering the number of the very small number of engine tests that are being planned and that mostly smaller or shorter duration engine tests are anticipated the results show that engine tests are expected to be performed without exceedances of the Air EPP assessment criteria at the nearest sensitive receptors.

Figure 7 Results for CO for Engine Test Scenario

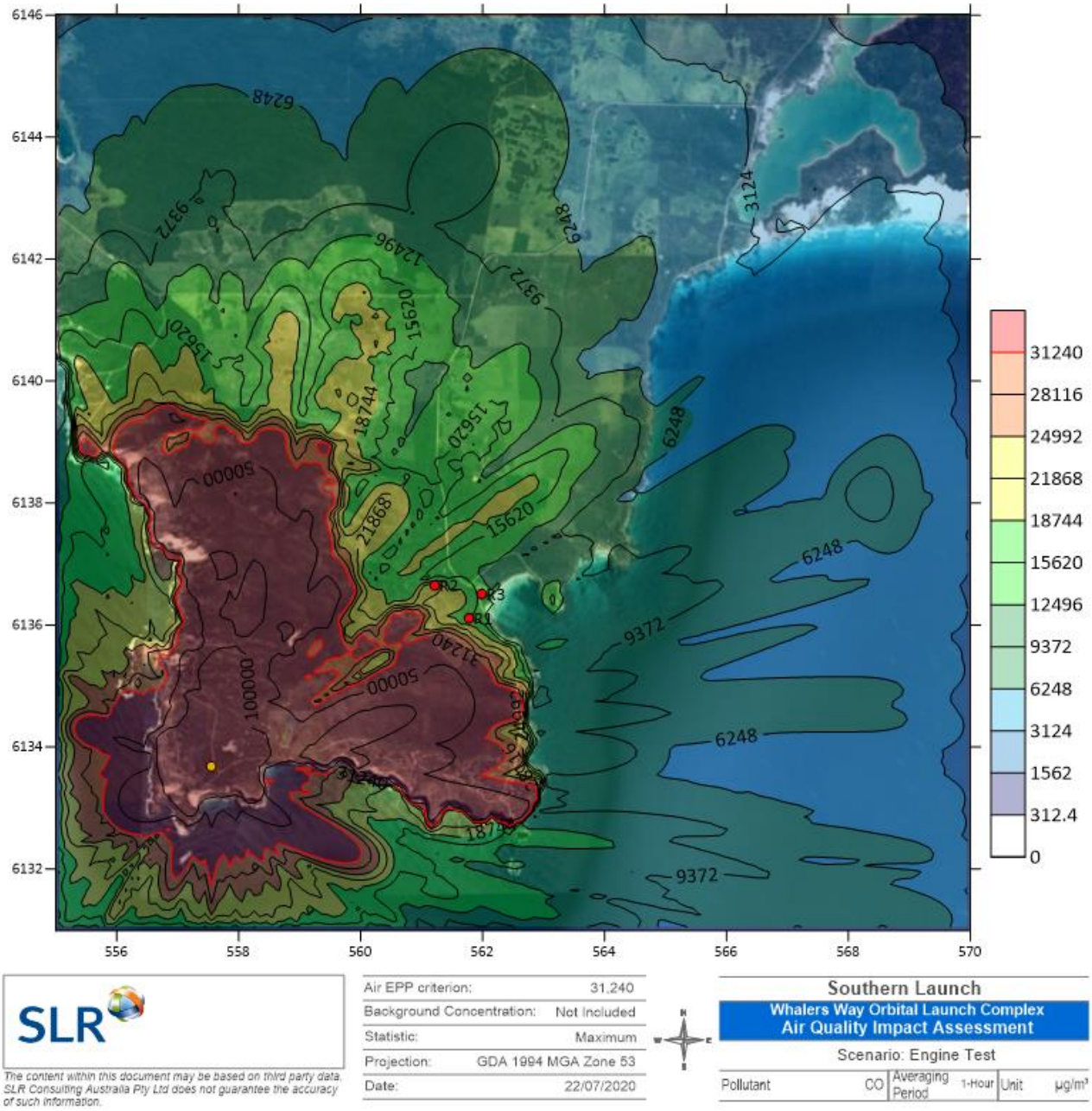


Figure 8 Results for NO_2 for Engine Test Scenario

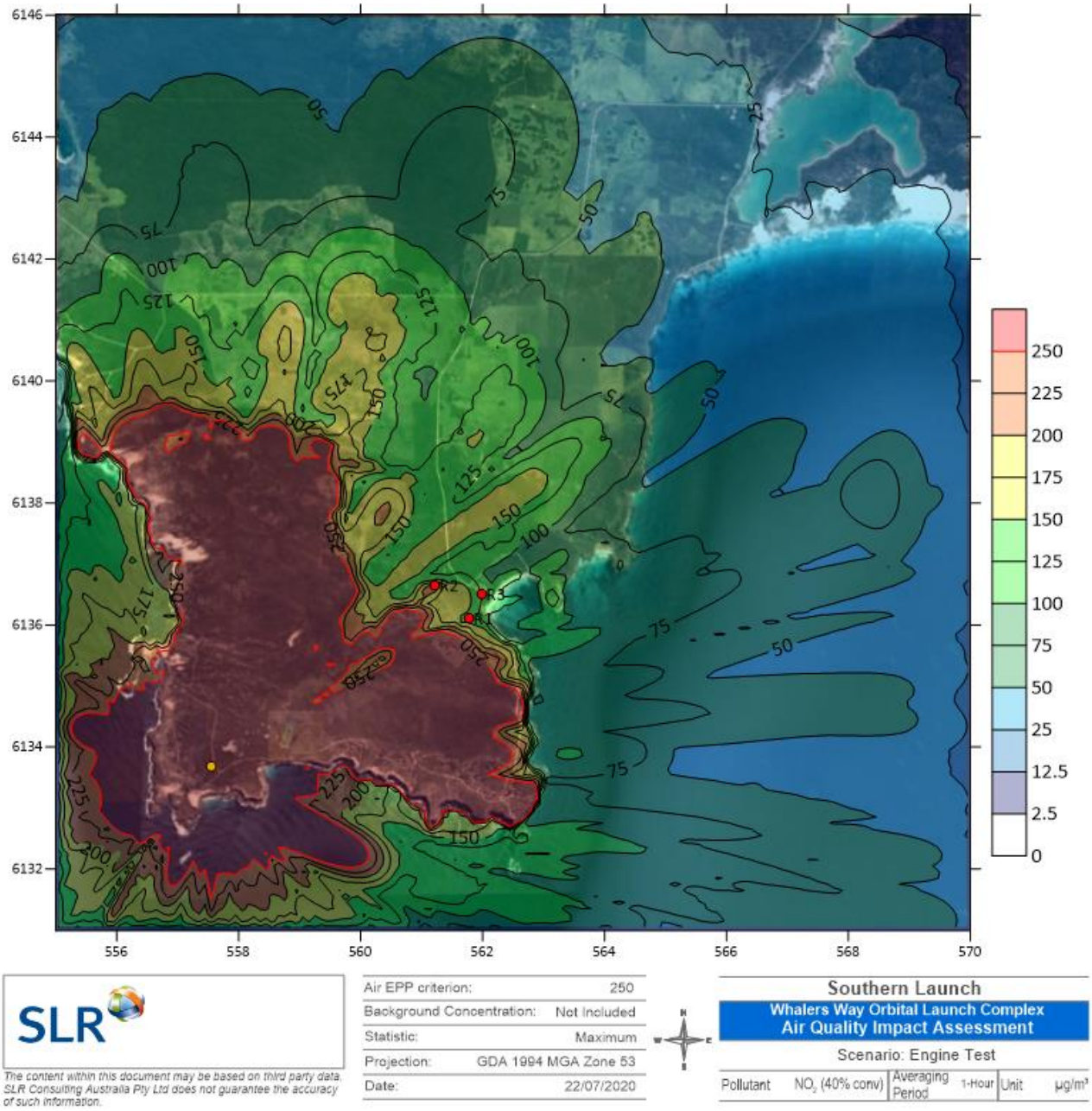


Figure 9 Results for $PM_{2.5}$ for Engine Test Scenario

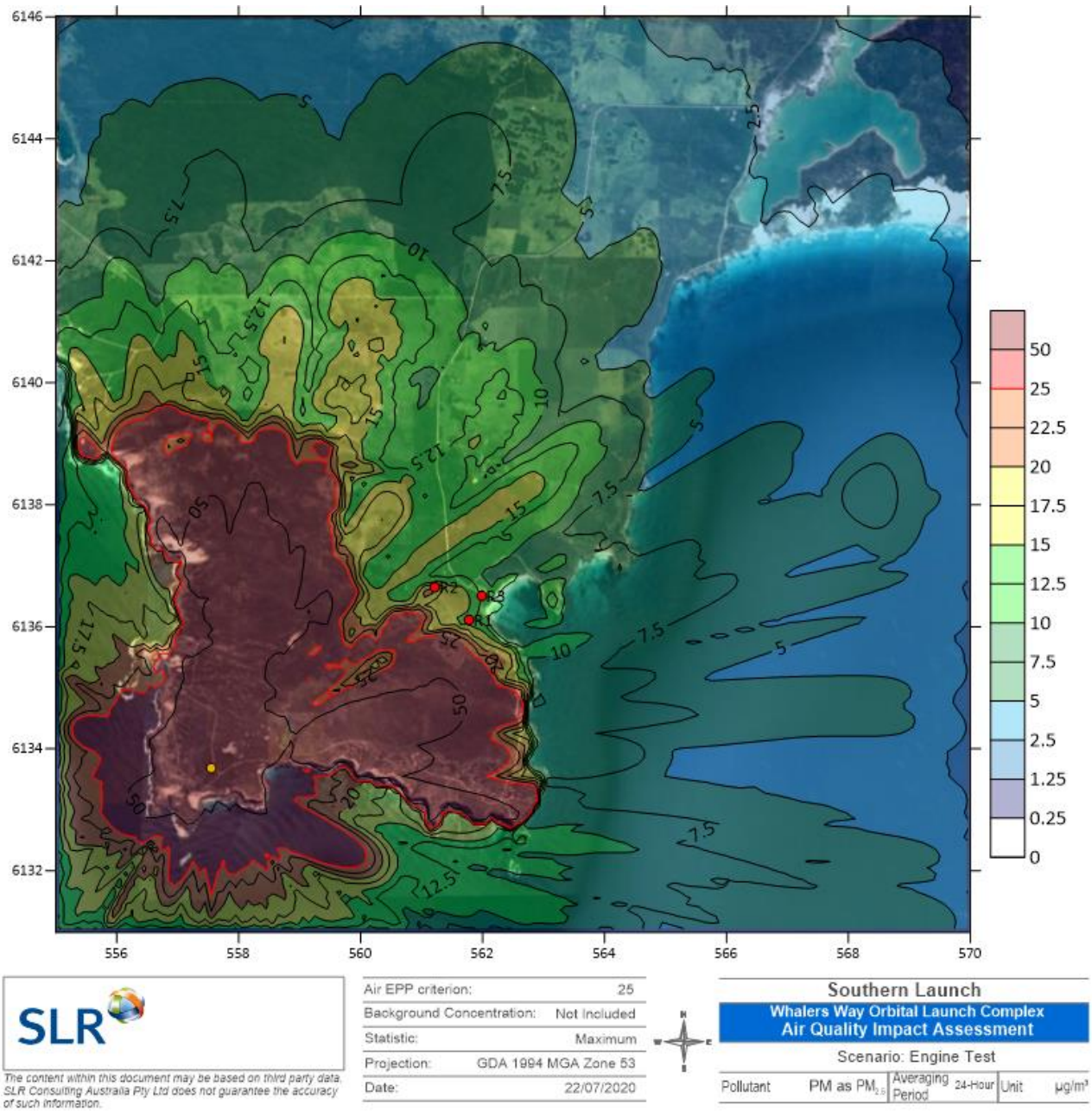


Table 10 Top 10 Ground Level Concentrations for R2 and Meteorological Conditions for Engine Test Scenario

Rank	Date stamp	Max GLC CO 1 hr avg (µg/m³)	Max GLC NO_2 (40%) 1 hr avg (µg/m³)	Max GLC $PM_{2.5}$ 1 hr avg (µg/m³)	$PM_{2.5}$ contrib. to 24 hr avg (µg/m³)	Wsp (m/s)	Wdir (°)	Stab class	MxHt (m)
Air EPP Assessment Criteria:		31,240	250	NA	25				
Maximum	2009/04/17 19:00	22,777	196	460	**19.2**	1.7	228	F	57
2nd highest	2009/12/11 21:00	17,713	152	358	14.9	2.8	229	F	78
3rd highest	2009/12/08 19:00	16,347	141	330	13.8	3.1	229	F	100
4th highest	2009/06/06 21:00	15,866	136	320	13.3	1.9	236	E	82
5nd highest	2009/04/14 05:00	14,439	124	292	12.2	3.0	227	F	97
6rd highest	2009/11/23 19:00	14,376	124	290	12.1	2.7	226	F	70
7th highest	2009/11/19 23:00	13,324	115	269	11.2	2.2	209	F	70
8nd highest	2009/12/11 23:00	13,116	113	265	11.0	3.1	227	F	110
9rd highest	2009/01/22 21:00	12,888	111	260	10.8	3.5	230	E	133
10th highest	2009/05/26 01:00	12,734	110	257	10.7	3.6	229	E	141

5 Conclusions

This assessment was performed as a conservative assessment to review the potential for air quality impacts associated with the proposed activities for the Whalers Way orbital launch complex. The assessment included both launch and engine tests events.

In considering the results the following should be noted:

- The emissions estimation was based on conservative emissions data and worst-case emissions for each pollutant.
- The emission rates for both launches and engine tests are high. However, they only occur for very short durations. For a launch event, emissions contributing to ground level concentrations only occur for up to 30 seconds and for engine tests, emissions only occur for up to 2.5 minutes.
- The operations plan for 36 launches and only a few engine tests per year. This means that emissions from site over a whole year are expected have a duration for less than an hour.
- The assessment considered emissions for every second hour of the year with modelling of 4,380 launches and engine tests respectively.
- An analysis of contribution to the ground level concentrations showed that the emissions closest to ground in stable conditions contribute to the most to the predicted highest concentration events. There is very little contribution to ground level concentration from emissions above 1,200 m.

Considering the relatively small number of launch and engine test events compared to the number of events assessed in all dispersion conditions it is unlikely that a launch or engine test would co-occur with the worst dispersion conditions and result in ground level concentrations as predicted. The emissions from the operations are expected to mostly occur in average dispersion conditions producing lower ground level concentrations than what was presented in the results.

The air quality impact assessment shows that there is a low risk associated with air quality impacts from the proposed orbital launch complex as assessed.

Should there be future plans for launches of much larger launch vehicles or engine tests of larger engines or with unusual fuels the emissions from the new operations should be reviewed and potentially assessed if there is reason for concern.

6 References

D. Schuch, G. F. (2017). The Use of an Atmospheric Model to Simulate the Rocket Exhaust Effluents Transport and Dispersion for the Centro de Lançamento de Alcântara. *Journal of Aerospace Technology and Management*, vol.9 no.2 São José dos Campos Apr./June 2017 https://www.scielo.br/scielo.php?script=sci_arttext&pid=S2175-91462017000200137.

Federal Aviation Administration. (2020). Draft Environmental Assessment for SpaceX Falcon Launches at Kennedy Space Center and Cape Canaveral Air Force Station, February 2020.

Jansen et al. (1988). L H J M Janssen, J H A van Wakeren, H van Duuren ans A J Elshout, A Classification of NO Oxidation Rates in Power Plant Plumes Based on Atmospheric Conditions. *Atmospheric Environment*, Vol 22 No 1pp 43-53.

NCAR. (2019). *Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, Z. Liu, J. Berner, W. Wang, J. G. Powers, M. G. Duda, D. M. Barker, and X.-Y. Huang, 2019: A Description of the Advanced Research WRF Version 4. NCAR Tech. Note NCAR/TN-556+STR, 145 pp.*

SA. (2016). *South Australia Environment Protection (Air Quality) Policy. Adelaide: South Australian Government.*

SRC. (2011). *CALPUFF Modelling System Version 6 User Instructions.*

APPENDIX A

Evaluation of Meteorological Data

Evaluation of Meteorological Data

The primary meteorological data parameters relevant for the dispersion are typically:

- wind (wind speed and direction)
- turbulence (atmospheric stability)
- mixing height (depth of turbulent layer)

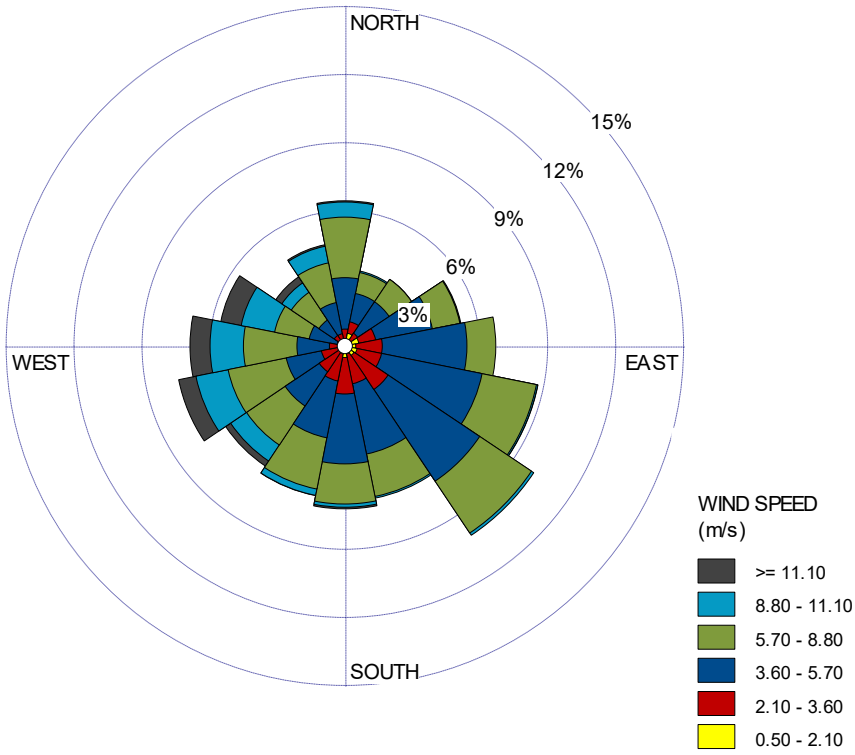
Evaluation of meteorological data for the above parameters extracted for the project location at Launch Site A is provided below.

Wind Speed and Wind Direction

Wind roses show the frequency of occurrence of winds by direction and strength. The bars show the direction the wind is blowing from and the lengths show the frequency of winds from that direction. The bars also show the wind speed categories for each direction with the frequency represented by the size of each bar with the lightest wind speed category closest to the centre of the wind rose.

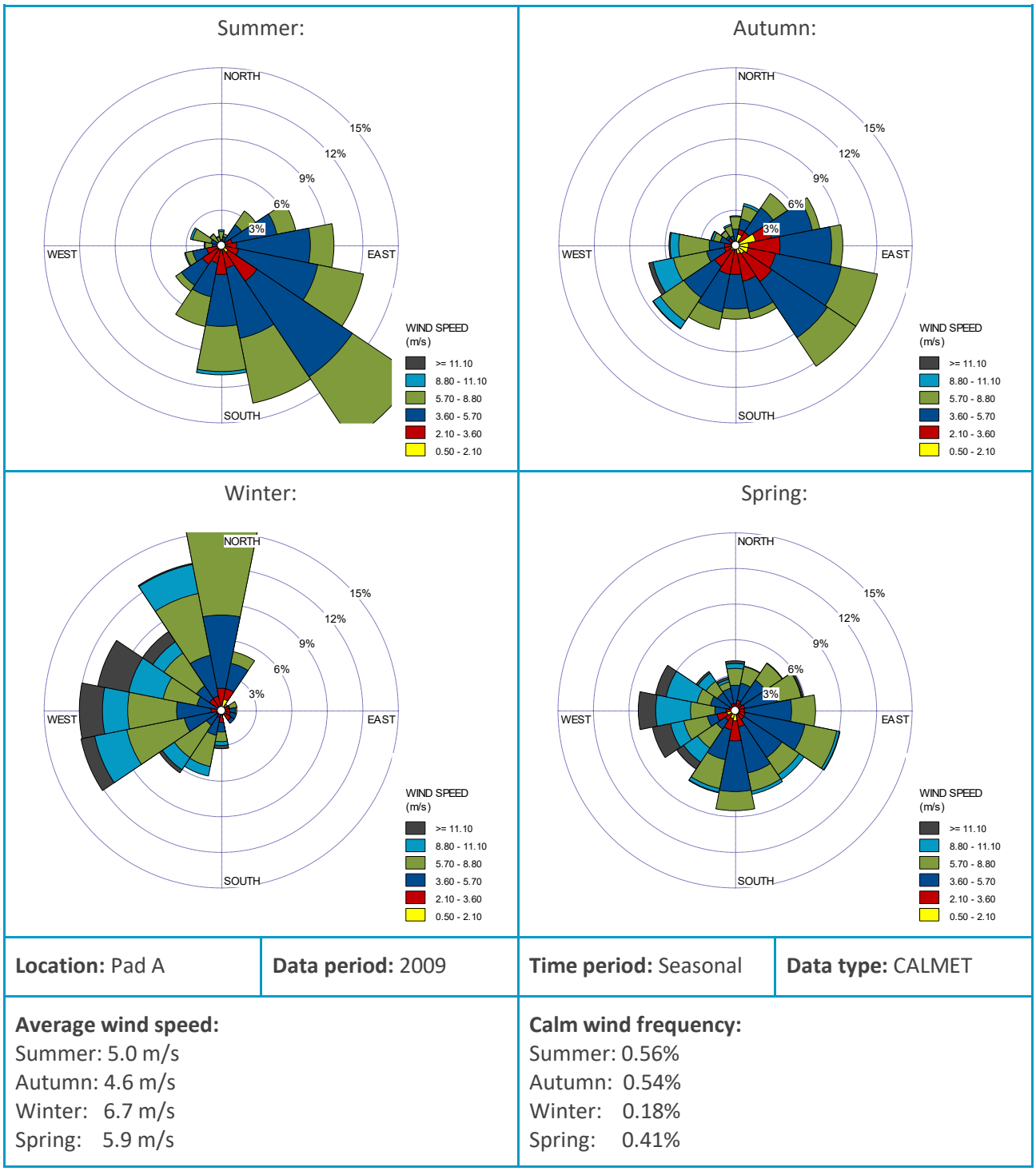
Wind roses are presented in **Figure 10** to **Figure 12** for the annual period of 2009 as well as for each season and time of day.

Figure 10 Wind Rose Project Site 2009



Location: Pad A	**Data period:** 2009	**Time period:** All hours	**Data type:** CALMET
Average wind speed: 5.53 m/s		**Calm wind frequency:** 0.42%	

Figure 11 Seasonal Wind Rose Project Site



Location: Pad A	**Data period:** 2009	**Time period:** Seasonal	**Data type:** CALMET

Average wind speed:
Summer: 5.0 m/s
Autumn: 4.6 m/s
Winter: 6.7 m/s
Spring: 5.9 m/s

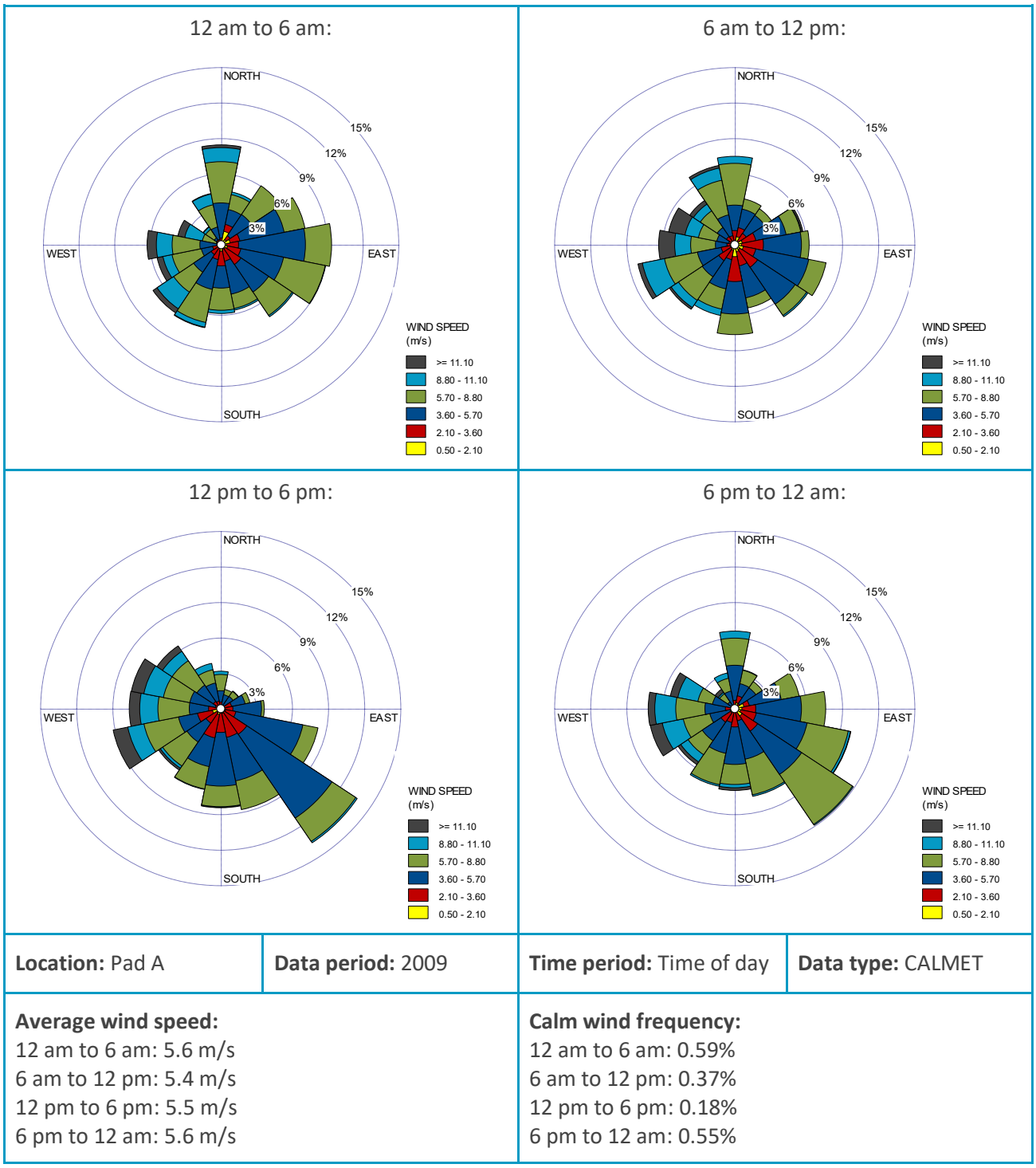
Calm wind frequency:
Summer: 0.56%
Autumn: 0.54%
Winter: 0.18%
Spring: 0.41%

On an annual basis (**Figure 10**) the prevailing wind direction is from the southeast. The critical wind direction for exposure of the nearest sensitive receptors is from the southwest.

The seasonal data (**Figure 11**) show prevailing south-easterly winds in the summer and autumn months and prevailing northerly and westerly stronger winds through winter.

The time of day data (**Figure 12**) show prevailing south-easterly winds in afternoons and evenings. Overall, the wind data does not show unfavourable conditions and wind directions towards the nearest receptors.

Figure 12 Time of Day Wind Rose Project Site



Location: Pad A	**Data period:** 2009	**Time period:** Time of day	**Data type:** CALMET

Average wind speed:
12 am to 6 am: 5.6 m/s
6 am to 12 pm: 5.4 m/s
12 pm to 6 pm: 5.5 m/s
6 pm to 12 am: 5.6 m/s

Calm wind frequency:
12 am to 6 am: 0.59%
6 am to 12 pm: 0.37%
12 pm to 6 pm: 0.18%
6 pm to 12 am: 0.55%

Atmospheric Stability

Atmospheric stability refers to atmospheric turbulence and the tendency of the atmosphere to resist or enhance vertical motion. Depending on conditions the atmospheric stability can either inhibit or promote pollutant dispersion. The Pasquill-Gifford scheme provides six stability classes, A to F, to categorise the degree of atmospheric stability as follows:

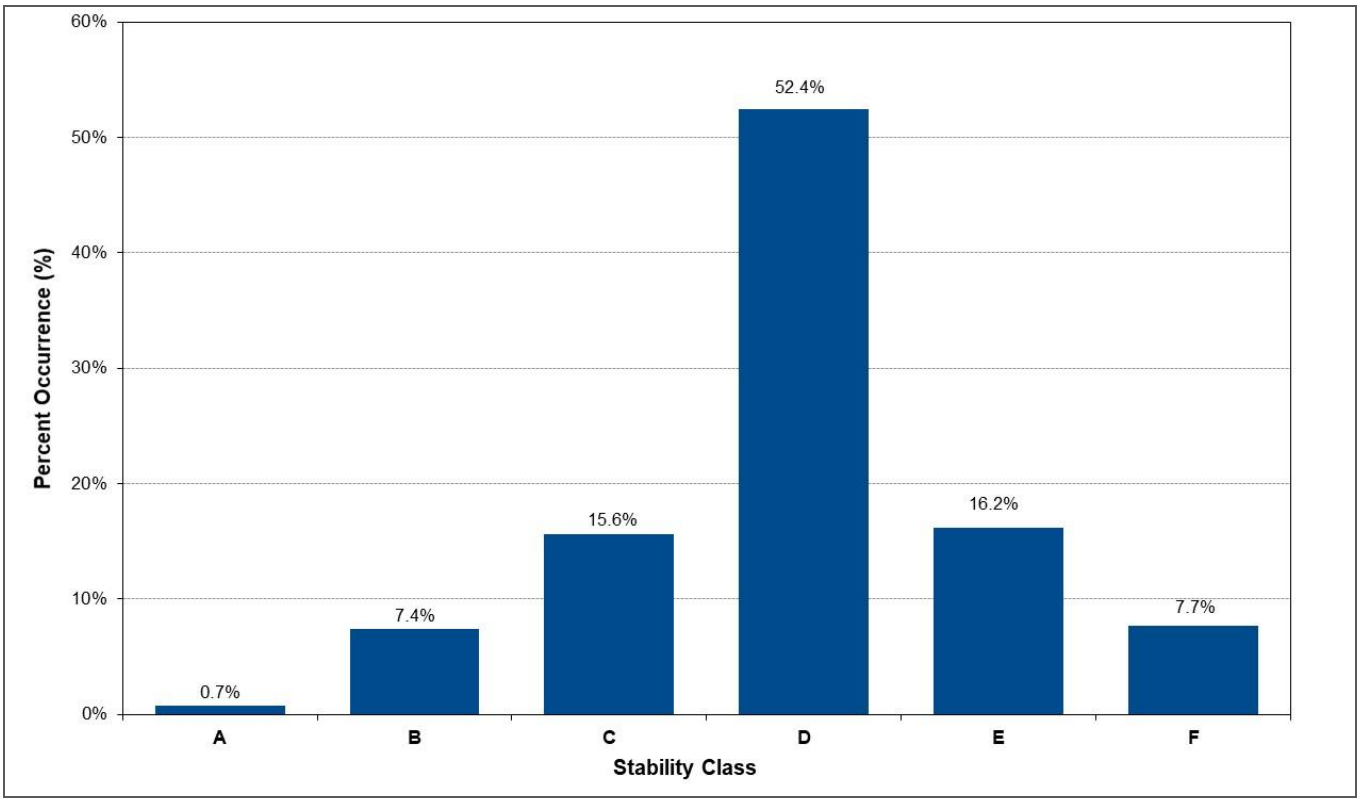
- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions

Unstable conditions are favourable for dispersion and stable conditions are unfavourable for dispersion.

The dispersion modelling in CALPUFF used a more advanced atmospheric stability scheme (based on micro meteorology). Stability class data was extracted from the meteorological dispersion modelling data set for the meteorological data evaluation.

Stability class data as extracted for the project site are presented in **Figure 13** and shows a high frequency of D class stability which is typical for near costal settings.

Figure 13 Distribution of Atmospheric Stability Classes



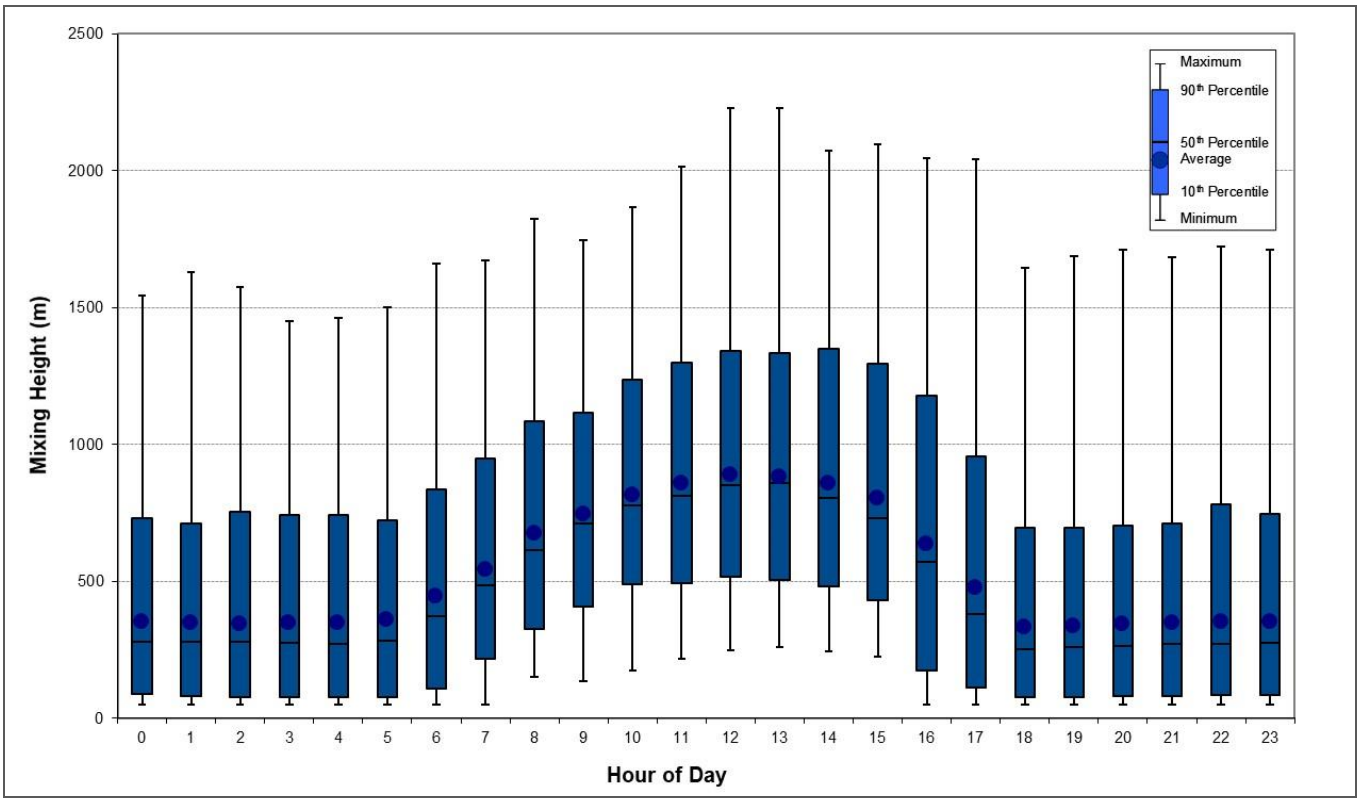
Mixing Height

The mixing height is the depth of the atmospheric mixing layer between ground level and an elevated temperature inversion. Depending on conditions vertical dispersion is typically limited by the mixing height. This is an important parameter in dispersion modelling since the mixing height largely sets the vertical profile the dispersion can take place in.

Mixing heights have a diurnal variation in response to mixing from convection due to insolation and grow from sunrise to around midday. Followed by a decline until sunset when there typically is a rapid decline. If a plume penetrates through, or is released above, the mixing height the pollutants will be trapped aloft with no mixing to ground level (unless in specific conditions such as fumigation). Similarly, if a plume is trapped below a low mixing height (inversion layer) the vertical dispersion will be limited, and higher ground-level concentrations are likely to occur.

The profile of the diurnal mixing heights predicted at the project site are presented in **Figure 14**and is consistent with near coastal locations.

Figure 14 Distribution and Statistics of Mixing Heights



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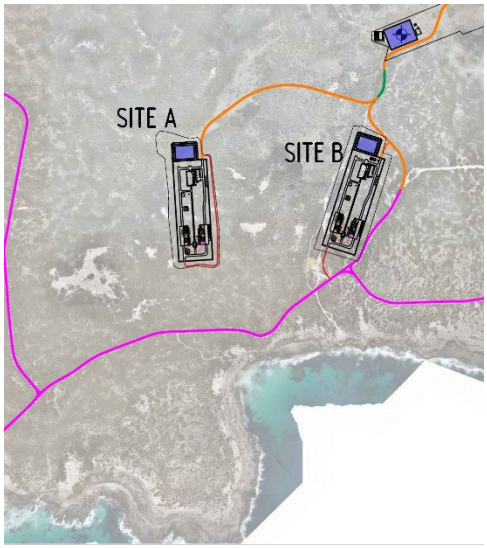
Dear Andrew

Technical Memorandum Re – Proposed Relocation of Rocket launch Site A (Second Revision)

As indicated on the revised plans WGA 181404-DR-CC-0001 (OVERALL SITE PLAN) (issued 15.02.2022), due to the outcome of further ecological assessment, Launch Site A will be constructed at a new site, closer to Launch Site B, see figure below.

Initial Launch Site A Location



Revised Launch Site A Location

It is understood that in addition to launches, engine tests have also been proposed at Launch Site A. Other sheets in the new (15.02.2022) plans provided also show new areas of cut and fill necessary to achieve the desired design grade at the new site but it is understood that the surface treatments and bunding surrounding the site will be identical to that planned at the initial launch Site A location.

The description of existing geological and hydrogeological conditions at the project site, included in the DWEMP[1] remains relevant to the revised launch Site A (and nearby launch Site B). The recommendations in the DWEMP for the development of a Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP), detailing ongoing water quality monitoring and management (to be in place before launches and/or rocket tests commence) will also apply to the revised launch Site A location, without amendment

Kind Regards

Peter Hicks

Principal Environmental Engineer

[1] Design Stage (Water) Environmental Management Plan Whalers Way Orbital Launch Complex, EA, 3/11/2020 (ref. P0020-07)

M UPDATED SACES REPORT - MAY 2022

South Australian Centre for Economic Studies

Potential Economic Impact of Southern Launch's Proposed Civilian Launch Operations – A 2022 Update

Report commissioned by:

Southern Launch

Report prepared by:

The South Australian Centre for Economic Studies
University of Adelaide

May 2022

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Contents

Executive Summary

Background

Southern Launch is proposing to take advantage of the emerging market for small and micro satellites deployed in polar and sun-synchronous orbits by developing a permanent multi-user launch facility at Whalers Way, which is located approximately 25 km south of Port Lincoln. This launch facility would be made available to third party rocket manufacturers who would be responsible for securing their own payloads. Southern Launch currently has temporary launch facilities at Whalers Way which are being used to carry out test rocket launches during 2022. The company is currently seeking approval to establish permanent facilities – the Whalers Way Orbital Launch Complex (WWOLC) – that would comprise two launch sites, a supporting infrastructure site and a range control facility for launch control and site administration.

The prospect of establishing a launch facility has been instrumental in encouraging one local vehicle manufacturer to establish manufacturing operations in South Australia. Should a permanent launch facility be successfully established it is possible that there will be spin-off benefits in terms of maintaining this existing manufacturing capability within South Australia (which is expected to grow), or encouraging another launch vehicle manufacturer to relocate final assembly to South Australia. With the Australian Government recently announcing funding to design, build and operate four new satellites for earth observation, there could also be potential spin off benefits in terms of establishing satellite manufacturing in South Australia.

Approach

In 2019 Southern Launch commissioned the SA Centre for Economic Studies to undertake an economic impact analysis in order to understand the potential impacts of its proposed launch activities. Southern Launch has subsequently engaged SACES to update its earlier analysis and consider additional spin off benefits in light of developments during the interim period. The analysis is forward looking, focusing on impacts over the 10-year period commencing 2022/23.

Three forms of potential economic impact in respect of Southern Launch activities have been assessed:

- Southern Launch's ongoing operations;
- capital works required to establish a permanent launch facility at Whalers Way; and
- the potential visitor numbers associated with the launches (i.e. staff from third party vehicle manufacturers visiting South Australia).

The data and key assumptions made around the potential activities associated with the launches have been provided by Southern Launch. The modelling itself and the data in the economic model have been conducted and sourced independently by SACES.

The gross economic impact of the impact of Southern Launch's proposed activities on the South Australian economy has been assessed using an input-output (IO) model. The methodology employed involves estimating the total direct and indirect employment and gross state product (GSP) arising from the production operations, investment activities and additional visitor expenditure. GSP is the state equivalent to gross domestic product.

Findings – impact of Southern Launch activities

Considering the direct and additional downstream production activity generated within the South Australian economy, then the overall 'production impacts' of Southern Launch's own operations would be to support an **average of 56 full-time equivalent (FTE) jobs** over the ten-year analysis period from 2022 to 2031/32 – see Table A.1.[1] Generation of employment indirectly through supply chain effects peaks at 15 FTE jobs in the first year of the analysis and falls thereafter as a consequence of Southern Launch reducing its purchases from intermediate suppliers as it shifts from temporary to permanent launch activities. In subsequent years direct employment accounts for around four-fifths of the total employment impact.

There are also one-off employment impacts over the period 2022/23 to 2026/27 as a result of the construction of the permanent orbital launch complex. The average gross impact on employment over this period is estimated to be 33 FTEs, with a peak employment impact of almost 53 FTEs in 2026/27.

On-going employment impacts from 2021/22 onwards associated with the spending by visitors associated with the launches (i.e. employees of launch firms) are expected to rise from 5.1 FTE jobs in 2022/23 to a peak of

[1] 'Production impacts' refer to the second order impacts flowing from South Australian based firms which supply Southern Launch purchasing goods and services from other South Australian based firms as inputs into their supply to Southern Launch, and so on down the supply chain.

30 FTE jobs in 2026/27. The average gross impact on employment over the analysis period is estimated to be 25 FTEs

The average gross impact on employment over the ten-year analysis period due to all Southern Launch activities (including one-off impacts from construction and increased business visitors) is expected to be almost **98 FTE positions**.

Table A.1 Estimated gross economic impact of Southern Launch activities and spin-off benefits Average or total impact over period from 2022/23 to 2031/32[(a)]

	Full-time equivalent jobs (average over period)	Gross State Product ($m) (present value over period)
Southern Launch Operations		
On-going operations	56.2	156.0
Capital spending	32.6	30.9
Launch vehicle staff spending	25.1	22.0
Total	**97.5**	**209.0**
Spin-off benefits		
Continued operation and growth of a launch vehicle manufacturer	485.4	449.6
Separate launch vehicle manufacturer undertaking assembly in SA	114.2	103.2
Satellite manufacturer undertaking manufacturing in SA	256.6	429.6

Note: (a) Impacts for capital spending relate to the five-year period from 2022/23 to 2026/27.

The estimated ***gross*** on-going impact on economic activity of Southern Launch's on-going operations would be to contribute $9.2 million in real Gross State Product (GSP) in 2022/23. With the number of launches expected to rapidly increase over subsequent years, the gross impact on GSP from Southern Launch's on-going operations is expected to rise significantly over this period, reaching a peak of approximately $26 million from 2026/27 and onwards. The impact of Southern Launch's operations on GSP are quite large by normal industry standards. Such a large GSP impact is attributed to Southern Launch earning relatively large gross operating surplus amounts in future years as it benefits from efficiencies associated with establishing permanent facilities, and associated with this, being a South Australian headquartered company, which implies that returns to capital accrue to the state. Moreover, as the estimates are forward looking, they exclude previous losses incurred by Southern Launch in establishing the business.

There are also impacts over the first five years of the analysis period to 2026/27 as a result of the capital expenditures associated with establishing the launch facilities at Whalers Way.

Finally, there will be on-going impacts associated with increased business visitor nights associated with staff of launch vehicle manufacturers both prior to and associated with the launches. The expected annual contribution to GSP is estimated to rise from $0.7 million in 2022/23 to a peak of $3.8 million in 2026/27.

Assessed over the full ten-year analysis period using South Australia Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (including the impact of capital works) resulting from Southern Launch's operations, capital investments, and induced visitor activity has a present value of **$209 million** in 2021/22 values.

If consumption impacts from workers at Southern Launch and its supply chain are included, then the average employment impact would be **169 FTE positions**, with the present value of the impact on GSP being **$312 million** in 2021/22 values (see Appendix A).

Potential spin-off impacts

The potential impacts discussed so far only relate to the operations of the launch facility itself and its associated supply chain. There is also the potential for the existence of a permanent launch facility to (i) preserve the continued presence of the launch vehicle manufacturer in South Australia, (ii) attract a separate launch vehicle manufacturer to establish a 'final assembly and testing' facility, and (iii) attract a satellite manufacturer to establish manufacturing operations in South Australia. If these scenarios do eventuate – particularly the final two which involve establishing new activities – they will significantly increase the benefits for the state from the launch facility.

The estimated ***gross*** production impact of the existing launch vehicle manufacturer maintaining and growing manufacturing and testing operations in South Australia would be to support 570 FTE positions once the manufacturing facility reaches full operation (assumed to be 2025/26, see Table B.1 in Appendix B). The average gross impact over the 10-year analysis period is **485 FTE positions**.

The estimated *gross* on-going impact on economic activity of the launch vehicle manufacturer maintaining and growing manufacturing and testing operations in South Australia would be to contribute **$79 million** in real GSP once full production activity is reached in 2025/26. Assessed over the full ten-year analysis period using SA Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (assuming no change in the scale of the R&D operation) has a present value of **$450 million** in 2021/22 values.

The estimated ***gross*** production impact of a **separate launch vehicle manufacturer undertaking final assembly** in South Australia would be to support approximately **143 FTE position**s from 2024/25 onwards (see Table C.1 in Appendix C), which is the first year in which the manufacturer is assumed to commence operations. The average gross impact over the 10-year analysis period is **114 FTE position**s.

The estimated ***gross*** impact on economic activity of a separate launch vehicle manufacturer undertaking final assembly and testing operations in South Australia would be to contribute **$20 million** in real GSP from 2024/25 onwards. Assessed over the full ten-year analysis period using SA Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (assuming no change in the scale of the R&D operation) has a present value of **$103.2 million** in 2021/22 values.

The estimated ***gross*** production impact of a satellite manufacturer undertaking manufacturing in South Australia would be larger, with on-going employment in the satellite manufacturer and its South Australian supply chain expected to support 325 FTE positions once the manufacturing facility reaches full operation (assumed to be 2025/26, see Table D.1 in Appendix D). The average gross impact over the 10-year analysis period is **257 FTE position**s.

The estimated ***gross*** impact on economic activity of a satellite manufacturer establishing operations in South Australia would be to contribute **$84 million** in real GSP per year once it is fully operational. Assessed over the full ten-year analysis period using SA Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (assuming no change in the scale of the R&D operation) has a present value of **$430 million** in 2021/22 values.

1. Introduction

An important trend in the space sector is the expanding range of uses for small and micro satellites (such as CubeSats) in low Earth orbits (also known as polar and sun-synchronous orbits). At a typical distance from the Earth of around 1,000 km above sea level these are significantly lower than the more traditional geosynchronous orbits which are typically around 36,000km above sea level. Low Earth orbits can be efficiently achieved from higher latitudes, whereas satellites which are being placed in geosynchronous orbits need to be launched from near the equator. The southern coast of South Australia, with its lack of population centres or major air routes or maritime transportation routes to its south, is an attractive potential launch site for small and micro satellites.

Southern Launch is proposing to take advantage of the emerging market for polar and sun-synchronous satellite orbits by developing a permanent multi-user launch facility at Whalers Way, approximately 25 km south of Port Lincoln at the southern end of Eyre Peninsula. This launch facility would be made available to third party rocket manufacturers who would be responsible for securing their own payloads. Southern Launch currently has temporary launch facilities at Whalers Way which are being used to carry out test rocket launches during 2022. The company is currently seeking approval to establish permanent facilities that would comprise two launch sites, a supporting infrastructure site and a range control facility for launch control and site administration (Southern Launch, 2021). This overall facility would be called the Whalers Way Orbital Launch Complex (WWOLC).

According to Southern Launch, the prospect of establishing a launch facility has been instrumental in encouraging one local launch vehicle manufacturer to establish manufacturing operations in South Australia. Should a permanent launch facility be established in the state it is possible that there will be spin-off benefits in terms of maintaining this existing manufacturing capability within South Australia (which is expected to grow strongly over the next several years), and/or encouraging another launch vehicle manufacturer to relocate final assembly to South Australia. With the Australian Government recently announcing funding to design, build and operate four new satellites for earth observation, there could also be potential spin off benefits in terms of establishing satellite manufacturing in South Australia. It is not possible to assess the likelihood of this occurring and so these potential impacts are excluded from the main analysis. However, they are estimated in Appendices B (existing manufacturing being maintained), C (separate manufacturer undertaking final assembly in South Australia), and D (satellite manufacturer undertaking manufacturing in South Australia) respectively.

In 2019 Southern Launch commissioned the SA Centre for Economic Studies to undertake an economic impact analysis in order to understand the potential impacts of its proposed launch activities. The timing and scale of the company's planned activities has changed considerably since that earlier analysis, in part due to delays caused by the COVID-19 pandemic, current approvals process and market developments. Southern Launch has consequently engaged SACES to update its earlier analysis and consider additional spin off benefits in light of recent developments.

The data and key assumptions made around the potential activities associated with the launches have been provided by Southern Launch. The modelling itself and the data in the economic model have been conducted and sourced independently by SACES.

There are three forms of potential economic impact: Southern Launch's direct operations, the capital works required to establish a permanent launch facility, and the potential visitor numbers associated with the launches (i.e. staff from third party vehicle manufacturers visiting South Australia). Each has been assessed individually.

Section 2 summarises the methodology and approach that is used to calculate the economic impacts. Section 3 presents the results of the economic analysis. Appendix A extends the main analysis to include the potential consumption impacts that could arise as a result of the additional economic activity in South Australia.

Appendix B explores the potential economic impact associated with the continued presence of a local launch vehicle operator in South Australia who would use the WWOLC. Appendix C considers the potential impact associated with a separate launch vehicle manufacturer choosing to establish a final assembly and testing facility in South Australia. Appendix D explores the potential impact should a satellite manufacturer establish manufacturing operations in South Australia.

2. Method and Approach

2.1 Method

The gross economic impact of Southern Launch's proposed activities on the South Australian economy has been assessed using an input-output (IO) model. The methodology employed involves estimating the total direct and indirect employment and gross state product (GSP) arising from the production operations and sustainment investment activities. GSP is the state equivalent to gross domestic product.

An input-output table describes the linkages between sectors of the economy based on their patterns of purchase and supply. For each of the sectors in the economy (e.g. agriculture, pipe manufacturing, utilities, transport and storage etc.) it details the inputs the sector uses (to produce output in the case of producing sectors; for consumption in the case of "consumer" sectors), and what sectors it sells its output to.

The intuition of the input-output approach is best illustrated by example. Suppose a hotel operator spends $10,000 on IT support from a South Australian firm. That IT firm then uses the $10,000 to purchase inputs from "primary" and "intermediate" suppliers. "Primary" suppliers are employees, providers of capital, indirect taxation, and "imports" from suppliers of goods and services located outside of South Australia. Primary income payments are therefore labour compensation (wages), profits to owners, indirect taxes (net of subsidies) and imports. The IT firm will also purchase intermediate inputs (e.g. office cleaning, stationary, electricity etc.) from intermediate suppliers in South Australia which, by and large, are other businesses. Payments to those business enterprises then flow to those businesses' own primary incomes and intermediate suppliers. And this process carries on repeatedly, with ultimately all of the payments flowing to primary incomes. The input-output table lets us trace through, and aggregate, this chain of impacts.

There are two types of impacts which are commonly considered, differing in the extent of the flow-ons which are accounted for. The first, having a narrower extent, is the "production impact". The production impact is the impact of the initial expenditure upon primary factor incomes and employment, derived by tracing through the chain of intermediate usage (i.e. supply chain effects). However, no allowance is made for expenditure of primary incomes. The second, with a broader coverage, encompasses production and "consumption" impacts. The consumption impact arises when households in receipt of wage income spend the incomes they receive.

The gross production and consumption impacts arising from the output of an industry can be calculated using coefficients and multipliers derived from the input-output tables. The concept of input-output multipliers is discussed in Box 2.1. In addition to the overall impact, multipliers can show separately the production and consumption impacts described above. Multipliers can be derived to show how a change in output for an industry affects a particular economic variable, such as output, value added (i.e. GSP), income or employment.

The IO modelling process generates estimates of gross impact in the sense that the IO model does not incorporate any displacement of other activities. This will be strictly valid only if all of the resources that are required for the activity being modelled are freely available without diverting them from other uses within the regional economy of interest or changing their prices. It will rarely be the case that this requirement is met strictly, but for small regions with sufficient underutilised or mobile labour and capital suitable for the new activity it may be met approximately, with the IO model thus generating estimates that are approximately right. While the current low unemployment environment increases the risk of displacement, the historical pattern of continued net interstate migration of younger more skilled individuals out of South Australia and high level of overseas inward migration suggests there is considerable scope for additional economic activity without substantial displacement to the extent new initiatives tap into these potential labour sources.

2.2 Input output table modifications and assumptions

The economic impacts were estimated using financial information and estimates of the scale of potential international visitor numbers associated with the staff of the launch vehicle operator, provided by Southern Launch and multipliers derived from an input-output table for the South Australian economy. We used a 60 industry sector input-output table for South Australia developed by SACES from a range of sources including a South Australian input output table derived from the TERM-Australia multiregional economic model of Australia (TERM-Australia is a computable general equilibrium framework developed by the Centre of Policy Studies at Victoria University), the ABS Labour Force Survey, the ABS National Accounts, and the 2016 Census.

Box 2.1 Input-output multipliers

An increase in the output of one industry will (at least in gross terms) lead to increased outputs in other sectors due to the purchases of intermediate inputs for production, and the spending of a proportion of the capital and labour income locally. A multiplier measures the total change across the entire economy arising from a unit change in the final demand for the output of an industry (the initial "shock" to the model). Multipliers can be calculated for a range for economic variables, such as individual and business income, gross value added, and employment, according to one's interest.

In some cases the interest in the model results will be restricted to Type I impacts, also known as the "production impact". This is the impact of the initial expenditure traced through the chain of intermediate goods and services usage for the relevant industry sectors. No allowance is made in this calculation for the expenditure of primary incomes (e.g. increases in local wage and capital income arising from the change in production). The total impact of an output change is derived from the production and consumption impacts. The consumption impact arises when primary factors − e.g. households in receipt of wage income − spend the incomes that they receive. These combined production and consumption impacts are known as Type II impacts. We call these "total impact" multipliers.

This model has been adjusted to make allowance for wage inflation over the analysis period, as the number of employees per dollar of output produced tends to decline over time as wages increase. The base year of the IO Table is 2012/13, and the employment-to-output ratios in the input-output table were adjusted to allow for actual changes in wage costs between this period and 2021/22.

These adjustments were based on the change in the ABS (2022) Wage Price Index between 2012/13 and 2020/21, and an assumed change in the nominal price of wages for future years based on the annual average rate of change by industry over the 10 years to 2020/21. For most industry sectors this implied an annual growth rate in the order of 2.5 per cent over the remainder of the analysis period.

The South Australian input output tables were then transformed via matrix manipulation to derive input-output multipliers in respect of output, gross state product and employment for each industry sector. Two types of multipliers were produced: "production impact" multipliers and "total impact" multipliers – see Box 2.1.

2.3 Limitations of input output models

There are some important limitations associated with input-output models that should be considered when interpreting the results of the input-output analysis.

Firstly, there are substantial data needs and complexity involved in constructing an input output table. The input output model is ultimately based on data that can only approximate the actual industrial linkages in the South Australian economy. The tables are compiled from a variety of data sources which are themselves subject to various forms of measurement error. In addition, due to the extensive nature of data required, input output tables tend to be compiled from data that is relatively dated.

Secondly, the results of input-output models represent the ***gross*** impacts in the absence of capacity constraints. In reality, except in economic downturns where there is substantial unused labour and capital, anything that boosts one form of economic activity is likely to increase wages and returns to capital to attract the additional resources it needs. This, in turn, leads to reduced economic activity in other sectors or regions. At the national level, the ***net*** impact of any new project on employment is likely to only be a small fraction of the gross impact when the national economy is close to full employment, with the benefits coming through increased wages and increased returns to capital. However, at the regional level (particularly for small regions such as South Australia) net impacts can be quite close to gross impacts as labour and capital can be drawn in from surrounding regions.

The implication of resource constraints is that the raw results obtained from the input output 'impact analysis' will tend to overestimate the potential economic impacts associated with Southern Launches operations. Assessing the degree to which the estimated 'gross' impacts calculated from the input output table do indeed approximate the actual 'net' impacts is challenging in the current economic environment. On one hand the currently historically low unemployment environment would suggest there is increased potential for labour displacement, while supply chain disruption and bottlenecks associated with the COVID-19 pandemic and geopolitical conflict may impede new construction and manufacturing activity from progressing as quickly as expected. Together these factors have contributed to a notable increase in inflationary pressures over the past year, which any new major initiatives will tend to accentuate. On the other hand, unemployment and underemployment remain relatively higher in South Australia compared to national standards, while there is potential to draw in resources from interstate. There is also potential to add to labour resources by reducing the net outward migration of young and skilled people from South Australia, and through the resumption of strong levels of overseas inward migration which have stalled during the COVID-19 pandemic.

Finally, in interpreting the modelling impact on employment it should be noted that employment impacts may in some cases be realised through increases in the hours worked by existing employees rather than the creation of new positions.

3. Results of the Economic Analysis

3.1 Southern Launch activities and operations

The direct future impacts of Southern Launch establishing a multi-user launch facility and associated infrastructure at Whalers Way have been modelled based on data provided by the firm. There are three sources of the expected impacts on the state from their direct operations:

- Capital works to establish the Whalers Way Orbital Launch Complex (WWOLC);
- The on-going operations of the launch facility and South Australian headquarter operations; and
- The increased number of international and interstate visitor days associated with launches and preparatory works (e.g. staff from launch firms visiting SA).

Capital works to establish the WWOLC relate to construction of four components comprising:

- two launch sites (Sites A and B) whereby Site A will cater for larger vehicles ranging from 30 up to approximately 100 tonnes, while Site B will cater for smaller vehicles ranging up to 60 tonnes;
- an infrastructure site that will facilitate construction and the subsequent maintenance of the overall facility; and
- a range control facility that will host operational, security and emergency services and oversee all operations on the site.

To date Southern Launch has incurred minor capital expenses for establishing test launch facilities. As the current analysis is focused on future impacts these expenditures are excluded from the analysis. Major capital works to establish the permanent launch facility will be undertaken over the first five years of the analysis period from 2022/23 to 2026/27. The capital works spending includes a small amount related to operating activities. Southern Launch has advised that these amounts are negligible and consequently no attempt has been made to separate out these capital expenses.

Financial and operational data including direct employment and the expected ramp up in launch activity has been provided by Southern Launch for the first five years of the analysis period. The key data provided by Southern Launch are set out in Table 3.1.

Since the previous economic impact assessment conducted in 2019, Southern Launch has provided a more forward-looking projection of future launch activity which envisions a much more aggressive ramp up in launch activity than was assumed in the earlier report. As a consequence, expected revenues and associated economic impacts over future years are much higher than was previously assumed.

Table 3.1 Forecast SA employment, turnover and capital expenditures by Southern Launch's civilian launch operations

	2022/23	2023/24	2024/25	2025/26	2026/27
Expected capital expenditure ($'million)	6.0	8.0	16.0	3.0	17.0
Projected operating expenditures ($'million)	7.4	7.4	8.3	8.9	9.8
Projected revenues ($'million)	10.1	18.5	26.1	26.6	30.4
Projected number of launches	4	17	24	24	26
Projected employment (FTEs)	34	40	43	45	49

Source: Southern Launch, personal communication, undated

3.2 Whole-economy economic impact of Southern Launch's activities and operations

Only production impacts were included in the main analysis (e.g. the impact of South Australian based suppliers to Southern Launch purchasing goods and services from other South Australian firms, and then those firms' purchasing inputs from local suppliers and so on). Appendix A reports estimates of the consumption impacts associated with the project.

Estimated revenue was provided by Southern Launch for the first five years of the analysis horizon. Beyond 2026/27 it was assumed that turnover would grow at a rate consistent with keeping employment constant at the 2026/27 level. More specifically, turnover is assumed to grow at the average annual rate of wage price inflation for the 'professional, scientific and technical services' sector over the 10 years to 2020/21 as indicated by ABS (2022).

The operations of Southern Launch were allocated to the (modified) sector 'professional, scientific and technical services' due to the skilled labour-intensive nature of the proposed operations.

One-off expenditures related to capital expenditures required to establish the launch facilities have been allocated to the sector 'construction – other'. Capital expenditures are allocated over the period from 2022/23 to 2026/27 inclusive based on data provided by Southern Launch.

The final form of economic impact expected from Southern Launch is additional business visitor nights (and associated spending) in the state associated with the launches. These primarily relate to employees of the launch vehicle manufacturers visiting to undertake preparatory work, and then to undertake the launch. Estimated spending per launch event was estimated based on Southern Launch's estimate of the number of visitor nights associated with each launch and their projected number of launches and assumptions regarding spending on international and domestic travel, accommodation, food and beverages, and local transport. Allocation of the spending between sectors was based on data on the tourism sector included in the input output tables.

The estimated future impact on gross value added has been adjusted to real 2021/22 values based on an assumed deflation factor of 2.5 per cent, which is broadly in line with the average rate of growth in the GDP deflator over the past 5 years to 2020/21 (ABS 2022).

The 'production impacts' of Southern Launch's own operations would be to **support 49 full-time equivalent (FTE) jobs** (see Table 3.2) in 2022/23, rising to a **peak of approximately 60 FTEs jobs in 2026/27**.[2] Generation of employment indirectly through supply chain effects peaks at 15 FTE jobs in the first year of the analysis and falls thereafter as a consequence of Southern Launch reducing its purchases from intermediate suppliers as it shifts from temporary to permanent launch activities. In subsequent years direct employment accounts for around four-fifths of the total employment impact. The average gross impact on employment over the entire ten-year analysis period is 56 FTE positions.

There are also one-off employment impacts over the period 2022/23 to 2026/27 as a result of the construction of the orbital launch complex. The average gross impact on employment over this period is estimated to be 33 FTEs, with a peak employment impact of almost 53 FTEs in 2026/27.

On-going employment impacts from 2021/22 onwards associated with the spending by visitors associated with the launches (i.e. employees of launch firms) are expected to rise from 5.1 FTE jobs in 2022/23 to a peak of 30 FTE jobs in 2026/27. The average gross impact on employment over the analysis period is estimated to be 25 FTEs

Table 3.2 Estimated gross additional employment impact of Southern Launch, full time equivalent (FTE) employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
On-going operations										
Direct employment (FTE)[a]	34.0	40.0	43.0	45.0	49.0	49.0	49.0	49.0	49.0	49.0
Production impacts (FTE)	15.0	8.6	9.6	9.5	10.8	10.5	10.5	10.5	10.5	10.5
Sub-total, on-going operations	49.0	48.6	52.6	54.5	59.8	59.5	59.5	59.5	59.5	59.5
Impact of other expenditures										
Capital spending, direct and indirect impacts (FTE)	21.7	27.0	51.8	9.5	52.7					
Launch vehicle staff spending, direct and indirect impacts	5.1	20.8	28.6	28.0	29.8	28.9	28.3	27.7	27.1	26.5
Total gross impact on employment (FTE)	75.8	96.4	132.9	92.0	142.3	88.4	87.8	87.1	86.5	85.9
Average employment impact over period (FTE)	**97.5**									

Note: [a] Direct employment only includes those employed directly by Southern Launch.

The average gross impact on employment over the ten-year analysis period (including one-off impacts and increased business visitors) is expected to be **98 FTE positions**.

The estimated ***gross*** on-going impact on economic activity of Southern Launch's on-going operations would be to contribute $9.2 million in real Gross State Product **(GSP)** in 2022/23. With the number of launches expected to rapidly increase over subsequent years, the gross impact on GSP from Southern Launch's on-going operations is expected to rise significantly over this period, reaching a peak of approximately $26 million from 2026/27 and onwards. The impact of Southern Launch's operations on GSP are quite large by normal industry standards. Such a large GSP impact is attributed to Southern Launch earning relatively large gross

[2] 'Production impacts' refer to the second order impacts flowing from South Australian based firms which supply Southern Launch purchasing goods and services from other South Australian based firms as inputs into their supply to Southern Launch, and so on down the supply chain.

operating surplus amounts in future years as it benefits from efficiencies associated with establishing permanent facilities, and associated with this, being a South Australian headquartered company, which implies that returns to capital accrue to the state. Moreover, as the estimates are forward looking, they exclude previous losses incurred by Southern Launch in establishing the business.

There are also impacts over the first five years of the analysis period to 2026/27 as a result of the capital expenditures associated with establishing the launch facilities at Whalers Way.

Finally, there will be on-going impacts associated with increased business visitor nights associated with staff of launch vehicle manufacturers both prior to and associated with the launches. The expected annual contribution to GSP is estimated to rise from $0.7 million in 2022/23 to a peak of $3.8 million in 2026/27.

Assessed over the full ten-year analysis period using South Australia Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (including the impact of capital works) has a present value of **$209.0 million** in 2021/22 values.

Table 3.3 Estimated gross direct and production impacts on economic output of Southern Launch ($'million)

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
GSP impact of ongoing operations ($million)	9.2	17.2	23.7	23.6	26.3	26.2	26.2	26.1	26.0	26.0
GSP impact of one-off construction costs ($ million)	4.9	6.4	12.4	2.3	12.5					
GSP impact of launch vehicle staff expenditures ($ million)	0.7	2.7	3.7	3.6	3.8	3.8	3.7	3.6	3.5	3.4
Total gross impact on Gross State Product ($ million)	14.7	26.2	39.9	29.5	42.7	30.0	29.8	29.7	29.5	29.4
Present value of GSP impact over period ($ million)	209.0									

Note: Impact on Gross State Product is expressed in real 2021/22 values.

Bibliography

Australian Bureau of Statistics (ABS) (2022), 'Wage Price Index, Australia', Cat No. 6345.0.

_____ (2022a), '5206.0 Australian National Accounts: National Income, Expenditure and Product, Table 4. Expenditure on Gross Domestic Product (GDP), Chain price indices.

SouthernLaunch.Space Pty Ltd (Southern Launch) (2021), 'EIS, Whalers Way Orbital launch Complex, Environmental Impact Statement'.

Appendix A

Potential Impacts if Consumption Impacts are Included

It is possible to extend the input output analysis to include what is known as 'consumption' impacts. As well as the direct and production impacts discussed above, consumption impacts also include the impact on South Australia from local spending of any additional labour and capital income received by South Australians as a result of the project.

These consumption impacts need to be interpreted with a degree of caution as it is even more difficult to identify the extent to which they are truly additional to what would have happened had the project not gone ahead. This is because it is *not only* necessary to assess the extent to which any economic activity resulting directly or indirectly from the project is truly additional[3] (as is the case with direct and production impacts) but also to assess the extent to which any increase in spending is going to be additional. This is more difficult, as even if all of the additional labour and capital income was truly additional it will not translate fully into increase spending. This is because households may have access to income replacement benefits when unemployed or underemployed, and can use other resources to smooth income such as depleting savings and increasing debt. This means that spending does not decrease by quite as much as labour incomes falls during unemployment or underemployment, and does not increase by the full amount when labour incomes increase. As such the share of household incomes spent in SA will be less than 100 per cent.

There are several other factors which lower the share of incomes spent locally:

- Many owners of capital will be resident outside of South Australia. For larger, ASX listed firms only about 5 per cent of the capital is held by South Australians. For small businesses the majority of the capital is locally owned.
- Not all household consumption spending is on local goods and services.
- Some household income will be lost to the state through income taxes and to savings.
- Some labour hired for projects will be from residents of other states.

It is not possible to precisely identify the appropriate share of factor incomes to treat as South Australian household incomes. Typically we would assume that the proportion of factor income attributable to South Australian residents was 0.5. This is broadly consistent with 40 per cent of capital income and 95 per cent of labour income accruing to South Australian households; 20 per cent of that South Australian wage and business income being lost to Commonwealth income taxes; 10 per cent of post-tax income saved, and 5 per cent of consumption spending spent outside of the state.

As noted in the main report, the 'production impacts' of Southern Launch's own operations would be to **peak at approximately 59.8 FTEs jobs in 2026/27**.[4] Including consumption impacts increases the estimated impact of the on-going operations in this peak year by a further 63.8 FTE positions.

Table A.1 Estimated gross additional employment impact of Southern Launch's civilian launch operations, direct, production and consumption impacts, FTE employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts										
On-going operations	49.0	48.6	52.6	54.5	59.8	59.5	59.5	59.5	59.5	59.5
One-off construction	21.7	27.0	51.8	9.5	52.7	0.0	0.0	0.0	0.0	0.0
Launch vehicle staff expenditure	5.1	20.8	28.6	28.0	29.8	28.9	28.3	27.7	27.1	26.5
Consumption impacts										
On-going operations	22.6	41.1	56.3	56.1	63.8	62.5	62.4	62.3	62.2	62.0
One-off construction	11.9	15.0	29.0	5.3	29.4	0.0	0.0	0.0	0.0	0.0
Launch vehicle staff expenditure	1.5	6.2	8.5	8.3	8.9	8.5	8.3	8.1	8.0	7.8
Total gross impact on employment (FTE) incl. consumption impacts	111.8	158.8	226.7	161.7	244.4	159.5	158.5	157.6	156.6	155.8
Average employment impact over period (FTE) incl. consumption impacts	169.1									

[3] E.g. That it would not have occurred as a result of some other activity if the project had not gone ahead.
[4] 'Production impacts' refer to the second order impacts flowing from South Australian based firms which supply Southern Launch purchasing goods and services from other South Australian based firms as inputs into their supply to Southern Launch, and so on down the supply chain.

There are also impacts over the period 2022/23 to 2026/27 as a result of the construction of the orbital launch complex. The average gross impact on employment over this period due to production effects is estimated to be 32.6 FTEs, with the impact increasing by an additional 18.1 FTEs if consumption impacts are considered.

The expenditures arising from the additional business visitor nights by staff of launch vehicle manufacturers is expected to have an average annual production impact of 25.1 FTE jobs over the 10-year analysis period, with consumption impacts potentially increasing the average annual impact by a further 7.4 FTEs.

The average gross impact on employment from direct, production and consumption impacts (including from one-off costs) over the ten-year analysis period is estimated to be **169 FTE positions**.

The estimated ***gross*** on-going impact on economic activity of Southern Launch's on-going operations would be to contribute $9.2 million in **GSP** in 2022/23, the first year of the analysis (see Table A.2). If consumption impacts are included then the estimated impact of Southern Launch would be **$4.5 million** higher in 2022/23. Looking at the peak contribution made by Southern Launch in 2026/27, the direct and production impacts are expected to be $26.3 million, with consumption impacts potentially contributing a further $13 million.

There are also impacts over the first five years of the analysis period to 2026/27 as a result of the capital expenditures associated with establishing the launch facilities at Whalers Way. The estimated gross production impact in terms of contribution to GSP is expected to reach a peak of $12.5 million in 2026/27, with the impact increasing by an additional $6.0 million if consumption impacts are considered.

Finally, there will be on-going impacts associated with increased business visitor nights associated with staff of launch vehicle manufacturers both prior to and associated with the launches. The expected annual contribution to GSP due to additional business visitor expenditures by staff of launch vehicle manufacturers is expected to rise from $0.7 million in 2022/23 to a peak of $3.8 million in 2026/27. With consumption impacts these contributions would increase by a further $0.3 million and $1.8 million respectively.

Assessed over the full ten-year analysis period using South Australia Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP when consumption impacts are included has a present value of **$312 million** in 2021/22 values.

Table A.2 Estimated impacts on economic output of Southern Launch's civilian launch operations, direct, production and consumption impacts, $million

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts										
GSP impact of ongoing operations ($million)	9.2	17.2	23.7	23.6	26.3	26.2	26.2	26.1	26.0	26.0
GSP impact of construction costs ($million)	4.9	6.4	12.4	2.3	12.5	0.0	0.0	0.0	0.0	0.0
GSP impact of business visitor expenditure ($million)	0.7	2.7	3.7	3.6	3.8	3.8	3.7	3.6	3.5	3.4
Consumption impacts										
GSP impact of ongoing operations ($million)	4.5	8.6	11.9	11.8	13.0	13.2	13.1	13.1	13.1	13.0
GSP impact of construction costs ($million)	2.4	3.1	6.0	1.1	6.0	0.0	0.0	0.0	0.0	0.0
GSP impact of business visitor expenditure ($million)	0.3	1.3	1.7	1.7	1.8	1.8	1.7	1.7	1.6	1.6
Total gross impact on Gross State Product ($million) incl. consumption impacts	**21.9**	**39.2**	**59.5**	**44.1**	**63.5**	**44.9**	**44.7**	**44.4**	**44.2**	**44.0**
Present value of GSP impact over period ($million) incl. consumption impacts	312.2									

Note: Impact on Gross State Product is expressed in real 2021/22 values.

Appendix B

Potential Impacts of Continued Presence and Growth of a Launch Vehicle Manufacturer in South Australia

B.1 The potential scenario

As a consequence of various strategic space investments being made in South Australia, including the prospect of a permanent rocket launch facility being established at Whalers Way and the Australian Space Agency being headquartered in Adelaide, four companies have entered into a partnership to establish the Australian Space Park space manufacturing hub with state and commonwealth government funding support. The four companies include Fleet Space Technologies, ATSpace, Q-CTRL and Alauda Aeronautics. Of these, space launch vehicle manufacturer ATSpace Pty Ltd has established new office headquarters at Wingfield, which includes facilities for manufacturing, assembly, and R&D.

The provision of a permanent launch facility helps to attract and maintain space manufacturing in South Australia since it helps to reduce the potential impact of delays in launch vehicles reaching the launch facility or damage the vehicles in transit, and enables any last-minute adjustments or alterations to the vehicles. This Appendix explores the potential impact of the continued growth of an existing launch vehicle manufacturer in South Australia. Appendix C outlines the potential impact were another separate launch vehicle manufacturer to establish final assembly in South Australia, while Appendix D considers the scenario of a satellite manufacturer establishing in South Australia.

We do not have any information on the turnover or employment for the existing launch vehicle manufacturer in South Australia. However, Southern Launch has advised that the existing manufacturer would currently directly employ around 100 FTE South Australian based staff, and is eventually expected to grow over the next several years to eventually employ 400 FTE staff. On this basis it is assumed that direct FTE employment for the launch vehicle manufacturer grows by 100 FTE positions per year, from a total of 100 FTEs in 2022/23 to 400 FTEs by 2025/26. In the absence of any turnover estimates, for the purposes of the analysis turnover has been imputed by assuming that the ratio of employment to turnover would match the sectoral average for 'other transport equipment manufacturing'.

B.2 Estimated economic impact of launch vehicle assembly

The economic impact of continued growth in the operations of a launch vehicle manufacturer undertaking their final assembly and testing in South Australia was modelled using a 60-sector input-output table for South Australia developed by SACES from a range of sources including data on interregional trade and production by industry derived from the TERM-Australia multiregional economic model of Australia. The table was modified to adjust for actual and projected changes in the compensation of employees by sector. See Chapter 3 for a discussion of the adjustments made to the model and limitations of that analytical approach.

Only production impacts were included in the main analysis (e.g. the impact of South Australian based suppliers to the launch vehicle manufacturer purchasing goods and services from other South Australian firms, and then those firms' purchasing inputs from local suppliers and so on). Section B.3 reports estimates of the consumption impacts associated with the potential investment.

The estimated ***gross*** production impact of a launch vehicle manufacturer maintaining assembly and testing in South Australia would be to support approximately **143 FTE position**s in 2022/23, the first year of the analysis period (see Table B.1). By 2025/26, when manufacturing operations and direct employment reach their maximum, the impact would be 570 FTEs. The estimated direct employment by the satellite manufacturer would account for the majority of the impacts at 400 FTEs by this peak stage, with the remaining employment arising from production effects.

Table B.1 Estimated gross employment impact of continued presence of a launch vehicle manufacturer in South Australia, full time equivalent (FTE) employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
On-going operations										
Direct employment (FTE)	100.0	200.0	300.0	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Indirect effect (FTE)	42.5	85.0	127.6	170.3	174.2	170.6	170.7	170.8	171.0	171.1
Total	142.5	285.0	427.6	570.3	574.2	570.6	570.7	570.8	571.0	571.1
Average employment impact over period (FTE)	485.4									

Table B.2 Estimated gross direct and production impacts on economic output of continued presence of a launch vehicle manufacturer in South Australia ($'million)

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
GSP impact of ongoing operations ($million)	19.8	39.6	59.4	79.2	78.9	79.2	79.1	79.1	79.1	79.0
Present value of GSP impact over period ($million)	449.6									

Note: Impact on Gross State Product is expressed in real 2018/19 values.
np = data not provided by proponent.

The average gross impact on employment for the ongoing vehicle manufacturer over the ten-year analysis period is expected to be **485 FTE positions**.

The estimated ***gross*** on-going impact on economic activity of the launch vehicle manufacturer maintaining final assembly and testing operations in South Australia would be to contribute **$20 million** in real GSP in 2022/23 (see Table B.2). By 2025/26, when full manufacturing operations are achieved, the impact on GSP would reach **$79 million**.

Assessed over the full ten-year analysis period using SA Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (assuming no change in the scale of the R&D operation) has a present value of **$450 million** in 2021/22 values.

As the estimated economic impacts for the continued presence of a launch vehicle manufacturer partly relates to existing manufacturing activity, the total net impacts do not represent a complete net addition to existing economic activity. The impacts partly reflect the existing economic footprint of the manufacturer (effectively the 100 FTEs and $20 million in GSP contributed in 2022/23), which in turn represents the economic activity that would be at risk of being lost in the event that the manufacturer decided to cease operations in South Australia, for example due to a local permanent launch facility not being established.

B.3 Estimated consumption Impacts of launch vehicle assembly

It is possible to extend the input output analysis to include what is known as 'consumption' impact. As well as the direct and production impacts discussed above, consumption impacts also include the impact on South Australia from local spending of any additional labour and capital income received by South Australians as a result of the project.

Table B.3 Estimated gross additional employment impact of continued presence of a launch vehicle manufacturer in South Australia, direct, production and consumption impacts, FTE employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts	142.5	285.0	427.6	570.3	574.2	570.6	570.7	570.8	571.0	571.1
Consumption impacts	44.3	88.7	133.1	177.6	180.4	177.7	177.8	177.9	178.0	178.0
Total gross impact	186.8	373.7	560.7	747.9	754.5	748.3	748.5	748.7	748.9	749.2
Average employment impact over period (FTE) incl. consumption impacts	**636.7**									

As noted in Appendix A these consumption impacts need to be interpreted with a degree of caution as it is even more difficult to identify the extent to which they are truly additional to what would have happened had the project not gone ahead. This is because it is *not only* necessary to assess the extent to which any economic activity resulting directly or indirectly from the project is truly additional[5] (as is the case with direct and production impacts) but also to assess the extent to which any increase in spending is going to be additional.

The assumptions underpinning the calculation of the consumption impact of the economic impact associated with the ongoing operations of a launch vehicle manufacturer in South Australia are the same as those set out in Appendix A.

The estimated ***gross*** production impact for the continued growth of the existing launch vehicle manufacturer in South Australia would be to support approximately 143 FTE positions in 2022/23, the first year of the analysis period, and to then increase over subsequent years to 570 FTEs by 2025/26, when full manufacturing operations are reached (see Table B.3). Including consumption impacts increases the estimated impact of the on-going operations by a further 44 FTE positions in 2022/23, rising to 178 FTE jobs by 2025/26.

[5] E.g. That it would not have occurred as a result of some other activity if the project had not gone ahead.

Table B.4 Estimated impacts on Gross State Product of continued presence of a launch vehicle manufacturer in South Australia, direct, production and consumption impacts, $million

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts	19.8	39.6	59.4	79.2	78.9	79.2	79.1	79.1	79.1	79.0
Consumption impacts	8.2	16.4	24.7	32.9	32.4	32.8	32.8	32.8	32.8	32.8
Total gross impact	**28.1**	**56.1**	**84.1**	**112.1**	**111.2**	**112.0**	**112.0**	**111.9**	**111.9**	**111.8**
Present value of GSP impact over period ($million) incl. consumption impacts	**635.9**									

Note: Impact on Gross State Product is expressed in real 2021/22 values.

The average gross impact on employment from direct, production and consumption impacts (including from one-off costs) over the ten-year analysis period is estimated to be **637 FTE** positions.

The estimated ***gross*** on-going impact on economic activity of a launch vehicle manufacturer maintaining and growing their manufacturing and testing operations in South Australia would be to contribute $20 million in GSP in 2022/23, the first year of the analysis period, and to then increase over subsequent years to $79 million by 2025/26, when full manufacturing operations are reached (see Table B.4). If consumption impacts are included then the estimated impact would be $8.2 million higher in 2022/23, increasing to $33 million by 2025/26.

Assessed over the full ten-year analysis period using South Australia Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP when consumption impacts are included has a present value of **$636 million** in 2021/22 values.

Appendix C

Potential Impacts of a Separate Launch Vehicle Manufacturer Undertaking Final Assembly in South Australia

C.1 The potential investment scenario

The second potential spin-off benefit of a rocket launch facility being established in South Australia is that another separate launch vehicle manufacturer may establish operations in South Australia to undertake final assembly. The rationale would be to reduce the potential impact of delays in launch vehicles reaching the launch site and to reduce the risk of damage to vehicles in transit, and to enable any last-minute adjustments or alterations to the vehicles.

This Appendix explores the potential impact of such a separate assembly operation being established in South Australia.

Southern Launch have indicated that if a separate manufacturer were to establish final assembly in South Australia it is most likely that its operations in terms of direct employment would resemble the scale of operations for the existing vehicle manufacturer assessed in Appendix B (i.e. 100 FTE South Australian based staff), with the main difference being that operations would not commence until 2024/25.

No potential data on local turnover is available and so for the purposes of the analysis turnover was imputed by assuming that the ratio of employment to turnover would match the sectoral average for the 'other transport equipment manufacturing' sector.

The uncertainties around the potential capital costs of establishing the assembly facility are considerable and they have not been included in the analysis.

C.2 Estimated economic impact of launch vehicle manufacturing

The economic impact of a separate launch vehicle manufacturer undertaking their final assembly and testing in South Australia was modelled using a 60-sector input-output table for South Australia developed by SACES from a range of sources including data on interregional trade and production by industry derived from the TERM-Australia multiregional economic model of Australia. The table was modified to adjust for actual and projected changes in the compensation of employees by sector. See Chapter 3 for a discussion of the adjustments made to the model and limitations of that analytical approach.

Only production impacts were included in the main analysis (e.g. the impact of South Australian based suppliers to the launch vehicle manufacturer purchasing goods and services from other South Australian firms, and then those firms' purchasing inputs from local suppliers and so on). Section C.3 reports estimates of the consumption impacts associated with the potential investment.

There are insufficient details available on the construction and fit-out activity that would be required and so that has not been included in the analysis.

The estimated ***gross*** production impact of a separate launch vehicle manufacturer undertaking final assembly in South Australia would be to support approximately **143 FTE position**s from 2024/25 onwards (see Table C.1). The estimated direct employment by the launch vehicle manufacturer would account for the majority of the impacts at 100 FTEs, with the remaining employment arising from production effects.

Table C.1 Estimated gross employment impact of a separate launch vehicle manufacturer undertaking final assembly in South Australia, full time equivalent (FTE) employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
On-going operations										
Direct employment (FTE)	0.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Indirect effect (FTE)	0.0	0.0	42.5	42.6	43.5	42.6	42.7	42.7	42.7	42.8
Sub-total, on-going operations	0.0	0.0	142.5	142.6	143.5	142.6	142.7	142.7	142.7	142.8
Capital expenditures										
Direct and indirect effects (FTE)	np	np	np							
Total gross impact on employment (FTE)	0.0	0.0	142.5	142.6	143.5	142.6	142.7	142.7	142.7	142.8
Average employment impact over period (FTE)	114.2									

Note: np = estimates not published due to data constraints.

Table C.2 Estimated gross direct and production impacts on economic output of a separate launch vehicle manufacturer undertaking final assembly in South Australia ($'million)

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
GSP impact of ongoing operations ($million)	0.0	0.0	19.8	19.8	19.7	19.8	19.8	19.8	19.8	19.8
GSP impact of one-off set up costs ($million)	np	np	np							
Total gross impact on Gross State Product ($million)	0.0	0.0	19.8	19.8	19.7	19.8	19.8	19.8	19.8	19.8
Present value of GSP impact over period ($million)	103.2									

Note: Impact on Gross State Product is expressed in real 2021/22 values.
np = estimates not published due to data constraints.

The average gross impact on employment for the ongoing vehicle manufacturer over the ten-year analysis period is expected to be **114.2 FTE positions**. This likely somewhat understates the potential impact of final assembly of a launch vehicle as its activities are only captured in 8 out of the 10 years of the Southern Launch analysis period.

The estimated ***gross*** impact on economic activity of a separate launch vehicle manufacturer undertaking final assembly and testing operations in South Australia would be to contribute **$20 million** in real GSP from 2024/25 onwards.

Assessed over the full ten-year analysis period using SA Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (assuming no change in the scale of the R&D operation) has a present value of **$103.2 million** in 2021/22 values.

Potential net impacts

An important question to consider is the extent to which these gross impacts would translate into net benefits for the state. This depends upon the extent to which there is currently unemployed (or under employed) labour and capital that the project could draw on (or which could be recruited by any incumbent firms who lose employees to the new entrant), or where suitable workers could be convinced to move to the state from interstate or overseas. This is because the increase in employment demand from the new activity being modelled is likely to, all other things being equal, increase wages, which in turn will lead to some current activities no longer being competitive, displacing some existing employment. The same process can occur for those capital inputs that need to be sourced domestically such as land and structures. At the regional level net impacts can be much closer to gross impacts if labour and capital can be drawn in from other regions, or if there are sufficient unemployed persons in the region with relevant skills.

Although there is a degree of uncertainty around the exact composition of launch vehicle manufacturing assembly workforce, it is likely to be a mix of advance manufacturing and engineering employees.

The final closure of GM-Holden's assembly line in late 2017, with its associated impacts on the supply chain, is likely to have resulted in a large number of individuals with relevant skills and experience in advanced manufacturing being underemployed, or employed in another sector that does not fully make use of their skills. This suggests that any advanced manufacturing employment generated in a launch vehicle manufacturer is unlikely to generate wage pressures that will offset the direct employment impacts.

The potential engineering and technical employees of a launch vehicle manufacturer will be predominantly highly skilled and mobile, and very specialised, with strong employment prospects. This means that they are very unlikely to be unemployed and so the launch vehicle manufacturer would only be able to fill their positions from those already employed, or to a lesser extent from those entering (or re-entering) the workforce. To the extent that these individuals are attracted from other South Australian employers then the gross impacts of the launch vehicle manufacturer will be wholly or partially offset by increases in wages in the sectors, and associated decreases in employment elsewhere. If the employees are attracted from interstate or overseas, or if the opportunities with the launch vehicle manufacturer encourage South Australians to remain in the state rather than move interstate or overseas, or if the opportunities encourage South Australian's to re-enter the labour force, then there would not be an offsetting reduction elsewhere in the South Australian labour market. And as the range and depth of a local labour market for a specialisation can drive the location decisions of skilled employees, the opportunities available through the launch vehicle manufacturer could have an indirect impact on increasing supply for skilled employees for the defence and aerospace sectors more broadly.

These countervailing forces mean that it is difficult to identify *a-priori* whether the net impacts on engineering employment are likely to be well below the gross impacts (if poaching from other South Australian firms predominates) or whether net impacts are likely to be close to the gross impacts (if increasing labour supply predominates). However our understanding of the labour pool from which a potential launch vehicle manufacturer is likely to draw is likely to be primarily located interstate or overseas, or have a high likelihood of relocating interstate or overseas in the absence of suitable opportunities in the space or aerospace sectors.

Looking more broadly at the indirect jobs induced from a launch vehicle manufacturer's likely purchases of goods and services from local firms, our judgment is that, given the generally healthy state of the South Australia labour market and recent supply chain constraints, the net impacts would be lower than the gross impacts over the next 2 to 4 years. Over the medium to long term, as existing supply constraints are expected to alleviate and resources are increasingly able to be drawn in from interstate and overseas, net impacts would be expected to improve relative to gross impacts. However, we do not foresee any changes in overall economic conditions that would lead to the net impact of the proposal falling close to zero.

C.3 Estimated consumption impacts of launch vehicle manufacturing

It is possible to extend the input output analysis to include what is known as 'consumption' impact. As well as the direct and production impacts discussed above, consumption impacts also include the impact on South Australia from local spending of any additional labour and capital income received by South Australians as a result of the project.

As noted in Appendix A these consumption impacts need to be interpreted with a degree of caution as it is even more difficult to identify the extent to which they are truly additional to what would have happened had the project not gone ahead. This is because it is *not only* necessary to assess the extent to which any economic activity resulting directly or indirectly from the project is truly additional[6] (as is the case with direct and production impacts) but also to assess the extent to which any increase in spending is going to be additional.

The assumptions underpinning the calculation of the consumption impact of the potential locating of a launch vehicle manufacturers final testing and assembly facility in South Australia are the same as those set out in Appendix A.

The estimated ***gross*** production impact of a separate launch vehicle manufacturer undertaking final assembly and testing in South Australia would be to support approximately **143 FTE position**s from 2024/25 onwards (see Table C.3). Including consumption impacts increases the estimated impact of the on-going operations by a further 44 FTE positions.

Table C.3 Estimated gross additional employment impact of a separate launch vehicle manufacturer undertaking final assembly in South Australia, direct, production and consumption impacts, FTE employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts										
On-going operations	0.0	0.0	142.5	142.6	143.5	142.6	142.7	142.7	142.7	142.8
One-off construction	0.0	0.0								
Consumption impacts										
On-going operations	0.0	0.0	44.4	44.4	45.1	44.4	44.5	44.5	44.5	44.5
One-off construction	0.0	0.0								
Total gross impact on employment (FTE) incl. consumption impacts	0.0	0.0	186.9	187.0	188.6	187.1	187.1	187.2	187.2	187.3
Average employment impact over period (FTE) incl. consumption impacts	149.8									

The average gross impact on employment from direct, production and consumption impacts (including from one-off costs) over the ten-year analysis period is estimated to be **149.8 FTE positions**.

The estimated ***gross*** on-going production impact on economic activity of a separate launch vehicle manufacturer establishing manufacturing and testing operations in South Australia would be to contribute **$20 million** in real GSP from 2024/25 onwards (see Table C.4). If consumption impacts are included, then the estimated impact of would be approximately **$8 million** higher from 2024/25 onwards.

[6] E.g. That it would not have occurred as a result of some other activity if the project had not gone ahead.

Table C.4 Estimated impacts on economic output of a separate launch vehicle manufacturer undertaking final assembly in South Australia, $million

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts										
GSP impact of ongoing operations ($million)	0.0	0.0	19.8	19.8	19.7	19.8	19.8	19.8	19.8	19.8
GSP impact of construction costs ($million)	np	np	np	np	np	np	np	np	np	np
Consumption impacts										
GSP impact of ongoing operations ($million)	0.0	0.0	8.2	8.2	8.1	8.2	8.2	8.2	8.2	8.2
GSP impact of construction costs ($million)	np	np	np	np	np	np	np	np	np	np
Total gross impact on Gross State Product ($million) incl. consumption impacts	0.0	0.0	28.0	28.0	27.8	28.0	28.0	28.0	28.0	28.0
Present value of GSP impact over period ($million) incl. consumption impacts	145.9									

Note: Impact on Gross State Product is expressed in real 2021/22 values.
np = estimates not published due to data constraints.

Assessed over the full ten-year analysis period using South Australia Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP when consumption impacts are included has a present value of $145.9 million in 2021/22 values.

Appendix D

Potential Impacts of a Satellite Manufacturer Undertaking Manufacturing in South Australia

D.1 The potential investment scenario

As part of the 2022-23 Budget the Australian Government announced the National Space Mission for Earth Observation which will see Australia design, build and operate four new satellites for earth observation. Funding of $1.2 billion from 2021-22 and $38.5 million per annum was committed to undertake the first phase of the new space program. With this initiative a third potential spin-off benefit of a rocket launch facility being established in South Australia is that a satellite manufacturer may establish operations in South Australia to undertake manufacturing and testing. The rationale would be to reduce the potential impact of delays in launch vehicles reaching the launch site and to reduce the risk of damage to vehicles in transit, and to enable any last-minute adjustments or alterations to the vehicles.

This Appendix explores the potential impact of such a satellite manufacturer being established in South Australia.

Given the novelty of this scenario, we do not have any information on the initial ramp and eventual scale of a satellite manufacturer establishing in South Australia in terms of the turnover or employment they would directly generate. For analysis purposes Southern Launch has advised that a reasonable scenario for a satellite manufacturer establishing a manufacturing capability in South Australia it that its operations in terms of direct employment would ramp up over four years from 25 FTE South Australian based staff in 2022/23 to a maximum of 200 FTE staff by 2025/26 (see direct employment in Table D.1).

No potential data on local turnover is available and so for the purposes of the analysis turnover was imputed by assuming that the ratio of employment to turnover would match the sectoral average for the 'other machinery and equipment manufacturing' sector, which includes professional and scientific equipment manufacturing such as global positioning system equipment, radar and sonar systems.

The uncertainties around the potential capital costs of establishing the satellite manufacturing facility are considerable and they have not been included in the analysis.

D.2 Estimated economic impact of satellite manufacturing

The economic impact of a satellite manufacturer establishing manufacturing operations in South Australia was modelled using a 60-sector input-output table for South Australia developed by SACES from a range of sources including data on interregional trade and production by industry derived from the TERM-Australia multiregional economic model of Australia. The table was modified to adjust for actual and projected changes in the compensation of employees by sector. See Chapter 3 for a discussion of the adjustments made to the model and limitations of that analytical approach.

Only production impacts were included in the main analysis (e.g. the impact of South Australian based suppliers to the launch vehicle manufacturer purchasing goods and services from other South Australian firms, and then those firms' purchasing inputs from local suppliers and so on). Section D.3 reports estimates of the consumption impacts associated with the potential investment.

There are insufficient details available on the construction and fit-out activity that would be required and so that has not been included in the analysis.

The estimated ***gross*** production impact of a satellite manufacturer undertaking manufacturing in South Australia would be to generate employment of **41 FTE position**s in 2022/23, the first year in which manufacturing operations are assumed to occur (see Table D.1). By 2025/26 when full manufacturing operations are achieved the impact would reach 325 FTEs. The estimated direct employment by the satellite manufacturer would account for the majority of the impacts at 200 FTEs by this peak stage, with the remaining employment arising from production effects.

Table D.1 Estimated gross employment impact of a satellite manufacturer in South Australia, full time equivalent (FTE) employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
On-going operations										
Direct employment (FTE)	25.0	50.0	100.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Indirect effect (FTE)	15.6	31.2	62.5	125.1	128.4	125.3	125.5	125.6	125.7	125.8
Sub-total, on-going operations	40.6	81.2	162.5	325.1	328.4	325.3	325.5	325.6	325.7	325.8
Capital expenditures										
Direct and indirect effects (FTE)	np	np	np							
Total gross impact on employment (FTE)	40.6	81.2	162.5	325.1	328.4	325.3	325.5	325.6	325.7	325.8
Average employment impact over period (FTE)	256.6									

Note: np = estimates not published due to data constraints.

Table D.2 Estimated gross direct and production impacts on economic output of a satellite manufacturer in South Australia ($'million)

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
GSP impact of ongoing operations ($million)	10.5	20.9	41.8	83.6	83.3	83.6	83.5	83.5	83.5	83.4
GSP impact of one-off set up costs ($million)	np	np	np							
Total gross impact on Gross State Product ($million)	10.5	20.9	41.8	83.6	83.3	83.6	83.5	83.5	83.5	83.4
Present value of GSP impact over period ($million)	429.6									

Note: Impact on Gross State Product is expressed in real 2021/22 values.
np = estimates not published due to data constraints.

The average gross impact on employment for the satellite manufacturer over the ten-year analysis period is expected to be **257 FTE positions**.

The estimated ***gross*** impact on economic activity of a satellite manufacturer establishing operations in South Australia would be to contribute **$10.5 million** in real GSP in 2022/23, the first year in which manufacturing operations are assumed to occur (see Table D.2). By 2025/26 when full manufacturing operations are achieved the impact on GSP would reach almost $84 million.

Assessed over the full ten-year analysis period using SA Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP (assuming no change in the scale of the R&D operation) has a present value of **$429.6 million** in 2021/22 values.

Potential net impacts

An important question to consider is the extent to which these gross impacts would translate into net benefits for the state. This depends upon the extent to which there is currently unemployed (or under employed) labour and capital that the project could draw on (or which could be recruited by any incumbent firms who lose employees to the new entrant), or where suitable workers could be convinced to move to the state from interstate or overseas. This is because the increase in employment demand from the new activity being modelled is likely to, all other things being equal, increase wages, which in turn will lead to some current activities no longer being competitive, displacing some existing employment. The same process can occur for those capital inputs that need to be sourced domestically such as land and structures. At the regional level net impacts can be much closer to gross impacts if labour and capital can be drawn in from other regions, or if there are sufficient unemployed persons in the region with relevant skills.

Although there is a degree of uncertainty around the exact composition of a satellite manufacturing workforce, it is likely to be a mix of advance manufacturing and engineering employees.

The final closure of GM-Holden's assembly line in late 2017, with its associated impacts on the supply chain, is likely to have resulted in a large number of individuals with relevant skills and experience in advanced manufacturing being underemployed, or employed in another sector that does not fully make use of their skills. This suggests that any advanced manufacturing employment generated in a launch vehicle manufacturer is unlikely to generate wage pressures that will offset the direct employment impacts.

The potential engineering and technical employees of a satellite manufacturer will be predominantly highly skilled and mobile, and very specialised, with strong employment prospects. This means that they are very unlikely to be unemployed and so the launch vehicle manufacturer would only be able to fill their positions from those already employed, or to a lesser extent from those entering (or re-entering) the workforce. To the extent that these individuals are attracted from other South Australian employers then the gross impacts of the launch satellite manufacturer will be wholly or partially offset by increases in wages in the sectors, and associated decreases in employment elsewhere. If the employees are attracted from interstate or overseas, or if the opportunities with the satellite manufacturer encourage South Australians to remain in the state rather than move interstate or overseas, or if the opportunities encourage South Australian's to re-enter the labour force, then there would not be an offsetting reduction elsewhere in the South Australian labour market. And as the range and depth of a local labour market for a specialisation can drive the location decisions of skilled employees, the opportunities available through the satellite manufacturer could have an indirect impact on increasing supply for skilled employees for the defence and aerospace sectors more broadly.

These countervailing forces mean that it is difficult to identify *a-priori* whether the net impacts on engineering employment are likely to be well below the gross impacts (if poaching from other South Australian firms predominates) or whether net impacts are likely to be close to the gross impacts (if increasing labour supply predominates). However our understanding of the labour pool from which a potential satellite manufacturer is likely to draw is likely to be primarily located interstate or overseas, or have a high likelihood of relocating interstate or overseas in the absence of suitable opportunities in the space or aerospace sectors.

Looking more broadly at the indirect jobs induced from a satellite manufacturer's likely purchases of goods and services from local firms, our judgment is that, given the generally healthy state of the South Australia labour market and recent supply chain constraints, the net impacts would be lower than the gross impacts over the next 2 to 4 years. Over the medium to long term, as existing supply constraints are expected to alleviate and resources are increasingly able to be drawn in from interstate and overseas, net impacts would be expected to improve relative to gross impacts. However we do not foresee any changes in overall economic conditions that would lead to the net impact of the proposal falling close to zero.

D.3 Estimated consumption impacts of satellite manufacturing

It is possible to extend the input output analysis to include what is known as 'consumption' impact. As well as the direct and production impacts discussed above, consumption impacts also include the impact on South Australia from local spending of any additional labour and capital income received by South Australians as a result of the project.

As noted in Appendix A these consumption impacts need to be interpreted with a degree of caution as it is even more difficult to identify the extent to which they are truly additional to what would have happened had the project not gone ahead. This is because it is *not only* necessary to assess the extent to which any economic activity resulting directly or indirectly from the project is truly additional[7] (as is the case with direct and production impacts) but also to assess the extent to which any increase in spending is going to be additional.

The assumptions underpinning the calculation of the consumption impact of the potential locating of a satellite manufacturer in South Australia are the same as those set out in Appendix A.

The estimated ***gross*** production impact of a satellite manufacturer establishing operations in South Australia would be to support approximately **41 FTE position**s in 2022/23, the first year of production activity, and to then increase over subsequent years to 325 FTEs by 2025/26, when full manufacturing operations are reached (see Table D.3). Including consumption impacts increases the estimated impact of the on-going operations by a further 23 FTE positions in 2022/23, rising to 181 FTE jobs by 2025/26.

[7] E.g. That it would not have occurred as a result of some other activity if the project had not gone ahead.

Table D.3 Estimated gross additional employment impact of a satellite manufacturer in South Australia, direct, production and consumption impacts, FTE employees

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts										
On-going operations	40.6	81.2	162.5	325.1	328.4	325.3	325.5	325.6	325.7	325.8
One-off construction	np	np	np							
Consumption impacts										
On-going operations	22.6	45.2	90.4	180.8	183.9	181.0	181.1	181.2	181.2	181.3
One-off construction	np	np	np							
Total gross impact on employment (FTE) incl. consumption impacts	63.2	126.4	252.9	505.9	512.3	506.3	506.5	506.7	506.9	507.1
Average employment impact over period (FTE) incl. consumption impacts	399.4									

Note: np = estimates not published due to data constraints.

The average gross impact on employment from direct, production and consumption impacts (including from one-off costs) over the ten-year analysis period is estimated to be **399.4 FTE positions**.

The estimated ***gross*** on-going production impact on economic activity of a satellite manufacturer establishing operations in South Australia would be to contribute $10.5 million in GSP in 2022/23, the first year of production activity, and to then increase over subsequent years to $83.6 million by 2025/26, when full manufacturing operations are reached (see Table D.4). If consumption impacts are included then the estimated impact would be $4.3 million higher in 2022/23, increasing to $34.8 million by 2025/26.

Assessed over the full ten-year analysis period using South Australia Treasury's recommended real post-tax discount rate of 7 per cent, the gross impact on GSP when consumption impacts are included has a present value of $607.8 million in 2021/22 values.

Table D.4 Estimated impacts on economic output of a satellite manufacturer in South Australia, $million

	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32
Direct and production impacts										
GSP impact of ongoing operations ($million)	10.5	20.9	41.8	83.6	83.3	83.6	83.5	83.5	83.5	83.4
GSP impact of construction costs ($million)	np	np	np	np	np	np	np	np	np	np
Consumption impacts										
GSP impact of ongoing operations ($million)	4.3	8.7	17.4	34.8	34.2	34.7	34.7	34.7	34.7	34.7
GSP impact of construction costs ($million)	np	np	np	np	np	np	np	np	np	np
Total gross impact on Gross State Product ($million) incl. consumption impacts	14.8	29.6	59.2	118.4	117.6	118.3	118.3	118.2	118.2	118.1
Present value of GSP impact over period ($million) incl. consumption impacts	607.8									

Note: Impact on Gross State Product is expressed in real 2021/22 values.
np = estimates not published due to data constraints.

N RDAEP ECONOMIC REPORT

Southern Launch (event date - September 2021)

RDA Eyre Peninsula Region - Economic impact model

$1,084,796 spend. Impact Industry: Air and Space Transport

- *Travel*
- *Meals and Entertainment*
- *Freight and Courier*
- *Operations*
- *Minor Plant & Equipment*
- *Repairs and Maintenance*
- *Labour*
- *Consulting expenses*
- *Hardware sundries*
- *Equipment Hire*
- *Services*
- *Hire vehicles and transport*
- *Accommodation*
- *Fuel*
- *Development Approvals*

Impact Summary

export

RDA Eyre Peninsula Region

Economic measure	Output ($m)	Value-added ($m)	Local jobs	Residents jobs
Starting position RDA Eyre Peninsula Region (year ended June 2020)	--	--	--	--
Air and Space Transport	16.26	6.37	49	56
All industries	4,659.59	2,240.35	24,504	26,308
Impacts on RDA Eyre Peninsula Region economy	--	--	--	--
Direct impact on Air and Space Transport sector	1.08	0.42	3	--
Industrial impact	0.36	0.14	1	--
Consumption impact	0.14	0.06	1	--
Total impact on RDA Eyre Peninsula Region economy	1.58	0.63	6	6
Type 1 multiplier (direct & industrial)	1.34	1.33	1.45	--
Type 2 multiplier (direct, industrial & consumption)	1.46	1.48	1.73	--
Impact on South Australia economy	--	--	--	--
Total impact - South Australia outside RDA Eyre Peninsula Region	0.09	0.04	0	0
Total impact South Australia economy	1.67	0.67	6	6
Impact on Australian economy	--	--	--	--
Total impact outside South Australia economy	0.86	0.39	3	3
Total impact on Australian economy	2.53	1.06	9	9

Source: National Institute of Economic and Industry Research (NIEIR) ©2021. Compiled and presented in economy.id by .id (informed decisions). Note: All $ values are expressed in 2018/19 base year dollar terms.

Impact on Output

The direct addition of $1.1 million annual output in the Air and Space Transport sector of the RDA Eyre Peninsula Region economy would lead to an increase in indirect demand for intermediate goods and services across related industry sectors. These indirect industrial impacts (Type 1) are estimated to be an additional $0.36m in Output, representing a Type 1 Output multiplier of 1.34.

There would be an additional contribution to the RDA Eyre Peninsula Region economy through consumption effects as correspondingly more wages and salaries are spent in the local economy. It is estimated that this would result in a further increase in Output of $0.14m.

The combination of all direct, industrial and consumption effects would result in total estimated rise in Output of $1.58m in the RDA Eyre Peninsula Region economy, representing a Type 2 Output multiplier of 1.46.

These impacts would not be limited to the local economy. Industrial and consumption effects would flow outside the region to the wider Australian economy to the tune of $0.95m in Output.

The combined effect of economic multipliers in the RDA Eyre Peninsula Region and the wider Australian economy is estimated to be $2.53m added to Australia's Output.

Impact on Local Employment (jobs)

The direct addition of $1.1 million annual output in the Air and Space Transport sector of the RDA Eyre Peninsula Region economy is estimated to lead to a corresponding direct addition of 3 jobs in the local Air and Space Transport sector. From this direct expansion in the economy it is anticipated that there would be flow on effects into other related intermediate industries, creating an additional 1 jobs. This represents a Type 1 Employment multiplier of 1.45.

This addition of jobs in the local economy would lead to a corresponding increase in wages and salaries, a proportion of which would be spent on local goods and services, creating a further 1 jobs through consumption impacts.

The combination of all direct, industrial and consumption effects would result in a total estimated increase of 6 jobs located in the RDA Eyre Peninsula Region. This represents a Type 2 Employment multiplier of 1.73.

Employment impacts would not be limited to the local economy. Industrial and consumption effects would flow outside the region to the wider Australian economy creating a further 4 jobs.

The combined effect of economic multipliers in the RDA Eyre Peninsula Region and the wider Australian economy is estimated to be an addition of 9 jobs.

Impact on value added

The direct addition of $1.1 million annual output in the Air and Space Transport sector of the RDA Eyre Peninsula Region economy would lead to a corresponding direct increase in value added of $0.42m. A further $0.14m in value added would be generated from related intermediate industries. These indirect industrial impacts represent a Type 1 value added multiplier of 1.33.

There would be an additional contribution to the RDA Eyre Peninsula Region economy through consumption effects as correspondingly more wages and salaries are spent in the local economy. It is estimated that this would result in a further increase in value added of $0.06m.

The combination of all direct, industrial and consumption effects would result in an estimated addition in value added of $0.63m in the RDA Eyre Peninsula Region economy, representing a Type 2 value added multiplier of 1.48.

These impacts would not be limited to the local economy. Industrial and consumption effects would flow outside the region to the wider Australian economy to the tune of $0.44m in value added.

The combined effect of economic multipliers in the RDA Eyre Peninsula Region and the wider Australian economy is estimated to be $1.06m added to Australia's value added.

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MALCOLM DAVIS PAPER – SOVEREIGN LAUNCH

The Strategic Importance of Sovereign Space Launch in South Australia - FINAL

Dr. Malcolm Davis, Davis Consultancies Pty Ltd

Introduction

The rapid growth of Australia's vibrant commercial space sector in South Australia, has a clear goal towards achieving sovereign space capability. This includes designing and building satellites and establishing space launch capabilities and launch sites as well as ground facilities and promoting the growth of industries for the utilisation of space as a new national resource.

The Whaler's Way Orbital Launch Complex in South Australia, which is being developed by Southern Launch Pty Ltd, based in Adelaide, will be vital for launching small satellites into sun-synchronous orbit (SSO) and polar orbit. These orbits are especially important for space-based earth observation tasks and fit perfectly into the requirements of Australia's defence and national security as it embraces a bolder approach to the space domain. Assuring access to space for the Australian Defence Force (ADF) is now emerging as a vital task, which can only be achieved through establishing sovereign launch capability. A sovereign launch capability also gives Australia a greater ability to burden share in orbit with allies, by augmenting and reconstituting space support in a crisis, and in doing so, strengthening resilience in space. Space technology is inherently dual use so investment in many defence related space capabilities can then support the growth of civil applications downstream, and in doing so, benefit the growth of Australia's commercial space sector.

Space launch can best support development of upstream and downstream activities by being located geographically close to those companies. This gives greater ease of space access and offers higher tempo of innovation. This is the basis of a 'space coast' model, whereby mutually supporting space activities generate sustainable momentum and continued demand for growth. It is this model that has been the basis for the rapid growth of the space sector in Florida, co-located with Cape Canaveral, and which could easily be applied in South Australia. When the needs of defence and national security are brought into this approach, it becomes possible for rapid development and deployment of new defence space capabilities to be achieved, in a manner that allows Australia to better respond to rapidly evolving challenges in a contested space domain.

This paper will make the case that establishing the Whaler's Way Orbital Space Launch Complex, as part of an evolving 'space coast' infrastructure, will make a vital contribution to Australia's rapidly expanding defence and national security missions in space, whilst creating new opportunities for the growth of Australia's commercial space sector, and driving new opportunities to develop civil applications in both upstream and downstream. It will seek to also consider how changing approaches to space access and the evolving nature of small satellite technologies can sustain an increasing role for Whaler's Way, looking forward to 2032.

The Strategic Importance of Whaler's Way Orbital Launch Complex

Assured access to space is vital for Australia's defence and national security given the critical role that it plays in modern joint and integrated military operations. But space is not a sanctuary that is free from competition, and which sits serene and untouched by terrestrial rivalries below. Space is contested as major power adversaries develop a full range of space capabilities, and most worryingly, test and deploy a range of counterspace capabilities that are designed to deny the United States and its allies, including Australia, access to essential space systems.[1]

The contested nature of the space domain has been an important factor that has shaped Australian defence policy since the release of the 2020 Defence Strategic Update and its accompanying Force Structure Plan.[2] It has seen greater prominence in defence thinking on the task of space control, which seeks to assure freedom of action in space and an ability to deny an opponent the ability to interfere in Australia's use of space. More recently, concerns over counterspace capabilities have highlighted the need for assured access to space, including sovereign space launch and resilient space capability. These tasks have received prominence in the 2022 Defence Space Strategy, which states that:

"Assurance of access to space capabilities in a congested, contested and competitive space environment cannot be achieved unless Defence develops a space architecture that is focused on capabilities that are resilient, can be reconstituted if compromised and defended if under attack.'[3]

and then goes on to argue that.

"Defence anticipates it will need access to a responsive and assured space launch capability in the future."[4]

The key message coming from the defence and national security policy community is the importance of assuring space access and resiliency in space. Both requirements are a basis for building sovereign space launch in Australia. The Whaler's Way Orbital Launch Complex will play a key role in supporting the defence and national security requirements of Australia by ensuring space access and boosting space resilience. But as noted later, it will also act as a central element for a vibrant commercial space sector that will establish a southern space coast.

Australia's timely access to space *cannot* be assured through sole reliance on foreign launch providers, in which critical payloads must wait in a distant queue before being launched to orbit. Likewise, dependency on others to provide access to space means that Australia's ability to augment existing space capability or reconstitute lost capability, would be dependent on the availability of a launch slot provided by the launching state, or the willingness of that state in a crisis to support Australian urgent requirements. Finally, apart from Wallops Island and Vandenberg Air Force Base in the United States, no foreign launch site is as geographically well placed to launch small satellites to SSO and polar orbit as that which exists at Whaler's Way.[5] All other polar orbit and SSO launch sites are thousands of kilometres distant from Australia's upstream and downstream commercial space industry, making the establishment of sovereign launch capability in Australia highly beneficial to that rapidly growing industry.

The importance of SSO and polar orbits for defence and national security purposes needs to be explained. In terms of Sun Synchronous Orbit, this is a particular type of polar orbit, where a satellite matches its orbital motion to be synchronous with the Sun.[6] This means that the satellite will always orbit over the same location on Earth at the same time each day. For defence purposes, the benefits of this are obvious, particularly for geo-intelligence roles, such as that envisaged to be undertaken by the Australian Geospatial Organisation (AGO) through Project DEF-799 Phase 2.[7] A constellation of small satellites in SSO could allow for daily monitoring of military activity in Australia's critical maritime and air approaches, and provide for innovative new approaches to emerging tasks such as defence against hypersonic missile technologies.[8] Polar orbit satellites move in a circular orbit from pole to pole, and as the Earth rotates below, a polar-orbit satellite can image the entire planet twice in a twenty-four-hour period. For defence purposes, this is highly useful for mapping and geodesy, broad area intelligence, reconnaissance and surveillance, and weather observation.

Therefore, by developing the Whaler's Way Orbital Launch Complex, Australia will enjoy a highly advantageous sovereign assured space access capability suitable for deploying micro and small satellite payloads to SSO and polar orbit. This contributes directly towards Defence's requirement for supporting several important space capabilities critical to understanding military developments in Australia's strategic neighbourhood, including the vital provision of geospatial information. Most importantly, Australia would have complete end-to-end sovereign control over its defence space capabilities, from development and manufacturing to launch through to on-orbit operations.

The Whaler's Way Orbital Launch Complex would open new opportunities for Australia's emerging commercial space sector, including small to medium enterprises and 'space start-ups' based in South Australia, to be much more competitive in winning contracts for future defence projects. Rather than Defence being wedded to major overseas primes to provide large, complex and expensive satellites, and potentially waiting years to see such satellites launched from overseas, it can directly approach the commercial space sector to develop innovative new capabilities based around constellations of small satellites, and with the establishment of sovereign space launch via the Whaler's Way Orbital Launch Complex, see such satellites developed and launched relatively quickly.

That means Australia is better placed to successfully compete in a rapidly growing global space sector that is increasingly driven by commercial innovation and 'space 2.0' business models.[9] We become an agile and forward focused actor that is a technology leader, rather than one which merely reacts to breakthroughs by others – and then waits on an opportunity to join an available launch queue of a foreign partner.

Sovereign launch from the Whaler's Way Orbital Launch Complex also gives Australia much greater opportunity to ensure *resilient* space capabilities that are vital in a more contested space domain, and which better contributes towards establishing credible *deterrence in space* against emerging counterspace threats. This is a means for Australia to directly burden share with allies in orbit to a much greater degree than has been done in the past. Australia already shares vital space domain awareness activities with the United States and other five-eyes partners and this role will grow as a national space surveillance network is established under defence project JP-9360.[10] These important activities contribute towards awareness of threats from adversary space activities, and the challenge posed by space debris in a congested space domain.

However, by establishing sovereign space launch, this gives Australia the ability to do more, by directly augmenting ADF and allied space capabilities in a crisis, as well as reconstituting capability lost either through adversary counterspace operations, or space debris incidents in a rapid and timely manner. By taking this step, it ensures Australian and allied space support can be sustained, whilst denying an adversary the chance to carry out a successful decisive counterspace attack, in what is often referred to as a 'space pearl harbour' scenario.[11] The Whaler's Way Orbital Launch Complex can therefore directly contribute in a very meaningful way to building both resilience and comprehensive deterrence by denial in orbit and thus reducing the chance of warfare in space.

With these factors in mind, the case for sovereign launch from South Australia, via the Whaler's Way Orbital Launch Complex provides a valuable opportunity to extend the state's leading role in space. It directly contributes to meeting the growing needs of Defence in space, especially in a manner that looks beyond large satellites, or which complements those capabilities to enhance ADF operational capability.

Thinking about a 'southern space coast' and the role of Whaler's Way Orbital Launch Complex

A vital requirement of establishing the Whaler's Way Orbital Space Launch Complex is to deepen opportunities for growing Australia's commercial space sector, through stimulating the growth of upstream activities. The geographic proximity of the launch site to Port Lincoln, with access to rapid air links to Adelaide, means that even if the two locations are geographically separated, they can be seen to be part of a wider 'southern space coast' concept.

However, it's not just about geographic proximity. Whaler's Way Orbital Launch Complex needs to become a central focus for upstream industries including rocket and satellite manufacture, whilst being developed in a manner that reduces supply chain lengths and opens potential for future development of the Whaler's Way site to establish supporting services close to the launch site. The establishment of a space coast approach would also provide greater opportunity and support to downstream industries, such as those which are developing new ways to fully utilise space support, not just for defence and national security, but also for commercial and civil applications. An agile and rapid innovation cycle is of key importance, and geographic proximity for commercial space companies in Adelaide to a dedicated launch site dramatically enhances their flexibility to develop new capabilities, whilst reducing cost, complexity and most importantly, project timelines.

The benefits of satellite development and manufacture being co-located with the Whaler's Way Orbital Launch would see commercial growth stimulated in related areas such as payload checkout and integration, range safety and tracking, as well as satellite operations in the downstream context. In a submission to the House of Representatives Standing Committee on Industry, Innovation, Science and Resources, leaders of Australia's launch providers stated in a submission that:

"Ultimately, the launch industry attracts and enables investment in, and development of, satellite manufacture, satellite mission control and other space related downstream industries. This is due to modern satellite companies wanting to reduce their supply chain lengths and position their manufacturing hubs as close to the launch infrastructure as practical, to reduce overall logistics costs and transportation timelines."[12]

This is consistent with the key defence objective of assured access to space. Establishing sovereign launch capability in a location close to satellite manufacture as well as other key services including payload integration, *assures* access to space to a far greater degree and in a much timelier manner than what would be possible through dependency on distant foreign partners. With government now increasingly supportive of sovereign launch, it makes much more sense to maximize the benefit of co-locating launch and other elements of the commercial space sector, especially those now flourishing in Adelaide.

Such an approach will attract further investment from new Australian companies, as well as foreign partners wishing to benefit from Australia's advantageous access to superior launch sites and short supply chains between launch, satellite development and downstream activities. This can generate a degree of self-sustaining momentum that draws in more investment and creates additional opportunities for job growth and an increasingly prosperous sector. It is this approach that generates a southern space coast centered around Whaler's Way Orbital Launch Complex and extending to Adelaide's vibrant commercial space sector at Lot 14 and the Australian Space Park.[13]

The key to making this approach work is building space activity around short supply chains. Keeping supply chains short accelerates innovation and growth and generates new opportunities for future

development of Australia's commercial space sector. This is beneficial from the vantage point of defence and national security decisionmakers as well. A space coast approach that makes full use of the Australian commercial space sector, including for launch, reduces the risk that key defence space capability development would be delayed even as our strategic environment deteriorates rapidly. A space coast that is built around co-located commercial enterprises allows sovereign space capability development in an end-to-end approach. That in turn allows local companies to gain experience such that over time, risk is reduced, and companies can offer more ambitious space capabilities to Defence. The result is that Defence has greater flexibility in providing solutions via small satellite technologies, that can be developed quickly and launched from Whaler's Way Orbital Launch Complex.

The establishment of sovereign launch from the Whaler's Way Orbital Launch Site will also draw in overseas companies to set up operations in Adelaide, rather than manufacture satellites thousands of kilometers from the launch site. Mr. Richard Price, CEO of the South Australian Space Industry Centre, stated in 2021:

"…if we don't have a solid launch base, we're not going to have any business case that makes sense to manufacture satellites in volume. Why would anybody manufacture satellites thousands of kilometers away from their launch site…? So, if we want to unlock a manufacturing base here for satellites, we naturally need to launch them here, if we want to do it in volume. That connection is critical."[14]

That observation is relevant both for Australian upstream industries seeking to launch satellites into SSO and polar orbit missions, and foreign partners seeking to access those same orbits. For overseas commercial space companies wishing to access these orbits, launching from Whaler's Way makes sense – which in turn demands establishing local manufacturing of both launch vehicles and payloads to avoid distant supply chains. An example of this is ATSpace, a partner in the Australian Space Park, is developing 3D printed rocket engines that would power the TiSpace Hapith V launch vehicle, is seeking a permit to launch from Whaler's Way.[15] The establishment of the Australian Defence Industry Space Capability Alliance (ADISCA) in March 2022 opens up a consortium of Australian owned space and defence companies that can act as an Australian defence prime, and make full use of a southern space coast for the launching of Australian space capabilities for defence and national security purposes.[16] This would support growth of the commercial space sector, and encourage development of upstream and downstream industry opportunities.

In summary, the establishment of Whaler's Way Orbital Launch Complex should be seen as the centrepiece of a rapidly emerging southern space coast, that will grow in sophistication and scope in coming years. The co-location of Whaler's Way to Adelaide's growing commercial space sector enhances opportunities to take on bolder and more ambitious goals for Australia in space, including for defence and national security purposes. It's useful to briefly consider how the role of Whaler's Way may evolve over the next ten years.

Looking ahead to a future space coast

Looking ahead, there are three potential developments that could drive future growth of the Whaler's Way Orbital Launch Complex and an associated southern space coast.

Firstly, the development of satellite megaconstellations opens new opportunities for Australian small satellite manufactures and associated launch providers to develop, deploy and operate large numbers of small satellites in LEO. Megaconstellations could typically see thousands of small satellites providing a range of terrestrial services, from 'broad band in the sky' including data networks to the 'internet of things', to advanced earth observation capabilities. The role of megaconstellations also has application for defence and national security, in terms of networked battle management, advanced logistics, and enabling widespread use of autonomous systems.

Secondly, if satellites are to be launched in significant numbers, as would be implied in the establishment of satellite megaconstellations, then development of small reusable launch vehicles may become economically viable. Current reusable launch vehicles such as the SpaceX Falcon 9 and the proposed Rocket Lab Neutron, are designed for larger payloads in comparison with that anticipated to be launching from Whaler's Way. However smaller reusable launch vehicles become more viable if the demand for small satellite launch increases. The main advantage of reusable launch is that providing there is sufficient demand for lift – as would be the case in any Australian move to exploit small satellites and megaconstellations – the cost of launch falls dramatically, whilst the operational tempo of launch increases.

Thirdly, the development and manufacture of small satellites and small launch vehicles are increasingly utilizing fourth industrial revolution ('4IR') techniques such as additive manufacturing, digital design, and synthetic testing to accelerate the design and manufacturing process. This trend will continue, and the applications of these technologies will enable greater ability to exploit fast innovation cycles, further accelerating the acquisition of new space technology in a way that opens new upstream and downstream applications of Australia's commercial space sector, including for defence and national security realms.

Bringing these three themes together, suggests a more rapid and innovative approach to space in the coming decade, in which the 'small, cheap and many' outpace and outperform traditional approaches towards large and complex, and expensive, satellites. In this sense, the Whaler's Way Orbital Launch Complex is ideally suited to exploit these trends, and uniquely positioned to support the needs of Australia's flourishing upstream community, and the ever more important requirements of Defence.

Conclusions

The Whaler's Way Orbital Launch Complex is well positioned to directly support the growth of Australia's commercial space sector, including upstream activity such as satellite design and manufacture, and launch vehicle development. Its geographic location makes it ideal for launching payloads into SSO and polar orbits, which are important for the needs of defence and national security. Furthermore, establishing Whaler's Way as a central element of Australia's commercial space sector will generate the prospect for a southern space coast that could see the rapid expansion and growth of commercial upstream and downstream activities, and entice foreign partners to contribute to this growth. The likely developments in future space technology, notably, satellite megaconstellations and the transformational impact of reusable launch, together with '4IR' manufacturing techniques, imply rapid growth of Australia's commercial space sector, with sovereign launch, including at Whaler's Way, being a key component of that growth over the next ten years.

[1]Brian Weeden, Victoria Sampson, Global Counterspace Capabilities – An Open Source Assessment, 2022, at https://swfound.org/counterspace/ ; see also US Defense Intelligence Agency, Challenges to Security in Space – Space Reliance in an Era of Competition and Expansion, 2022, at https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf

[2] Department of Defence, 2020 Defence Strategic Update, 3.21 – 3.24, 2020; 2020 Force Structure Plan, 6.1 – 6.9.

[3] Department of Defence, Australia's Defence Space Strategy, 2022, p. 17

[4] Department of Defence, op cit.

[5] Malcolm Davis, 'Australia one step closer to a sovereign launch capability', *The Strategist*, 15th October 2020, at https://www.aspistrategist.org.au/australia-one-step-closer-to-a-sovereign-launch-capability/

[6] European Space Agency, 'Polar and Sun-synchronous orbit', 2020, at https://www.esa.int/ESA_Multimedia/Images/2020/03/Polar_and_Sun-synchronous_orbit

[7] Department of Defence, Defence Project 799, at https://defence.gov.au/AGO/library/DEF_799_Enhanced_Satellite_ISR_Capability.pdf ; see also Malcolm Davis, 'Force's bold launch into space projects', *The Australian*, February 25th 2019, at https://www.theaustralian.com.au/national-affairs/defence/australia-must-be-a-space-power/news-story/5b3de8002129fe29d1c207446859adc6

[8] Malcolm Davis, 'Australia needs new early warning capability to counter threat from China's new missiles', *The Strategist*, 21st December 2021, at https://www.aspistrategist.org.au/australia-needs-new-early-warning-capability-to-counter-threat-from-chinas-new-missiles/

[9] Malcolm Davis, 'Space 2.0 – enabling war in space?', *The Strategist*, 9th May 2019, at https://www.aspistrategist.org.au/space-2-0-enabling-war-in-space/

[10] Malcolm Davis, 'Keep looking up: Australia's next steps in space surveillance', *The Strategist*, 2nd March 2022, at https://www.aspistrategist.org.au/keep-looking-up-australias-next-steps-in-space-surveillance/

[11] Malcolm Davis, The Australian Defence Force and contested space, 15th August 2019, at https://www.aspi.org.au/report/australian-defence-force-and-contested-space

[12] Lloyd Damp, Submission 50, The Now Frontier: Developing Australia's Space Industry, House of Representatives Standing Committee on Industry, Innovation, Science and Resources, November 2021, p. 89-90

[13] South Australian Space Industry Centre, 'Australian Space Park', https://sasic.sa.gov.au/precinctsprojects/australian-space-park/

[14] Richard Price, South Australian Space Industry Centre, The Now Frontier: Developing Australia's Space Industry, House of Representatives Standing Committee on Industry, Innovation, Science and Resources, November 2021, p. 95.

[15] ATSpace, 'Kestrel', https://atspace.com.au/Kestrel.html; see also 'TiSpace', https://www.tispace.com/; and 'Commercial rocket launch permit granted for South Australia', https://drive.google.com/file/d/1Inc1E_XwmMwxBmtv9IPUMij6lS5kykCK/view

[16] Australian Defence Industry Space Capability Alliance, https://www.adisca.com.au/

P FISHING AND SEAFOOD INDUSTRY LETTERS OF SUPPORT

9 November 2021

Mike Damp
Southern Launch
mike.damp@southernlaunch.space

Dear Mike

I write to you on behalf of the Spencer Gulf and West Coast Prawn Fishermen's Association (the Association). We would like to acknowledge receipt of a recent draft submission paper you have prepared for AMSA. The paper outlines Southern Launch Space Pty Ltd's (Southern Launch) liaison and communication protocols with the aviation and fishing industries that it will invariably interact with as part of its launch activities in the maritime area south of the Lower Eyre Peninsula.

Of relevance to the Association is Southern Launch's collaboration with the fishing industry. The Association would like to recognise the procedures implemented in the lead up and during the recent launch attempts in September 2021. The communication and liaison with the industry was thorough and effective. Based on this experience the Association is supportive of the following arrangement as a standard protocol to ensure minimal disruption to fishing activities and the safety of our industry members.

Southern Launch Space Pty Ltd will fully communicate with AMSA and Tumby Bay Volunteer Marine Rescue coastal radio network, all sectors of the Port Lincoln fishing industry and South Australian Research and Development Institute.

1. Communication will include the date and duration of the proposed launch window, the nominal flight trajectory of the rocket and the isopleths of the drop zones.
2. AMSA will distribute a Notice to Mariners, which is a familiar and official form of communication with fishers.
3. An advertisement to be placed in the local media no more than 10 days, or less than two days, preceding each launch window opening, or as specified under the *Space (Launches and Returns) Act 2018*. These notices will be issued through:
    - 5CC
    - Port Lincoln Times
    - Australian Broadcasting Corporation
    - Southern Launch's Facebook and LinkedIn accounts.
    - AMSA through RCC issuing a Notice to Mariners

4. Communication will occur with the fishing industry executive officers three days prior to the launch following the BOM weather report to enable fishing vessels to move away form an affected fishing locality if required.
5. Contact will again be made with the fishing industry executive officers 1 day prior to the launch attempt to obtain an indication of the movement of fishing vessels from the relevant sectors.
6. On the day of the launch, if there are vessels in the launch area, Southern Launch will monitor AIS data and forward predict the vessel's position at the time of launch. Southern Launch's area controller will contact the Joint Rescue Coordination Centre and request they contact the identified vessel and notify them of the pending launch if required.
7. Broadcast a security call on VHF Radio Channel 16 and 18 notifying of each proposed launch event no less than 30 minutes prior to planned lift off and cancel the call after the area is clear of danger.

The Association will endeavour to provide timely and precise information to assist with the required safety procedures and communication, to enable Southern Launch Space Pty Ltd to conduct its launch activities. The Association looks forward to a continued open dialogue with the relevant company representatives.

Yours sincerely

Kelly Pyke-Tape
Executive Officer

PO Box 8, Port Lincoln, South Australia, 5606
P: 08 8682 1859
E: admin@prawnassociation.com.au

SARDI

SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Government of South Australia

Department of Primary Industries and Regions

South Australian Aquatic Sciences Centre
2 Hamra Avenue
West Beach SA 5024
Correspondence
PO Box 120
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Developing South Australian Research and Innovation

13 December 2021

Mike Damp
Southern Launch
Level 8, 70 Pirie Street
ADELAIDE SA 5000
Mike.damp@southernlaunch.space

Dear Mike,

Letter of Support

The South Australian Research and Development Institute (SARDI), the research arm of South Australia's Department of Primary Industries and Regions (PIRSA), undertakes research activity to support the sustainable development of the State's seafood industry. SARDI staff routinely undertake field-based research along South Australia's extensive coastline on research and industry vessels, as well as engaging on-site with land and sea-based aquaculture industries in the regions. The safety of SARDI staff, stakeholders and community is our highest priority, so understanding the activities of Southern Launch will be an important consideration in maintaining our focus on a safe working environment. SARDI Aquatic Sciences supports Southern Launch's communication strategy as forwarded.

Yours sincerely,

Dr Mike Steer
Research Director
SARDI Aquatic and Livestock Sciences

AUSTRALIAN SOUTHERN BLUEFIN TUNA
INDUSTRY ASSOCIATION LTD (ASBTIA)

3 November 2021

Mr Lloyd Damp
Chief Executive Officer
Southern Launch Space Pty Ltd
Level 8, 70 Pirie St
Adelaide SA 5000

Dear Lloyd

Collaboration on operating protocols

I again confirm the tuna industry's general support for SL's developments on Eyre Peninsula.

I also confirm that the exchange of letters on the draft air and sea protocols reflects our agreement to those protocols. These protocols are based on the principle of informed risk for all Parties.

We agree that the next step is to turn those draft protocols into formal proposals to CASA and AMSA to underpin our agreement.

Further discussions with ASBTIA should remain through Craig Hughes who will be responsible for having them ratified by the ASBTIA Executive Committee before submission to CASA and AMSA.

Brian Jeffriess
CEO – Australian SBT Industry Association
PO Box 1146
Port Lincoln SA 5606
Ph: 0419840299 E. austuna@bigpond.com

South Australian Sardine Industry Association Inc.

Mr Lloyd Damp
Chief Executive Officer
Fisheries and Aquaculture
Southern Launch Space Pty Ltd
Level 8
70 Pirie St
Adelaide 5000

PO Box 2909
Port Lincoln SA 5606

CERTIFIED SUSTAINABLE SEAFOOD MSC www.msc.org

Dear Lloyd

Re: Collaboration with the SA Sardine Industry

Consistent with recent correspondence received by you from the Australian Southern Bluefin Tuna Industry Association (ASBTIA), I write you to confirm that the concept of “informed risk” operational protocols is further supported by the members of the South Australian Sardine Industry Association (SASIA).

SASIA also agrees that these protocols should now progress formally to ensure support and adoption is achieved from both the Civil Aviation Safety Authority (CASA) and the Australian Maritime Safety Authority (AMSA).

SASIA maintains a close affiliation with ASBTIA and will continue to communicate with Mr. Craig Hughes on this matter to ensure both the Fishing and Space Industries can operate collaboratively in the future and ensure minimal disruption to our respective Industries.

We wish you and your team at Southern Launch all the best with your project.

Paul Watson

Executive Officer
South Australian
Sardine Industry Assoc. Inc. (SASIA)
Mob. 0429 830776
eo@sasardines.com.au

Sean Kalling
President
SASIA

Dr. Daryl Evans
Vice President
SASIA

ABALONE INDUSTRY ASSOCIATION OF SOUTH AUSTRALIA Inc.

Working for a Sustainable Future

31 05 2022

Mike Damp, Southern Launch

Dear Mike,

RE: Southern Launch's proposed collaboration with the Abalone Industry Association of South Australia (Feb 2022)

Thank you for the proposal put forward to the Abalone Industry Association of South Australia (AIASA) (Feb 2022) regarding Southern Launch's proposed collaboration. Industry appreciate receiving your formal document, following our discussions, with information regarding Southern Launch's proposal as it relates specifically to our Industry.

AIASA supports the notion of sharing the coastal maritime area so that abalone harvesting can continue with minimal disruption. AIASA also supports the overall objective to establish a clear reciprocal communication system.

For more than 50 years, our wild-catch Industry has used a 'rotational' method of sustainably harvesting abalone, which is where divers fish successive reefs in each year thereby allowing reefs to recover. The Fishery Bay area (largely comprising Southern Launch's proposed exclusion zone) produces at least 2.2 tonnes annually (6.6 tonne whole weight) of high quality Greenlip and Blacklip abalone harvested by our Industry (SARDI et al 2019), with an approximate value of $500,000.

Restricting the available area to fish will impact on the ability to rotate between reefs and will have implications for the sustainability of the fishery. We are seriously concerned that the "reasonable balance" between this development and reduced access to this valuable abalone growing area for commercial fishers will be significantly disrupted and cause disorder to the sustainable rotation harvest equilibrium.

With regard to this particular proposal, the following concerns were raised:

- Recognition that AIASA are primary stakeholders, as part of the commercial wild catch Industry is imperative, as wild-catch and aquaculture Industries operate in a different landscapes (eg. aquaculture has 'security' over access and stock). Southern Launch need to amend in the first paragraph of the proposal - our Industry are wild catch not aquaculture as described.

- Due to the nature of Abalone operations (restrictions and limitations) in the area....

  > **Southern Launch is mindful of the numerous restrictions** (not limited to weather and sea conditions, geographic location of suitable ocean bottom topography and seasonal availability of abalone stock) placed on the Abalone Industry and is also aware of **the logistical impediments** (beach launching and decompression times related to depth of dives etc) **that effect and limit the harvesting periods during the abalone fishing season.**
  >
  > Additionally, **Southern Launch recognises that the coastline adjacent to and immediately alongside the eastern and western boundaries of our envisaged orbital launch complex are prime habitat for both Greenlip and Blacklip abalone**.

  M.Damp, 17/11/2021 in the first reiteration of this proposal. The text has been removed from the final version. ?

  Our industry members cannot operate, on a launch day, in the area. It is not simply a matter of moving out of the restricted zone for a short period of time, as suggested by Southern Launch in the current proposal (7/2/21).

  > It is envisaged that abalone harvesters would only have to exit the one-in-a-million hazard zone when the rocket is fuelled on the launch pad ready for launch and they could **re-enter the zone immediately after launch** when it is safe to do so.

Southern Launch are familiar with the nature of Abalone operations; on a day of a launch, commercial abalone dive teams will not be able to operate in the area (due to the introduction of exclusion zones). Southern Launch need to amend the proposal to acknowledge this.

- The proposed '*conditions'* (our members are expected to agree to) in order to have access to the area covering the Aquatics Activity Licence Area and the Marine Safety Exclusion Zone (MSEZ) including:
    - Southern Launch's expectation of AIASA members to accept a "personal acceptance of risk", founded on Southern Launch's models, which are based on a single person (not vessel).

      ….various industry stakeholders are **cognisant of the risks associated** with operating in a shared environment
    - The power of decisions that can be made by Southern Launches Area Controller, (i.e. indicative agreements) without independent authority/monitoring

      If an operator wishes to harvest within the area covered by the Aquatics Activity License, but remain outside the MSEZ, they could do so following clearance from the **Area Controller on an informed consent basis.**

  Before proceeding AIASA seeks clarification and reassurance from Southern Launch regarding who has legal responsibilities if/when an "Incident /hazard" occurs?

Our Industry launches vessels from Fishery Bay Beach on average 20-30 days per year to harvest abalone from the surrounding areas (PIRSA DCR records). Whilst Southern Launch recognise the necessity of sharing the coastal maritime area so that abalone harvesting can continue with minimal disruption on one of these fishing days, what this actually means in real terms, is minimal disruption = loss of use (a fishing day in the area). In the short-term the sporadic interruption will have a negative impact on commercial abalone harvesting and in long term, if there is frequent disruption, may have a deleterious impact and cause disorder to the sustainable rotation harvest equilibrium. Fair and reasonable compensation must be considered if access is significantly diminished.

In principle AIASA supports ongoing collaboration with Southern Launch, however reiterate the need for testing the proposed communication system prior to any launch. We wish to continue to be involved in discussions regarding the development/testing of this system ensuring information relevant to launch activity can be accurately and rapidly disseminated to the Abalone Industry members.

Given that this project is progressing though the PlanSA pathway, we plan on forwarding our response/position to the government departments, next week. We look forward to ongoing communications on this matter.

Kind Regards

Dr Nicole Hancox & Thomas McNab
Abalone Industry Association of South Australia Inc.

Q ISSUES MATRIX

ISSUE	RESPONSE DOCUMENT SECTION REFERENCE
Access restrictions beach, site	Section 13.2.3
Air Pollution	Section 12.1
Australian Sea Lion	Section 5.0
Biodiversity loss	Section 4.0, 5.0, 6.0
Bore Water Details	Section 9.2
Bushfire Risk	Section 10.2
Chemical toxic fallout from launch	Section 12.0, 12.2, 12.2
Clean Green image impact	Section 12.1.3.2, 13.2
Climate Change Impacts	Section 12.1.3.2
Coastal Erosion	Section 4.20, 10.3
Conflict of interest with Mayor	N/A
Credibility of bird experts	Section 4.0, 6.0
Cultural Heritage Impacts	Section 14
Cycling Safety	Section 9.1.5
Diesel vs renewable energy for site	Section 2.4
Eastern Osprey	Section 6.0
Economic generation issues (jobs etc)	Section 13.0
Emergency Services Use as a private company	Section 10
Endangered Species	Section 4.0, 5.0
Environmental Damage	Section 12.0
Exclusion Zone Management	Section 2.3.4, 2.5.6, 2.5.7, 13.3
Fishing/seafood industry impact	Section 13.4
Greenhouse Gas 1.6% of SA annually	Section 12.1.3.2
Habitat Loss	Section 4.6
Hearing loss - animals	Section 4.15
Heritage Agreement Concern	Section 7.0
inadequate wind modelling	Section 12.0
Inconsistent with Zone	Section 15.0
Introduced species risk	Section 8.0
Lack of adequate disaster response plan	Section 10.0
Landscape quality assessment and visual impact assessment	Section 11

ISSUE	RESPONSE DOCUMENT SECTION REFERENCE
Livestock spooking	Section 2.5
Local Community Negative Impact	Section 13.0
Long Nose Fur Seal	Section 5.0
Marine Park Concern	Section 5.0
Military target concern	Section 16
Native Vegetation Impact	Section 4.0, 7.0
Noise and Vibration	Section 3.0, 4.15
Ocean Dumping	Section 12.3
Other Fauna Species Impacts	Section 4.0, 5.0, 6.0
Pointy Nosed Seals	Section 5.0
Privacy	Section 11, 13.2.3
Public access	Section 13.2.3
Raptor assessment qualifications	Section 6.0
Roadkill	Section 4.8
Shipping Lane impact	Section 13.3
Southern Emu Wren	Section 4.0
Southern Right Whale	Section 5.0
Space junk Management	N/A
Tests should be concluded prior to the application proceeding	Section 3.5.10
Tourism negative impacts	Section 13.2
Traffic Impact Heavy vehicles, increase - safety, maintenance including school bus route	Section 9.1
Transparency - redacted reports	N/A
Water Supply use and water contamination (town water used for the facility)	Section 9.2, 12.2
Western Whipbird	Section 4.0
White Bellied Sea Eagle	Section 6.0